CLEAPSS

Supporting practical science and technology
in schools and colleges

HAZCARDS

2016 Edition (Updated 11/18)

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CLEAPSS

- **Read these *Hazcards* in conjunction with *About Hazcards* (Guide GL 120).**

  About Hazcards provides guidance for interpreting and using *Hazcards* (CLP 2016 Edition and later updates). References and links to more-detailed guidance on the CLEAPSS website are also provided where appropriate.

- **See also *Hazcards Index* (GL 121).**

  Chemicals are listed in this index by their systematic names and/or by their commonly used alternative names. The date of the most recent *Hazcard* update is given in the *Index*.

***Hazcards, About Hazcards* (GL 120) and *Hazcards Index* (GL 121) are working documents and will be subject to frequent changes.**

Always check for latest versions at www.cleapss.org.uk.

Emergency Hazcard (E1a)

Dealing with an incident (general strategy)

Assess, prioritise and then act quickly

Do not put yourself or others in danger

ASSESS

- Hazards
- Injuries

Situation is safe to deal with (or can be made safe)

- Minimal risk of further harm occurring.
- You have the expertise and resources.

Situation is NOT safe to deal with (or becomes unsafe)

- Evident risk of further harm occurring.
- You do **NOT** have the expertise or resources.

RESPOND

Possible actions (prioritise as required)

- Send for assistance as required.
- Take steps to maintain safety:
  → isolate, secure, contain, ventilate, shut off ignition/fuel sources …
- Treat **CASUALTIES** as quickly as possible.
- Deal with **fire**, **spill** or **gas escape**.
- Continually monitor and re-assess.

Possible actions (prioritise as required)

- Move to a safe area and/or evacuate.
- Send for specialist assistance as required.
- If necessary and safe to do so:
  → ventilate area and shut off ignition/fuel sources but do **not** delay evacuation.
- Treat **CASUALTIES** as quickly as possible.
- Secure the area. Inform others.

FIRE / SPILL (includes gas release), see card E1b

Treat CASUALTIES as quickly as possible

- Apply **IRM**.
- Call for assistance if needed but do **NOT** delay **IRM**.

IRM, see cards E2a & E2b

MANAGE

- **Follow school procedures for managing incidents, contacting parents/guardians and record keeping.**
- **After the incident: RECORD, REPORT, REVIEW and UPDATE procedures if necessary.**

Read this E-*Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Emergency Hazcard (E1b) FIRE and SPILLS

FIRE

- **NOT SAFE TO DEAL WITH →** Evacuate & isolate area. Call the Fire & Rescue service (FRS) on 999.
- **SAFE TO DEAL WITH →** Cut off ignition/fuel sources (if possible without causing a spark). Extinguish flames.

SPILL

- **NOT SAFE TO DEAL WITH →** Isolate/secure spill area.

  Call CLEAPSS for advice or, in extreme cases, call the Fire & Rescue Service (FRS) on 999.

- **SAFE TO DEAL WITH**:
  - ○ Check *Hazcard*. Wear correct PPE. Maintain safety.
  - ○ Contain, collect and treat spill. Clean spill area. Dispose of treated spill.
  - ○ Clean up. Ensure all contaminated equipment is cleaned. Check own clothes/skin. Wash thoroughly.

ASSESS → **CONTAIN** → **COLLECT** → **TREAT** → **DISPOSE**

Calling the Fire & Rescue Service (FRS)

In an emergency involving fire, chemical spill or vapour/gas release, where either life is at risk or a noxious or flammable substance is escaping uncontrollably, the FRS should be called via 999 (inform the school's Senior Leadership Team).

It is useful for the FRS to know, preferably at the point of call if possible without delaying the call:-

1. The identity of the chemical(s) involved.
2. How the chemical is contained (or if it is not).
3. The quantity involved.
4. Any hazard information that is available without delaying the process.

Arrange for someone who knows about the situation/hazards to talk to the 999 operator and, if required, to meet the FRS crew on their arrival.

Note: If the incident does not require immediate action but involves the spill/release of a chemical that may require specialist equipment, call the FRS but stress that the incident is contained and will not escalate.

Read this E-*Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Emergency Hazcard (E2a) Immediate Response Measures (IRM)

IRM Immediate Response Measures: ALL staff in the science department (including technicians and other support staff) should be familiar with and trained to carry out these response measures; speed is essential.

In the event of an incident:

- **Immediately begin applying the measures below and/or on Emergency *Hazcard* 2b. Call a First Aider to continue treatment.**
- **If necessary, call the emergency services (999 or 111).**
- **Keep the casualty as still as possible. Look out for signs of shock or developing unconsciousness.**
- **Follow school procedures for managing incidents, contacting parents/guardians and record keeping.**
- **Call the CLEAPSS *Helpline* (01895 251 496) for further advice if required.**

Non-chemical emergencies requiring IRM

Hair and/or clothing on fire	**STOP, DROP & ROLL**. Stop casualty moving around. Drop casualty gently to the floor. Wrap flames tightly in a fire blanket (or other non-flammable material) OR roll casualty to smother flames. Treat for burns.
Burns	**COOL.** Cool the burn by immediately irrigating with gently running water for at least 10 minutes and until pain is relieved and heat is no longer felt.
Severe cuts	**CONTROL BLEEDING**. Ask casualty to apply pressure to the wound using sterile pads, cloths or fingers. Raise wound as high as possible. Lower casualty gently to floor. Do **not** remove embedded objects; apply pressure around them. Protect yourself from contamination.
Asthma attack **Anaphylactic shock**	**SUPPORT & PROTECT**. Follow the school's agreed procedures. Help the casualty to access and use their medication, in accordance with your training.
Fainting **Epileptic fit** **Unconsciousness**	**SUPPORT & PROTECT**. Lower casualty gently to floor if they are losing consciousness. Make the area safe to protect casualty from further injury. If unconscious, place casualty in recovery position. If regaining consciousness, lay casualty on floor and raise their legs.
Electric shock	**ISOLATE FROM SUPPLY**. If safe: break circuit by switching off or pulling out plug. If not safe: use an insulator (eg, wooden broom handle, rubber gloves) to remove casualty from the circuit. Call 999.

Read this E-*Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Emergency Hazcard (E2b) Immediate Response Measures (IRM) - continued

IRM If someone has been exposed to a chemical (eg, in eyes, on skin, inhaled or ingested), do **not** delay IRM. Check *Hazcard* for additional information; some chemicals present specific problems that may require extra measures.

Chemical emergencies requiring IRM, follow the advice below **Check *Hazcard* for additional information**

Chemical is …	**Immediate response and accompanying action**		**Notes**
.. in the eye	**IRRIGATE** (More than 10 mins)	▪ If severe symptoms apparent (eg, pain, blindness, redness), call 999. ▪ In **all** other cases, call 111. ▪ **Continue irrigation** in all cases until attention/advice is obtained from qualified medical staff.	Eye damage may occur even in the absence of symptoms. **Always** get a qualified medical assessment.
.. in the mouth (may/may not have been ingested)	**RINSE** and **SPIT**	▪ If severe symptoms apparent (eg, blistering, breathing problems, swelling), call 999. ▪ Even if minimal/no symptoms, call 111.	Do **not** swallow/drink any liquid. Do **not** induce vomiting.
.. inhaled (gas/vapour/dust)	**MOVE TO FRESH AIR** (Sit down/support)	▪ If severe symptoms apparent (eg, drowsiness, breathing problems, nausea), call 999. ▪ Even if minimal/no symptoms, call 111.	Evacuate and/or ventilate the area if necessary. Beware: Some chemicals have delayed effects.
.. on the skin	**IRRIGATE** (More than 10 mins)	▪ If severe symptoms apparent, call 999. ▪ In all other cases, call 111. ▪ Do **not** apply any 'neutralising' chemicals. **Continue irrigation** until attention/advice is obtained from qualified medical staff.	Wipe/brush off excess but do **not** delay irrigation. Remove any contaminated and/or restricting clothing or jewellery *while irrigating*.

Calling 999 or 111. Be ready to give the information below. **Have *Hazcard* to hand & send with casualty if necessary.**

- **chemical** (name, concentration, etc)
- **signs or symptoms apparent**
- **how exposed, for how long, when**
- **IRM already applied**
- **who exposed** (age/gender)
- **any known pre-existing medical conditions**

1 Risk Assessment Guidance

Aluminium

Aluminium powder Al (26.98)

DANGER

Flammable solid [H228]. In contact with water releases flammable gases [H261].

Aluminium powder is dangerous in contact with:

- WATER. Under very hot conditions, hydrogen is formed. ACIDS and ALKALIS. Hydrogen is formed.
- ALCOHOLS. Violent reactions occur after a lengthy induction period.
- HALOGENS, ORGANOHALOGENS. SULFUR. Violent or explosive reactions occur.
- METAL OXIDES, NITRATES(V), CHLORATES and other SOLID OXIDISING AGENTS. Explosive mixtures form.
- MERCURY and its COMPOUNDS (includes solutions). Rapid oxidation of aluminium occurs, may cause ignition.

WEL (mg m^{-3}): 10 (LTEL), 30 (STEL), as inhalable dust; 4 (LTEL), 12 (STEL), as respirable dust.

Storage

Storage code: **FW** [Dull-grey powder]

- An oxide layer forms on turnings and powder (which is particularly prone to oxidation). This surface oxide reduces the activity of the metal. Keep containers tightly closed and dry.

Aluminium foil Al (26.98)

Currently not classified as hazardous.

Aluminium foil is dangerous in contact with:

- ACIDS and ALKALIS. Hydrogen is formed.
- HALOGENS. Violent reactions occur.
- MERCURY and its COMPOUNDS (includes solutions). Rapid oxidation of aluminium occurs which may cause ignition

Storage

Storage code: **GIn** [Shiny-silver metal]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **If aluminium powder catches fire**: Although difficult to ignite, the powder burns vigorously and is difficult to extinguish. If safe to do so, extinguish small fires by smothering with clean, **dry** sand (keep a container of sand specifically for this purpose).

1 Risk Assessment Guidance

Aluminium

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Aluminium powder	 DANGER (See reverse)	TT (Y7)	• Wear eye protection. • Avoid raising dust. Keep powder away from naked flames. **Other notes; see also detailed activity-specific guidance**: • Thermite reaction (TT): See *Thermite reaction*. • Powdered aluminium is particularly dangerous if blown into a Bunsen burner flame. Do **not** use aluminium powder in reactions with acids, alkalis, chlorine or bromine; use small pieces of foil. **Disposal**: W2, WSpec; see below
Aluminium foil	Currently not classified as hazardous, but see notes on reverse.	Y7	• Eye protection and/or other control measures may be advised for some procedures. Check activity-specific guidance and/or GL 120. **Disposal**: W3, W8

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> of aluminium powder**: • **WSpec**: Work in a fume cupboard. Ensure no naked flames. Add 10 g of the powder to 1 litre of 2 M hydrochloric acid (in a bucket or large beaker). Ensure solution remains acidic (use an indicator); add more acid if necessary. Leave mixture in the fume cupboard for an hour or until reaction appears to be complete. Pour resulting solution down a foul-water drain, diluting it further with a bucket of water.

2A Risk Assessment Guidance Aluminium compounds: chlorides and bromides

Aluminium chloride-6-water	*hydrated aluminium chloride, aluminium chloride hexahydrate* $AlCl_3.6H_2O$ (241.43)
WARNING	Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: classification/labelling varies by supplier. Some classify/label as for the anhydrous compound. WEL (mg m^{-3}): 2 (LTEL), 6 (STEL)
Storage	Storage code: **GIn** [Colourless crystals] • Absorbs water from the atmosphere (is hygroscopic) to give an acidic solution.

Aluminium chloride	*anhydrous aluminium chloride* $AlCl_3$ (133.34)
Aluminium bromide	*anhydrous aluminium bromide* $AlBr_3$ (266.69)
(bromide) DANGER	Causes severe skin burns and eye damage [H314]. Harmful if swallowed [H302], aluminium bromide. Note: classification/labelling varies by supplier. **These substances are dangerous in contact with**: • WATER. Vigorous, exothermic reactions forming hydrochloric/hydrobromic acid fumes/aerosols. WEL (mg m^{-3}): 2 (LTEL), 6 (STEL)
Storage	Storage code: **CW** [White-pale yellow solids, see notes below] • Pressure may build up in the closed container due to a slow reaction with water absorbed from the atmosphere (hydrogen chloride fumes are produced). Keep inside another container that also contains soda lime. Cover container with a cloth and open containers cautiously in a working fume cupboard. • Hydrogen chloride fumes can leak into the store and accelerate the corrosion of metals. The fumes may also cause white deposits on bottles (see also *Hazcard* 47A). • Although the pure solid is white, purchased samples are often yellow due to the presence of iron(III) salts. If the solid does appear white this is likely to be aluminium hydroxide or oxide formed by reaction with moist air; the solid has decomposed and should be disposed of.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (skin, eyes).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

2A Risk Assessment Guidance **Aluminium compounds: chlorides and bromides**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid aluminium chloride-6-water and solutions: ≥ 1.5 M	 WARNING Irritant (skin, eyes) Irritant (respiratory), ≥ 1.5 M	Y9	• Wear eye protection. • Wear splash-proof goggles when using the anhydrous solids. • Avoid raising dust when using the anhydrous solids. • Ensure laboratory is well ventilated. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes**; **see also detailed activity-specific guidance**: • **Heating hydrated aluminium chloride**: Hydrogen chloride gas (corrosive, toxic) is produced. Ensure laboratory is well-ventilated or use a fume cupboard. Loosely plug open end of the test-tube with mineral wool to minimise fumes.
Aluminium chloride solutions: < 1.5 M and ≥ 0.8 M			
< 0.8 M	Currently not classified as hazardous		
Anhydrous solids: • Aluminium chloride • Aluminium bromide	  (bromide) DANGER (See reverse)	Y12	**Disposal:** W7 or W4; see notes below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **W7 (hydrated salt solutions)**: Dilute solutions to below 0.4 M. • **W4 (anhydrous solids)**: Use a fume cupboard. Add no more than 60 g of anhydrous solid in small portions to 1 litre of 1 M sodium carbonate solution. Allow reaction to subside before adding further portions. Pour the resulting slurry down a foul-water drain with further dilution.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

2B Risk Assessment Guidance Aluminium compounds (except chlorides & bromide)

Aluminium nitrate(V)-9-water		$Al(NO_3)_3.9H_2O$ (375.13)
Aluminium ammonium sulfate(VI)-12-water	*ammonium alum*	$AlNH_4(SO_4)_2.12H_2O$ (453.33)

 (nitrate)  WARNING	**Nitrate**: May intensify fire; oxidiser [H272]. **Both**: Causes skin irritation [H315]. Causes serious eye irritation [H319].

Aluminium sulfate(VI)-16-water	*aluminium sulfate(VI)*	$Al_2(SO_4)_3.16H_2O$ (630.39)

 DANGER	Causes serious eye damage [H318].

Aluminium oxide	*alumina*	Al_2O_3 (101.96)
Aluminium ethanoate	*aluminium acetate*	$Al(CH_3COO)_3$ (204.11)
Aluminium potassium sulfate(VI)-12-water	*potassium aluminium sulfate, (potash) alum*	$AlK(SO_4)_2.12H_2O$ (474.39)
Currently not classified as hazardous		

WEL (mg m^{-3}):	2 (LTEL), 6 (STEL); soluble aluminium salts 10 (LTEL), 30 (STEL) / 4 (LTEL), 12 (STEL); aluminium oxides as inhalable/respirable dust

Storage	Storage code: **Ox** (nitrate); **GIn** (others) [Colourless crystals (nitrate); colourless-white solid (other)] • The nitrate(V) salt absorbs water from the atmosphere to become damp. The ‘solution’ formed is acidic.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (eyes)**: Aluminium sulfate. • **General spills/clearing up: OXIDISING.** Nitrate(V) salt.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

2B Risk Assessment Guidance **Aluminium compounds (except chlorides & bromide)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Aluminium nitrate solid	  WARNING (See reverse)	Y9	• Wear eye protection. • Wear splash-proof goggles when transferring/dispensing large quantities of the corrosive solutions. **Other notes; see also detailed activity-specific guidance:** • **Preparation of aluminium salt solutions (TT)**: *Recipe* 4. • **Use of aluminium salts**: Solutions are acidic (pH of ~ 3 for 0.1 M solutions). • **Heating hydrated aluminium nitrate, aluminium sulfate(VI) or alum**: Use a fume cupboard. The nitrate(V) salt produces nitrogen dioxide (toxic, corrosive). Sulfate(VI) and alum produce sulfur trioxide (corrosive). **Disposal**: see below
Solutions ≥ 0.4 M of: • Aluminium nitrate • Ammonium alum	 WARNING Irritant (skin, eyes)	Y7	
Aluminium sulfate solid and solutions ≥ 0.1 M	 DANGER Corrosive (eyes)		
Aluminium sulfate solutions < 0.1 M and ≥ 0.03 M	 WARNING Irritant (eyes)		
• Aluminium oxide • Aluminium ethanoate • Aluminium potassium sulfate	Currently not classified as hazardous (solid, solutions)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **W8**: Aluminium ethanoate, aluminium oxide. • **W7** (→0.1 M): Aluminium nitrate, ammonium alum, aluminium sulfate. • **W7, W8**: Aluminium potassium sulfate (alum).

3A Risk Assessment Guidance Amines: aliphatic monosubstituted (and salts)

Methylamine (40% aqueous solution)	*aminomethane*	CH_3NH_2 (31.06)
Ethylamine (70% aqueous solution)	*aminoethane*	$C_2H_5NH_2$ (45.08)
Butylamine	*1-aminobutane*	$C_4H_9NH_2$ (73.14)

DANGER

Highly flammable liquid and vapour [H225]. Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Causes severe skin burns and eye damage [H314]. Harmful if inhaled [H332]. May cause respiratory irritation [H335]. Note: Classification and labelling may vary by supplier.

The *anhydrous* liquid ethylamine, which boils at 17 °C, is **not** suitable for school use.

Note:	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})	
• methylamine (40%)	– 10	~ 48	–	–
• ethylamine (70%)	– 10	~ 40	3.8 (LTEL),	11 (STEL)
• butylamine	– 12	77	–	–

Storage

Storage code: **FL** (Organic) [Colourless-yellow liquids, ‘fishy’ odours]

- Regularly check bottle screw tops for leaks or deterioration. Wipe away any white solid from the bottle’s surface (usually a chloride salt due to vapours reacting with hydrogen chloride fumes).
- Open bottles cautiously in a fume cupboard (pressure may have built up).

Methylammonium chloride	*methylamine hydrochloride*	CH_3NH_3Cl (67.52)
Ethylammonium chloride	*ethylamine hydrochloride*	$C_2H_5NH_3Cl$ (81.55)

WARNING

Harmful if swallowed [H302], methylamine hydrochloride. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

Storage

Storage code: **GIn** [White/colourless solids]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes, inhalation), alkali**: Amines (liquid, solution, vapour).
- **General spills/clearing up: FLAMMABLE, CORROSIVE LIQUID, alkali.**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

3A Risk Assessment Guidance — Amines: aliphatic monosubstituted (and salts)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• Methylamine (40%) • Ethylamine (70%) • Butylamine	   DANGER (See reverse)	TT (Y12)	• Wear splash-proof goggles. Protect the face when opening bottles of the concentrated solutions/liquids (pressure may have built up). • Use a fume cupboard for transferring/dispensing the liquids. Avoid inhaling vapours. Ensure laboratory is well ventilated. • Ensure no naked flames or other sources of ignition. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Reactions of amines**: The 'fishy' odour of the amines is not pleasant. Butylamine is often the preferred compound to illustrate amine reactions. Provide stoppered test tubes containing the required drops of amine. These may be used on the open bench in a well-ventilated laboratory. Note: some reactions generate the alkaline gases methylamine or ethylamine (corrosive, extremely flammable). • **Preparing and labelling amine solutions (TT)**: See *Recipe* 6. **Disposal**: W5 in a fume cupboard
Aqueous solutions of methyl/ethylamine ≥ 3%	 DANGER Corrosive (eyes)	Y12	
Aqueous solutions of methyl/ethylamine < 3% and ≥ 1%	 WARNING Irritant (skin, eyes)		
Chloride salts: solids, and solutions ≥ 1.3 M	 WARNING Irritant (skin, eyes)	Y7	• Wear eye protection. **Disposal**: W7 → 0.5 M

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

3B Risk Assessment Guidance — Amines: aliphatic polysubstituted (1)

1,2-diaminoethane *ethylenediamine* $NH_2CH_2CH_2NH_2$ (60.10)

DANGER

Flammable liquid and vapour [H226]. Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Causes severe skin burns and eye damage [H314]. May cause an allergic skin reaction [H317]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334].

Flash point: 34 °C Boiling point: 117 °C

1,6-diaminohexane *hexamethylenediamine* $NH_2(CH_2)_6NH_2$ (116.20)

DANGER

Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335].

Flash point: 85 °C

Storage

Storage code (1,2-diaminoethane): **CLb** (Organic) [Colourless liquid, ammonia-like odour]

Storage code (1,6-diaminohexane): **CS** (Organic) [White-pale yellow solid, ammonia-like odour]

- Samples may deteriorate/discolour on storage. Test to check the amine still gives desired effect. If a fresh sample is black, return it to the supplier. Regularly check bottle screw tops for leaks or deterioration. Wear gloves to wipe away any white solid from the bottle's surface (usually the chloride salt due to vapours reacting with hydrogen chloride fumes).
- The pure amines are hygroscopic (absorb water). Both can also be purchased as aqueous solutions (eg, 1,6-diaminohexane, usually as a 5% aqueous solution which is ~ 0.4 M).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes), alkali**.

3B Risk Assessment Guidance

Amines: aliphatic polysubstituted (1)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**		**User**	**Suggested general control measures and guidance**
• Diaminoethane • Diaminohexane	DANGER (See reverse)		TT (Y12)	• Wear eye protection. Wear splash-proof goggles when using the pure amines and/or solutions classified as corrosive. • Avoid inhaling vapours. Use a fume cupboard for dispensing or transferring the pure liquid/concentrated solutions. Ensure laboratory is well-ventilated. • Take particular care to protect the skin. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparing 1,2-diaminoethane solutions (TT)**: *Recipe* 6. • **Use of 1,2-diaminoethane solutions**: Solutions ≤ 0.1 M may be used on the open bench in a well-ventilated laboratory. • **Preparing a 1,6-diaminohexane solution for the ‘nylon rope’ activity (TT)**: See *Recipe* 62.
Diaminoethane solutions: < 0.8 M & ≥ 0.5 M	DANGER	As below, but: Corrosive (eyes)		
< 0.5 M & ≥ 0.15 M	DANGER	Sensitiser (skin, respiratory) Irritant (skin, eyes)		
< 0.15 M & ≥ 0.01 M		Sensitiser (respiratory)		
Diaminohexane solutions: < 2 M & ≥ 1.7 M	DANGER	Corrosive (skin, eyes) Irritant (respiratory)		
< 1.7 M & ≥ 0.4 M	DANGER	Corrosive (skin, eyes)	TT (Y9)	
< 0.4 M & ≥ 0.25 M		Corrosive (eyes) Irritant (skin)		
< 0.25 M & ≥ 0.09 M	WARNING	Irritant (skin, eyes)	Y7	**Disposal**: W5 in a fume cupboard

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

3C Risk Assessment Guidance

Amines: aliphatic polysubstituted (2)

Hexamine *methenamine, hexamethylene tetramine* $(CH_2)_6N_4$ (140.19)

WARNING

Flammable solid [H228]. May cause an allergic skin reaction [H317].

Note: Classification and labelling vary. Some suppliers may also indicate: May cause allergy or asthma symptoms or breathing difficulties if inhaled [H317]. In this case, the GHS 08 pictogram (and DANGER) would replace GHS 07 (and WARNING).

Hexamine is dangerous in contact with:

- HEAT. Decomposition occurs (≥ 263 °C) and toxic fumes are released.
- OXIDISING AGENTS, ACIDS. Dangerous or explosive reactions may occur.

Flash point: 250 °C (melting point is also 250 °C).

Storage

Storage code: **FS** (Organic) [White solid, amine-like odour]

- The solid is hygroscopic (absorbs water). Keep dry. Store in a desiccator. Do **not** use tablets if they have become damp (even those that are wax coated to minimise water absorption).

EDTA, disodium salt, dihydrate *bis[bis(carboxymethyl)amino]ethane (disodium salt)* $C_{10}H_{14}N_2Na_2O_8.2H_2O$ (372.24)

WARNING

Note: Classification/labelling vary. Some suppliers may indicate no hazards; others may indicate one or more of: Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319].

Storage

Storage code: **GIn** [Colourless-white solid]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120).

3C Risk Assessment Guidance

Amines: aliphatic polysubstituted (2)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Hexamine	 WARNING (See reverse)	TT	• Wear eye protection. • Take particular care to avoid skin contact. Manipulate tablets (especially if not wax-coated) with tongs/tweezers. See also activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Hexamine fuel for model steam engines**: See *How to use a model steam engine.* Do **not** use tablets if they may have become damp (they may 'spit' or 'explode' on heating). • **Hexamine as a fuel**: **Not** suitable for investigations. Safer materials exist. **Disposal**: W6, see note below.
EDTA disodium salt solid, and solutions ≥ 0.3 M	 WARNING (See reverse)	Y7	• Wear eye protection. **Other notes; see also detailed activity-specific guidance:** • **Titrations involving EDTA**: The disodium, dihydrate salt is commonly used for titration work (0.1 M or 0.05 M solutions are suitable). For accurate work see also *Recipe* 94 for details on standardising EDTA solutions. **Disposal**: W7 → 0.25 M
EDTA solutions < 0.3 M	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W6 (hexamine tablets, if dry):** Use a fume cupboard for burning small leftover fragments/1-2 tablets.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

3D Risk Assessment Guidance **Amines: physiologically-active compounds**

Acetylcholine chloride	$C_7H_{16}NO_2Cl$ (181.66)
Caffeine	$C_8H_{10}N_4O_2$ (194.19)
 WARNING	**Acetylcholine chloride**: Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. **Caffeine**: Harmful if swallowed [H302].
Storage	Storage code: **GOrg** [Colourless/white solids]

Adrenaline	*epinephrine*	$C_9H_{13}NO_3$ (183.21)
 DANGER	Toxic if swallowed [H301]. Toxic in contact with skin [H310]. Toxic if inhaled [H331].	
Storage	Storage code: **Cold** (Organic)	[Brown-beige solid]

Nicotine $C_8H_{10}N_4O_2$ (162.23)	**Colchicine** $C_{22}H_{25}NO_6$ (399.44) **Ethidium bromide** $C_{21}H_{20}N_3Br$ (394.29)
 DANGER Fatal if swallowed & if inhaled [H300, H330]. Fatal in contact with skin [H310]. Toxic to aquatic life with long lasting effects [H411]. WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL), Sk	 DANGER **Colchicine**: Fatal if swallowed [H300]. May cause genetic defects [H340]. **Ethidium bromide**: Harmful if swallowed [H302]. Fatal if inhaled [H330]. Suspected of causing genetic defects [H341].

Nicotine, Colchicine, Ethidium bromide: these compounds are not recommended for school use (but see reverse for nicotine).

Storage code: **T** (Organic); **prior to disposal**, **W1/W2**.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

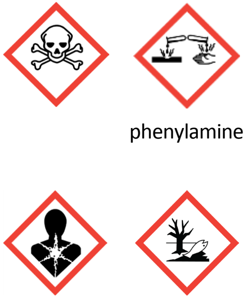
3D Risk Assessment Guidance Amines: physiologically-active compounds

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk			
General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
- Acetylcholine chloride - Caffeine	 WARNING (See reverse)	Y12 (Y9)	- Wear eye protection. - Avoid raising dust. - Adrenaline: Take particular to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** - **Heart rate investigations (stimulation, inhibition)**: Caffeine experiments on humans are not recommended and do not generate meaningful results. See *Using the Daphnia heart as a model for the human heart*. **Disposal**: W7, see note below
Adrenaline	 DANGER (See reverse)		
Nicotine	 DANGER (See reverse)	TT	- Wear eye protection. - Wear gloves and dispose of them after use. - Use a fume cupboard. **Other notes; see also detailed activity-specific guidance:** - **Smoking machine:** Legislation currently permits the use of a smoking machine demonstration in schools in England, Wales and Northern Ireland as part of education about health. For detailed guidance on the procedure and how to organise the demonstration, see *Cigarette smoking 'machine'* and the *Smoking machine demonstration* (video clip). **Disposal:** W1, W2 only

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** - **W7 (adrenaline):** Dissolve no more than 1 g in 1 litre of water. Rinse down a foul-water drain.

4A Risk Assessment Guidance (see also **4B**) — Amines: aromatic (1)

Phenylamine	*aminobenzene, aniline, benzenamine*	$C_6H_5NH_2$ (93.13)
Phenylammonium chloride	*aniline hydrochloride, anilinium chloride, benzenamine hydrochloride*	$C_6H_5NH_3Cl$ (129.59)
Diphenylamine	*N-phenylbenzenamine*	$(C_6H_5)_2NH$ (169.22)
N,N-dimethylphenylamine	*N,N-dimethylaniline*	$C_6H_5N(CH_3)_2$ (121.18)



DANGER

All: Toxic if swallowed [H301]. Toxic in contact with skin [H311]. Toxic if inhaled [H331].

Phenylamine (& salts): May cause an allergic skin reaction [H317]. Causes serious eye damage [H318]. Suspected of causing genetic defects [H341]. Suspected of causing cancer [H351], *also dimethylphenylamine*. Causes damage to organs through prolonged or repeated exposure [H372].

Diphenylamine: May cause damage to organs through prolonged or repeated exposure [H373].

Phenylamine: Very toxic to aquatic life [H400] (with long lasting effects [H410], diphenylamine).

Dimethylphenylamine: Toxic to aquatic life with long lasting effects [H411].

	Flash point (^oC)	Boiling point (^oC)	WEL (mg m^{-3})		
phenylamine	~ 76	184	4 (LTEL);	12 (STEL)	Sk
diphenylamine	~ 153	302	10 (LTEL);	20 (STEL)	
dimethylphenylamine	~ 63	193	25 (LTEL);	50 (STEL)	Sk

Storage

Storage code: **T** (Organic) [Pungent odours, see below]

- **Phenylamine**: Oily liquid. Typical amine/‘rotten fish’ odour. Pure phenylamine is colourless but darkens over time. For most school uses, this coloured liquid is suitable (purification needs reduced-pressure distillation).
- **Diphenylamine**: White crystalline solid with a ‘floral’ odour.
- **Dimethylphenylamine**: Colourless to pale yellow oily liquid with a sharp amine-like odour.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes):** Phenylamine.

4A Risk Assessment Guidance (see also **4B**) **Amines: aromatic (1)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
• Phenylamine • Diphenylamine • Dimethylphenylamine • Phenylammonium chloride	 DANGER (See reverse)	Y12	• Wear eye protection. Wear splash-proof goggles when transferring/dispensing large quantities of phenylamine. • Use a fume cupboard for dispensing/transferring the liquids. • Ensure laboratory is well ventilated. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120 • Wearing a lab coat (or similar) is recommended. **Other notes; see also detailed activity-specific guidance**: • **Reactions of phenylamine**: Use 5 drops (**no more**) for test-tube scale activities. Ethyl 4-aminobenzoate may be used as a safer alternative. See *Safer chemicals, safer reactions.* • **Diazotisation/azo dye preparation**: The solid phenylammonium chloride is easier to transfer than phenylamine and avoids the use of a fume cupboard. Sulfanilic acid and ethyl 4-aminobenzoate are safer alternatives. See *Safer chemicals, safer reactions*. **Disposal:** W5, see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W5**: Add no more than 1 cm^3 (or 1 g) of the amine to 100 cm^3 of 1 M ethanoic acid. Flush the resulting mixture down a foul-water drain with further dilution.

4B Risk Assessment Guidance (see also **4A**) **Amines: aromatic (2)**

Benzocaine	*ethyl 4-aminobenzoate, ethyl 4-aminobenzenecarboxylate*	$NH_2C_4H_4COOC_2H_5$ (165.19)
Luminol	*3-aminophthalhydrazide, 3-aminobenzene-1,2-dicarboxylic hydrazide*	$C_8H_7N_3O_2$ (177.16)
Sulfanilic acid	*4-aminobenzenesulfonic acid*	$NH_2C_6H_4SO_3H$ (173.19)

 WARNING	**Benzocaine** and **Sulfanilic acid**: May cause an allergic skin reaction [H317]. **Luminol** and **Sulfanilic acid**: Causes skin irritation [H315] and serious eye irritation [H319]. **Luminol**: May cause respiratory irritation [H335].

Storage	Storage code: **GOrg** • **Benzocaine** and **Sulfanilic acid**: White or off-white solids. Keep benzocaine under lock and key. • **Luminol**: Yellow-tan coloured solid.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120)**.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

4B Risk Assessment Guidance (see also **4A**) **Amines: aromatic (2)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
• Benzocaine • Luminol • Sulfanilic acid	 WARNING (See reverse)	Y7	• Wear eye protection. • Avoid raising dust when using/transferring the solids. • Benzocaine and sulfanilic acid: Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Solubility**: Luminol and benzocaine are almost insoluble in pure water at room temperature. Sulfanilic acid is sparingly soluble (~ 10 g per litre of water at 20 ^{o}C). • **Chemiluminescence reaction mixtures**: see *Recipe* 23. • **Diazotisation/azo dye preparation**: Sulfanilic acid and benzocaine are safer alternatives to phenylamine and its salts. **Disposal**: benzocaine/luminol, W2; see note below sulfanilic acid, W7; see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W2**: Residues from activities are likely to be in a more soluble form, check activity-specific guidance. • **W7**: Dissolve up to 10 g of sulfanilic acid in 1 litre of water. Pour down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

4C Risk Assessment Guidance — Amines: heterocyclic

Pyridine *azine, azabenzene* C_5H_5N (79.10)

DANGER

Highly flammable liquid and vapour [H225]. Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Harmful if inhaled [H332].

Note:	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})
	17	115	16 (LTEL), 33 (STEL)

Storage Storage code: **FL** (Organic) [Colourless liquid, ‘fish-like’ odour]

Pyrrole *azole, imidole* C_4H_4NH (67.09)

DANGER

Flammable liquid and vapour [H226]. Toxic if swallowed [H301]. Causes serious eye damage [H318]. Harmful if inhaled [H332].

Note:	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})
	39	130	–

Storage Storage code: **FL** (Organic) [Colourless - dark yellow liquid; ‘fish-like’ odour]

- The pure liquid is initially colourless but rapidly darkens in air.
- If there is limited room in the flammables cabinet, this chemical may be stored with **GOrg**.

2,3,5-triphenyltetrazolium chloride *tetrazolium chloride, TTC* $C_{19}H_{15}ClN_4$ (334.80)

WARNING

Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

Storage Storage code: **GOrg** [White crystalline powder]

Emergencies **Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**:

- **CORROSIVE (eyes)**: Pyrrole.

4C Risk Assessment Guidance

Amines: heterocyclic

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Pyridine	 DANGER (See reverse)	Y12	- Wear eye protection. Wear splash-proof goggles when transferring or dispensing large volumes of pyrrole. - Wear disposable gloves. Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. - Use a fume cupboard. Avoid inhaling vapours. **Other notes; see also detailed activity-specific guidance:** - **Chromatography solvents**: pyridine may be used in chromatography solvents (eg, separation of sugars). See *Recipe* 26. **Disposal**: W2, see note below
Pyrrole	 DANGER (See reverse)		
TTC (solid)	 WARNING (See reverse)	Y7	- Wear eye protection. **Disposal:** W7
TTC solutions < 0.3 M (10 %)	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE**: - **W2 (pyridine, pyrrole)**: Do **not** mix with other waste. Store in a separate container before disposal.

5 Risk Assessment Guidance (see **6** for ammonia solution) **Ammonia gas, $NH_3(g)$**

Ammonia gas	NH_3 (17.01)
 DANGER	Flammable gas [H221]. Causes severe skin burns and eye damage [H314]. Toxic if inhaled [H331]. Very toxic to aquatic life [H400]. **Ammonia is dangerous in contact with**: • MERCURY. Explosive solid formed on prolonged contact. • OXYGEN. Explosions can occur. • CHLORINE, BROMINE, IODINE, SILVER SALTS. Under some conditions, explosive products form. WEL (mg m^{-3}): 18 (LTEL), 25 (STEL). **Ammonia has a distinctive, pungent odour that the human nose can detect at a level below the WEL values. Severe poisoning by inhalation is rare because the pungent smell usually ensures that evasive action is quickly taken. However, see Emergencies below.** **Ensure that the fume cupboard is working efficiently (especially recirculatory filter models) when ammonia gas is prepared or used.**
Storage	Storage code: **Situ** [Colourless gas, very pungent odour, less dense than air] • Gas cylinders are **not** recommended. Prepare the gas *in situ* when required.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **GAS RELEASE**: Evacuate if people are affected. If safe to do so, ventilate the area as much as possible. • **CORROSIVE, TOXIC (inhalation). BEWARE DELAYED EFFECTS.** • **CORROSIVE (skin, eyes), alkali.**

5 Risk Assessment Guidance (see **6** for ammonia solution) **Ammonia gas, $NH_3(g)$**

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Ammonia gas	 DANGER (See reverse)	TT (Y7)	• Do **not** inhale the gas. Prepare and use in an efficiently-working fume cupboard (unless working on a small, test-tube, scale, see **Other notes**). • Wear splash-proof goggles when preparing or using the gas on a large scale (eg, for demonstration activities). Check activity-specific guidance for additional eye protection advice. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparation of ammonia gas (large-scale; TT)**: See *Recipe* 5. • **Making & testing ammonia gas (small-scale; students)**: Eye protection requirements will depend on the test-tube preparation method selected. Ensure the laboratory is well ventilated. Use the correct technique for smelling gases. **Disposal**: W6 in an efficient fume cupboard

BEWARE DELAYED EFFECTS

Effects of exposure by inhalation may or may not be immediately apparent and can develop and/or increase over time.

Inhalation by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions.

If affected at any time, call the emergency services, informing them of the quantity of ammonia involved.

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

6 Risk Assessment Guidance

Ammonia solution, NH_3(aq)

Ammonia solution	*'880' ammonia (if 35% w/w solution), ammonium hydroxide* NH_3 (17.01)
 DANGER	Causes severe skin burns and eye damage [H314]; May cause respiratory irritation [H335]; Very toxic to aquatic life [H400]. **Ammonia is dangerous in contact with**: • CHLORINE, BROMINE, IODINE, SILVER SALTS. Under some conditions, explosive products are formed. • MERCURY. Explosive solid formed on prolonged contact. • OXYGEN. Explosions can occur. WEL (mg m^{-3}): 18 (LTEL), 25 (STEL) Ammonia gas (TOXIC, CORROSIVE, FLAMMABLE) diffuses from solutions.
Storage	Storage code: **CLb** [Colourless liquid, pungent odour] • The concentration of commercially available 35% (w/w) ammonia is 18 M. This solution has a specific gravity of 0.880 and so is often referred to as '880 ammonia'. • Pressure builds in containers of concentrated solution on warm days. Open bottles cautiously (in fume cupboard), especially newly purchased ones, protecting the face. Store in a cool place, at floor level. • Keep containers tightly closed (ammonia gas reacts with hydrogen chloride gas to form a white powder which deposits on bottles in the store). The solution has a limited shelf life, possibly as short as 5 years depending on storage conditions. • Diluted solutions will not keep for long periods and should be prepared when required.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120)**. **NOTE**: • **CORROSIVE (skin, eyes), alkali.** Beware, the vapour and even dilute solutions can cause eye damage. • **CORROSIVE, TOXIC (inhalation)**: **BEWARE DELAYED EFFECTS** (ammonia gas, see *Hazcard* 5). • **General spills/clearing up**: If safe to do so, ventilate the area as much as possible. Add absorbent and/or solid citric acid to the spill (citric acid will neutralise the ammonia and reduce fumes).

Ammonia solution, $NH_3(aq)$

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Concentrated (‘880’) ammonia & solutions ≥ 3 M	 DANGER Corrosive (skin, eyes). Irritant (respiratory).	TT (Y9)	• Wear splash-proof goggles. • Protect the face when opening bottles of concentrated ammonia (pressure may have built up) or when transferring or dispensing large volumes. • Use a fume cupboard. Do **not** inhale vapour. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Disposal**: W7 (→ 0.5 M) or W5; in a fume cupboard
Solutions < 3 M and ≥ 1.8 M	 DANGER Corrosive (eyes). Irritant (skin).	Y9	• Wear splash-proof goggles for solutions ≥ 1.8 M. • Wear eye protection even when dilute solutions are used. • Avoid inhaling vapour. Consider using a fume cupboard. Ensure the room is well-ventilated. See **Other notes**.
Solutions < 1.8 M and ≥ 0.6 M	 WARNING Irritant (skin, eyes)	Y7	**Other notes; see also detailed activity-specific guidance**: • Even at concentrations ≤ 0.6 M, solutions release ammonia vapour (corrosive, toxic). Warn students **not** to inhale vapour. • Experience of the use of this solution in school science activities indicates that it is appropriate to apply the control measures given here. It is advisable to include a warning to this effect on the label. **Disposal**: W7 (→ 0.5 M) or W5; see note below
Solutions < 0.6 M	Currently not classified as hazardous. See **Other notes**.		
Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • A fume cupboard may be needed, even for dilute solutions (especially on warm days).		

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Ammonium dichromate(VI) $(NH_4)_2Cr_2O_7$ (252.07)

DANGER

May intensify fire; oxidiser [H272]. Toxic if swallowed [H301]. Harmful in contact with skin [H312]. Causes severe skin burns and eye damage [H314]. May cause an allergic skin reaction [H317]. Fatal if inhaled [H330]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. May cause genetic defects [H340]. May cause cancer [H350]. May damage fertility. May damage the unborn child [H360FD]. Causes damage to organs through prolonged or repeated exposure [H372]. Very toxic to aquatic life with long lasting effects [H410].

Ammonium dichromate(VI) is dangerous in contact with:

- ALUMINIUM, MAGNESIUM, CARBON, SULFUR, PHOSPHORUS, COMBUSTIBLE MATERIALS, including ORGANIC SUBSTANCES. The reactions are violent and may become explosive.

Never mix ammonium dichromate with metals, especially if powdered (eg, aluminium, magnesium).

Never heat ammonium dichromate in a confined space; explosion risk. See **Other notes** (reverse).

WEL (mg m^{-3}): 0.05 (LTEL), 0.15 (STEL), Carc, Sen; as chromium (Cr)

Storage

Storage code: **T** [Orange-red crystals]

- Do **not** store beside flammable liquids (FL) or other combustible materials (eg, organic chemicals (GOrg).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE, OXIDISING, VERY TOXIC (skin, eyes, inhalation).**
- **General spills/clearing up**: **TOXIC**, **OXIDISING**.
  Collect up carefully to avoid raising dust. Be aware that heat, friction and fire (or other ignition sources) can cause rapid 'explosion-like' decomposition. Small quantities of a spill may be treated as described in **Disposal** (see reverse). Otherwise, retain for disposal by Registered Waste Carrier, W1.

7 Risk Assessment Guidance

Ammonium dichromate(VI), $(NH_4)_2Cr_2O_7$

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solid, and solutions ≥ 0.4 M	DANGER (See reverse)	TT (Y12)	Inhalation of dichromate(VI) salts is a remote possibility if significant amounts of dust become airborne. Use correct transfer techniques. Do **not** allow small volumes of solution to dry out on glassware/lab surfaces. Wipe up spills immediately with a damp cloth/paper towel. • Wear splash-proof goggles. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. • Avoid raising dust. **Other notes; see also detailed activity-specific guidance**: • **Weighing the solid**: Weigh on a balance placed in a fume cupboard that is **not** switched on. Have sash partially down. Wipe down work area with a damp paper towel. • **Thermal decomposition (‘volcano experiment’)**: **Never** mix with metal powders. See *Safer chemicals, safer reactions* for methods that limit dust production. **Disposal**: WSpec, see below
Solutions < 0.4 M and ≥ 0.1 M	DANGER As below, plus: Corrosive (skin, eyes), Harmful (ingestion), Irritant (respiratory)		
Solutions < 0.1 M and ≥ 0.004 M	DANGER Irritant (skin, eyes), ≥ 0.04 M Sensitiser (skin, respiratory) Serious health hazard (RE), ≥ 0.04 M Serious health hazard (CM**R**)		
Solutions < 0.004 M	Currently not classified as hazardous.		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **WSpec: Use a fume cupboard (sulfur dioxide produced)**. Dissolve no more than 10 g of ammonium dichromate in about 250 cm^3 of 1 M sulfuric acid. Add ~ 12 g of solid sodium metabisulfite in small portions with stirring. The solution will turn green due to the formation of Cr^{3+} ions (see *Hazcard* 24). Mix thoroughly. Pour away down a foul-water drain with further dilution.

Ammonium salts: oxidising agents

Ammonium salts must NOT be mixed or ground with potassium chlorate(V) or manganate(VII). Explosive mixtures may form.

Ammonium nitrate(V)	NH_4NO_3 (80.04)
  WARNING	May intensify fire; oxidiser [H272]. Causes serious eye irritation [H319]. Suppliers may also indicate one or more of the following: Causes skin irritation [H315]. May cause respiratory irritation [H335]. **Ammonium nitrate(V) is dangerous in contact with:** • ALUMINIUM, MAGNESIUM, SODIUM, POTASSIUM, CARBON, SULFUR, PHOSPHORUS. Explosive mixtures are formed which are sensitive to movement. • POTASSIUM MANGANATE(VII). The mixture explodes spontaneously after a while. • ETHANOIC ACID and other ORGANIC COMPOUNDS. Unstable explosive mixtures are formed. **Do NOT grind this salt. Do NOT allow the salt to become contaminated with organic matter.**
Storage	Storage code: **Ox** [Colourless-white crystalline solid, hygroscopic]

Ammonium persulfate *(di)ammonium peroxodisulfate(VI)*	$(NH_4)_2S_2O_8$ (228.20)
   DANGER	May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Causes skin irritation [H315]. May cause an allergic skin reaction [H317]. Causes serious eye irritation [H319]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. May cause respiratory irritation [H335]. **Ammonium peroxodisulfate(VI) is dangerous in contact with**: • POWERED ALUMINIUM, ZINC. Explosive reactions may occur. • POTASSIUM CHLORATE(VII), POTASSIUM MANGANATE(VII). Explosive mixtures are formed. • HEAT. If heated strongly, it will explode.
Storage	Storage code: **Ox** [White crystalline solid] • Pressure may build up in bottles. Take care when opening.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Ammonium salts: oxidising agents

Ammonium salts must NOT be mixed or ground with potassium chlorate(V) or manganate(VII). Explosive mixtures may form.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Ammonium nitrate(V)	 WARNING (See reverse)	TT (Y9)	- Wear eye protection. **Other notes; see also detailed activity-specific guidance**: - **General use of ammonium nitrate(V)**: For many activities a safer alternative will be suitable and should be used (eg, potassium chloride for endothermic dissolving processes). - **Activities involving the heating of ammonium nitrate (TT)**: Do **NOT** heat more than 0.5 g unless the employer holds an Explosives Certificate issued by the police. Wear eye protection. Use safety screens. Discontinue heating if brown fumes are seen. **Disposal**: W7 → 0.4 M
Do NOT grind this salt. Do NOT allow the salt to become contaminated with organic matter. NEVER try to recrystallize ammonium nitrate(V) by directly heating the solution. If recovery of the salt is essential, let the water evaporate (room temperature, dust-free environment).			
Ammonium persulfate(VI) solid	 DANGER (See reverse)	TT	- Wear eye protection. - Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: - **Clock reaction mixtures**: See *Recipe* 29. **Disposal**: WSpec (solid), see note below W7 → 0.1 M (solutions)
Persulfate solutions ≥ 0.9 M	 DANGER As below plus: Harmful (ingestion) Irritant (respiratory)	Y9	
< 0.9 M & ≥ 0.04 M	 DANGER Sensitiser (skin, respiratory). Irritant (skin, eyes), ≥ 0.4 M		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** - **WSpec (ammonium persulfate solid)**: Work in a fume cupboard. Dissolve up to 5 g of solid in 100 cm^3 of water. Add 2 g of sodium metabisulfite and stir. Flush away down a foul-water drain.

9A Risk Assessment Guidance

Ammonium salts: other (1)

Ammonium salts must NOT be mixed or ground with potassium chlorate(V) or manganate(VII), explosive mixtures may form.

Ammonium carbonate	*sal volatile (and 'smelling salts'), salt of hartshorn*	$(NH_4)_2CO_3$ (96.09)
Ammonium chloride	*sal ammoniac*	NH_4Cl (53.49)
Ammonium bromide		NH_4Br (97.94)
Ammonium iodide		NH_4I (144.94)
Ammonium molybdate(V)-4-water		$(NH_4)_6Mo_7O_{24}.4H_2O$ (1235.86)

WARNING

Ammonium carbonate, chloride, molybdate*: Harmful if swallowed [H302].

Ammonium chloride, bromide*, iodide*, molybdate*: Causes serious eye irritation [H319].

*Classification/labelling vary. Suppliers may indicate: Causes skin irritation [H315], May cause respiratory irritation [H335].

WEL (mg m^{-3}): 10 (LTEL), 20 (STEL); as ammonium chloride 'fume' (very small particles)
5 (LTEL), 10 (STEL); soluble molybdenum compounds (as Mo)

Ammonium ethanoate	*ammonium acetate*	NH_4CH_3COO (77.08)
Ammonium sulfate(VI)		$(NH_4)_2SO_4$ (132.14)

Currently not classified as hazardous.

Storage

Storage code: **GIn** [Colourless solids]

- Ethanoate, bromide and iodide salts are hygroscopic (absorb water from the air).
- The reagent sold as 'ammonium carbonate' is usually a 1:1 mixture of ammonium carbamate (NH_2COONH_4) and ammonium hydrogencarbonate (NH_4HCO_3). This mixture is designed to have the same ammonium content as ammonium carbonate. Solid decomposes to ammonia and carbon dioxide.
- Keep container lids firmly closed.

Emergencies **Follow standard procedures (see *Emergency Hazcards* and GL 120).**

9A Risk Assessment Guidance

Ammonium salts: other (1)

Ammonium salts must NOT be mixed/ground with potassium chlorate(V) or manganate(VII), explosive mixtures may form.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solids: carbonate, chloride, bromide, iodide, molybdate	⚠ WARNING (See reverse)	Y7	• Wear eye protection. • Ensure room is well-ventilated. **Other notes; see also detailed activity-specific guidance**: • **Using/heating ammonium carbonate**: Ensure room is well-ventilated. Solid decomposes even at room temperature to release water vapour, carbon dioxide and ammonia gas. Do **not** inhale gases. • **Ammonium chloride**: This is the white deposit often seen on bottles in poorly-ventilated stores. Wear eye protection and gloves when wiping down bottles. • **Heating ammonium chloride**: Loosely plug the test-tube with mineral wool to prevent inhalation of dust. Ensure room is well-ventilated (ammonia gas is released). • **Preparing ammonium chloride and/or pH 7 buffer solutions:** see *Recipes* 7 and 18.
Solutions: ≥ 2.5 M (carbonate) ≥ 4.5 M (chloride) ≥ 0.2 M (molybdate)	⚠ WARNING Harmful (ingestion) Irritant (skin, eyes)		
Solutions: < 2.5 M & ≥ 1.0 M (carbonate) < 4.5 M & ≥ 1.8 M (chloride) < 0.2 M & ≥ 0.1 M (molybdate)	⚠ WARNING Irritant (skin, eyes)		
Solutions: < 1.0 M (carbonate) < 1.8 M (chloride) < 0.1 M (molybdate)	Currently not classified as hazardous.		
Ethanoate and sulfate(VI) salts (solids or solutions)			

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:**		
	carbonate/halides W7 → 1.0 M	molybdate W7 → 0.1 M	ethanoate/sulfate W7

9B Risk Assessment Guidance

Ammonium salts: other (2)

Ammonium salts must NOT be mixed or ground with potassium chlorate(V) or manganate(VII); explosive mixtures may form.

Ammonium thiocyanate	NH_4SCN (76.12)
 WARNING	Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Harmful if inhaled [H332]. Contact with acids liberates very toxic gas [EUH032]. Harmful to aquatic life with long lasting effects [H412]. **Ammonium thiocyanate is dangerous in contact with**: • CONCENTRATED ACIDS or HOT DILUTE ACIDS. A very toxic gas is liberated.
Storage	Storage code: **GIn** [Colourless solid]

Ammonium vanadate(V) *ammonium metavanadate, ammonium polytrioxovanadate*	NH_4VO_3 (116.98)
 DANGER	Toxic if swallowed [H301]. Fatal if inhaled [H330]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: Classification and labelling vary. Some suppliers indicate Toxic if inhaled [H331]. Exposure via inhalation is low and controlled if risk assessment advice is followed.
Storage	Storage code: **T** [White-yellow solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

9B Risk Assessment Guidance — Ammonium salts: other (2)

Ammonium salts must NOT be mixed or ground with potassium chlorate(V) or manganate(VII); explosive mixtures may form.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Ammonium thiocyanate solid	 WARNING (See reverse)	Y7	• Wear eye protection. • Avoid contact with concentrated/hot acids. See **Other notes**. **Other notes; see also detailed activity-specific guidance**: • Mixtures involving dilute acids do not usually pose a problem (eg, Volhard's method for the determination of chloride ions in solution). **Disposal**: W7 → 1 M
Ammonium thiocyanate solutions: ≥ 3 M	 WARNING Harmful (ingestion)		
Ammonium vanadate(V) solid	 DANGER (See reverse)	TT	• Wear eye protection. • Avoid raising dust when transferring the solid. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Weighing the solid**: Weigh solid on a balance placed in a fume cupboard that is **not** switched on. Have sash partially pulled down. • **Preparation of vanadate(V) solution (TT)**: See *Recipe* 8. The solid is not very soluble in water (~ 4.8 g dm^{-3}). The prepared 0.1 M solution (acidified) is suitable for investigating oxidation states of vanadium. **Disposal**: W7 → 0.05 M
Ammonium vanadate(V) solution* 0.1 M	 WARNING Irritant (skin, eyes)	Y7	

*Solutions made up in dilute acid (see *Recipe* 8).

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

10A Risk Assessment Guidance **Barium metal, barium carbonate and chloride**

Barium metal

Ba (137.30)

DANGER

In contact with water releases flammable gases [H261]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

If dry, the metal can be impact sensitive.

Barium metal is dangerous in contact with:

- WATER. Reacts to form hydrogen gas.

Storage

Storage code: **FW** [Grey solid]

- It is sometimes supplied under argon. Once open, store under liquid paraffin.
- Barium is difficult to cut into small pieces. If possible, buy the metal as small granules or pieces.

Barium chloride-2-water *barium chloride dihydrate*

$BaCl_2.2H_2O$ (244.26)

DANGER

Toxic if swallowed [H301]. Harmful if inhaled [H332].

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); soluble compounds as barium (Ba).

Storage

Storage code: **T** [White solid; powder or crystalline]

Barium carbonate

$BaCO_3$ (197.30)

WARNING

Harmful if swallowed [H302].

Storage

Storage code: **GIn** [White solid, powder]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes), alkali:** barium metal.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

10A Risk Assessment Guidance **Barium metal, barium carbonate and chloride**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Barium metal	🔥 ❗ DANGER (See reverse)	Y12	• Wear eye protection. • Use tongs or forceps to transfer/manipulate pieces of metal. **Other notes; see also activity-specific guidance:** • Barium metal is difficult to cut. If required, hold the metal in a vice and use a junior hacksaw with care. Alternatively, use wire snips to cut the metal (hold inside a small box/strong bag to prevent pieces flying off). The metal may be supplied as irregularly-sized/shaped pieces. Variable surface area will affect how quickly the barium oxidises and also how it reacts with water and other reagents. **Disposal**: W5, WSpec; see below
Barium carbonate solid	❗ WARNING (See reverse)	Y7	
Barium chloride solid	☠ DANGER (See reverse)	Y9	
Barium chloride solutions ≥ 0.4 M	❗ WARNING Harmful (ingestion)	Y7	• Wear eye protection. **Other notes; see also activity-specific guidance**: • Solutions below 0.4 M are adequate for most pre-16 work. **Disposal**: W7 → 0.05 M

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **W5 (barium metal)**: Add no more than 10 g of small pieces (piece by piece) to 250 cm^3 of 1 M ethanoic acid. Once reacted, dilute to 1 litre with water and rinse away down a foul-water drain. • **WSpec (barium metal)**: Place small pieces in propan-2-ol. Leave until completely reacted. Add solution to water and pour down a foul-water drain. • **W5 (barium carbonate):** Use no more than 100 g of barium carbonate per litre of 1 M ethanoic acid. • **WSpec (barium chloride solid)**: Dissolve in water and add sodium sulfate(VI) to precipitate barium sulfate(VI). Filter off solid for disposal in normal refuse (currently barium sulfate(VI) is not classified as hazardous but see *Hazcard* 10B). Pour filtrate solution (sodium chloride) down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

10B Risk Assessment Guidance (also *Hazcards* **10A, 11**) **Barium compounds, other**

Barium oxide BaO (153.33)

Barium hydroxide-8-water $Ba(OH)_2.8H_2O$ (315.46)


(oxide)


(hydroxide)


DANGER

Barium oxide: Toxic if swallowed [H301].

Barium hydroxide-8-water: Harmful if swallowed [H302].

Both: Harmful if inhaled [H332]. Causes severe skin burns and eye damage [H314].

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); as barium in soluble compounds.

Storage Storage code: **CS** [White or white-yellow solid]

Barium diphenylamine sulfonate *diphenylamine-4-sulfonic acid (barium salt)* $(C_6H_5NHC_6H_4SO_3)_2Ba$ (633.88)


WARNING

Harmful if swallowed [H302]. Harmful if inhaled [H332].

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); as barium in soluble compounds.

Storage Storage code: **GIn** [White solid]

Barium sulfate(VI) *barium sulfate, barytes* $BaSO_4$ (233.39)

Currently not classified as hazardous. WEL (mg m^{-3}): 10/4 (LTEL), 30/12 (STEL); as inhalable/respirable dust.

Storage Storage code: **GIn** [White solid]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes), alkali**: Barium hydroxide and barium oxide.

10B Risk Assessment Guidance (also *Hazcards* **10A, 11**) **Barium compounds, other**

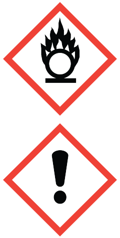
Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Barium oxide, solid	 DANGER (See reverse)	TT (Y9)	• Wear splash-proof goggles. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Barium hydroxide solutions**: Barium hydroxide is only slightly soluble in water (~ 4 g in 100 cm^3 at room temperature). Solutions will immediately go cloudy when exposed to the atmosphere (barium carbonate forms). Use boiled distilled water to prepare solutions and protect with a soda lime guard tube. **Disposal**: W5
Barium hydroxide -8-water, solid	 DANGER (See reverse)		
Barium hydroxide solutions ≥ 0.05 M	 WARNING Irritant (skin, eyes)		
Barium diphenylamine sulfonate	 WARNING (See reverse)	Y7	• Wear eye protection. **Other notes; see also detailed activity-specific guidance:** • **Redox titrations**: Barium diphenylamine sulfonate can be used as an indicator in dichromate(VI) titrations. See *Recipe* 49. **Disposal**: diphenylamine sulfonate, W7; see below sulfate(VI), W8,
Barium sulfate(VI)	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W7 (barium diphenylamine sulfonate, 0.2 % indicator)**: Rinse unused solution down a foul-water drain. Unused solid is W1.

11 Risk Assessment Guidance — Barium chromate(VI), nitrate(V) and peroxide

Barium chromate(VI)	$BaCrO_4$ (253.32)
Barium nitrate(V)	$Ba(NO_3)_2$ (261.34)
Barium peroxide	BaO_2 (169.33)



DANGER

May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Harmful if inhaled [H332].

Barium nitrate(V) is dangerous in contact with:

- CARBON, SULFUR, POWDERED METALS. Readily ignites - is extremely sensitive to friction or impact.

Barium peroxide is dangerous in contact with:

- COMBUSTIBLE MATERIAL including ORGANIC SUBSTANCES. Violent or explosive reactions occur. May ignite spontaneously, particularly if damp.
- POWDERED METALS. Dangerous reactions occur.
- ETHANOIC ACID and ETHANOIC ANHYDRIDE. Explosions occur.
- WATER. Vigorous reaction occurs forming a corrosive solution. Oxygen gas is rapidly evolved.

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); as barium (Ba) in soluble compounds.
0.05 (LTEL), 0.15 (STEL), Carc, Sen; as chromium (Cr) for barium chromate(VI).

Storage

Storage code: **Situ** (chromate) [Yellow solid]

Storage code: **Ox** (nitrate; peroxide) [Colourless-white hygroscopic crystals; Grey-white solid]

- Keep barium peroxide dry. The solid decomposes in water to produce oxygen gas. Barium peroxide tins often split after keeping for several years.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **Barium peroxide in the mouth/swallowed: Immediately call 999.** This substance can cause serious internal damage due to the release of oxygen gas.
- **General spills/clearing up**: **OXIDISING**. Keep dry while collecting up (barium peroxide).

11 Risk Assessment Guidance **Barium chromate(VI), nitrate(V) and peroxide**

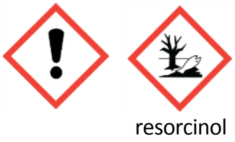
Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solids • chromate(VI) • nitrate(V) • peroxide	 DANGER (See reverse)	TT (Y9)	• Wear eye protection. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Thermite reaction (TT)**: Some published methods may suggest the use of barium nitrate(V) or barium peroxide in an initiator mix. Refer to CLEAPSS guidance on the *Thermite reaction*; the methods described avoid the use of barium peroxide. This guidance also takes into account the requirements of the current Explosives Regulations (see *Fireworks and explosives*). • **Precipitation reactions:** Use sodium carbonate instead of potassium chromate(VI) for investigations involving the precipitation of barium compounds. **Disposal**: chromate(VI), W2 nitrate(v) and peroxide (solids), WSpec nitrate(v) solutions, W7 → 0.2 M
Barium nitrate(V) solutions	Currently not classified as hazardous	Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **WSpec for barium nitrate(V):** Dissolve the solid in water then add 1 M sodium carbonate to precipitate barium carbonate. Filter off the solid (barium carbonate) for disposal in normal refuse, W8. Rinse the aqueous filtrate (sodium nitrate) down a foul-water drain with plenty of water. • **WSpec for barium peroxide:** Add no more than 5 g in small portions to 1 litre of 1 M sulfuric(VI) acid in a beaker. Leave stirring overnight. Allow solid to settle then decant the liquid layer down a foul-water drain with plenty of water. The solid barium sulfate(VI) can go in the normal refuse, W8.

Benzene diols

Benzene-1,2-diol	*catechol, pyrocatechol, 1,2-dihydroxybenzene (o-dihydroxybenzene)*	$(HO)_2C_6H_4$ (110.11)
Benzene-1,3-diol	*resorcinol, 1,3-dihydroxybenzene (m-dihydroxybenzene)*	$(HO)_2C_6H_4$ (110.11)



WARNING

Both: Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319].

Benzene-1,2-diol: Harmful in contact with skin [H312].

Benzene-1,3-diol: Very toxic to aquatic organisms [H400].

WEL (mg m^{-3}): 23 (LTEL), 69 (STEL); benzene-1,2-diol
46 (LTEL), 92 (STEL), Sk; benzene-1,3-diol

Benzene-1,4-diol	*quinol, hydroquinone, 1,4-dihydroxybenzene (p-dihydroxybenzene)*	$(HO)_2C_6H_4$ (110.11)

DANGER

Harmful if swallowed [H302]. May cause an allergic skin reaction [H317]. Causes serious eye damage [H318]. Suspected of causing genetic defects [H341]. Suspected of causing cancer [H351]. Very toxic to aquatic organisms [H400].

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL)

Storage

Storage code: **GOrg** [White or colourless crystalline solids]

- These compounds are best stored out of direct light.

These substances are dangerous in contact with:

- CONCENTRATED NITRIC(V) ACID. A vigorous (possibly explosive) reaction occurs.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes)**: benzene-1,4-diol.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

12A Risk Assessment Guidance — Benzene diols

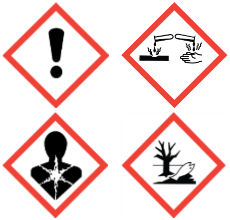
<table>
<tr><td colspan="4">Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk</td></tr>
<tr><th>General use of:</th><th>Hazard information</th><th>User</th><th>Suggested general control measures and guidance</th></tr>
<tr>
<td>Benzene-1,2-diol (<i>catechol</i>)

Benzene-1,3-diol (<i>resorcinol</i>)</td>
<td>
resorcinol
WARNING
(See reverse)</td>
<td>Y7</td>
<td rowspan="2">

Wear eye protection. Wear splash-proof goggles when using benzene-1,4-diol solutions ≥ 0.3 M (~ 3 %).
Take particular care to avoid skin contact (benzene-1,4-diol). See activity-specific guidance and/or GL 120.

Other notes; see also detailed activity-specific guidance:

Benzene-1,2-diol (<i>catechol</i>) turns brown on exposure to air/light.
Developer solutions (for silver halide photography) contain benzene-1,4-diol (<i>quinol, hydroquinone</i>). Hazard classification will depend on the formulation; check supplier information.
The solids are soluble in water at room temperature and are also soluble in ethanol. Check activity-specific guidance for solution hazard information.

<table>
<tr><th></th><th>Solubility (g per 100 cm^3 water)</th></tr>
<tr><td>Benzene-1,2-diol</td><td>43</td></tr>
<tr><td>Benzene-1,3-diol</td><td>140</td></tr>
<tr><td>Benzene-1,4-diol</td><td>7</td></tr>
</table>
Disposal: W4, see also note below
</td>
</tr>
<tr>
<td>Benzene-1,4-diol (<i>quinol</i>)</td>
<td>
DANGER
(See reverse)</td>
<td>Y9</td>
</tr>
</table>

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **Benzene diols**: Dilute aqueous solutions may be disposed of as W7. Check activity-specific guidance.

12B Risk Assessment Guidance **Benzene triols**

Benzene-1,2,3-triol	*pyrogallol, 1,2,3-trihydroxybenzene* $(HO)_3C_6H_3$ (126.11)
 WARNING	Harmful if swallowed, in contact with skin or if inhaled [H302, H312, H332]. Suspected of causing genetic defects [H341]. Harmful to aquatic life with long lasting effects [H412].

Benzene-1,3,5-triol	*phloroglucinol, 1,3,5-trihydroxybenzene* $(HO)_3C_6H_3$ (126.11)
 WARNING	Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

Storage	Storage code: **GOrg** [White or colourless crystalline solids]

These substances are dangerous in contact with:

- CONCENTRATED NITRIC(V) ACID. A vigorous (possibly explosive) reaction occurs.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

12B Risk Assessment Guidance

Benzene triols

<table>
<tr><td colspan="4">Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk</td></tr>
<tr><th>General use of:</th><th>Hazard information</th><th>User</th><th>Suggested general control measures and guidance</th></tr>
<tr><td>Benzene-1,2,3-triol
(pyrogallol)</td><td>
WARNING
(See reverse)</td><td>Y9</td><td rowspan="2">

- Wear eye protection.

Other notes; see also detailed activity-specific guidance:

- These compounds are sensitive to air/light (discolour).
- **Alkaline pyrogallol solutions:** These are sometimes suggested for certain gas analysis activities. However, solutions in very concentrated sodium or potassium hydroxide are hazardous to prepare and use. Safer alternatives are possible depending on the requirements of the activity.
- The solids are soluble in water at room temperature and are also soluble in ethanol. Check activity-specific guidance for solution hazard information.

<table>
<tr><th></th><th>Solubility (g per 100 cm^3 water)</th></tr>
<tr><td>Benzene-1,2,3-triol</td><td>40</td></tr>
<tr><td>Benzene-1,3,5-triol</td><td>1</td></tr>
</table>

Disposal: W4, see also note below
</td></tr>
<tr><td>Benzene-1,3,5-triol
(phloroglucinol)</td><td>
WARNING
(See reverse)</td><td>Y7</td></tr>
</table>

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • Dilute aqueous solutions may be disposed of as W7. Check activity-specific guidance.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

13A Risk Assessment Guidance

Benzoic acid & related compounds

Benzoic acid	*benzenecarboxylic acid* C_6H_5COOH (122.12)
  DANGER	Causes skin irritation [H315]. Causes serious eye damage [H318]. Causes damage to organs (lungs) through prolonged or repeated exposure (inhalation) [H372].

Benzoyl chloride	*benzenecarbonyl chloride* (see *Hazcard* 41 for other acid chlorides) C_6H_5COCl (140.57)
  DANGER	Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Causes severe skin burns & eye damage [H314]. May cause an allergic skin reaction [H317]. Harmful if inhaled [H332]. Note: Vapour is lachrymatory; irritates eyes and causes them to water. Flashpoint: 72 °C.

Benzamide	*benzenecarboxamide* $C_6H_5CONH_2$ (121.14)
Benzonitrile	*benzenecarbonitrile, phenyl cyanide* C_6H_5CN (103.12)
  benzamide WARNING	**Both**: Harmful if swallowed [H302]. **Benzonitrile**: Harmful in contact with skin [H312]. **Benzamide**: Suspected of causing genetic defects [H341].

Storage	Storage Codes: **GOrg** (benzoic acid, benzamide, benzonitrile); **CW** (Organic) (benzoyl chloride): • **Benzoic acid**, **benzamide**: white solids, faint odours. **Benzonitrile**: colourless liquid, 'almond-like' odour. • **Benzoyl chloride**: colourless liquid, pungent odour. Reacts with water vapour in the atmosphere to produce hydrogen chloride gas. Store the bottle inside another container that also contains soda lime.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (skin, eyes), TOXIC (inhalation)**: benzoyl chloride. **CORROSIVE (eyes)**: benzoic acid. • **General spills/clearing up (benzoyl chloride)**: **CORROSIVE WATER-REACTIVE.** Hydrogen chloride gas forms. If safe to deal with: Ventilate area as much as possible. Cover spill with absorbent. Scoop into a bucket and take to a fume cupboard. Add a large excess of water and leave to hydrolyse before neutralising the mixture with sodium carbonate. Liquid portion → foul water drain. Rinsed solid absorbent → normal refuse.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

13A Risk Assessment Guidance — Benzoic acid & related compounds

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Benzoic acid	 DANGER (See reverse)	Y7	• Wear eye protection. • Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance:** • **Heating benzoic acid**: This solid can be used for crystallisation and sublimation activities but steps should be taken to minimise the escape of vapour (eg, use a mineral wool plug in the open end of test-tubes). • **Reactions of amides:** Benzamide can be used in place of ethanamide. **Disposal**: W4 (benzoic acid) or W2
Benzamide	 WARNING (See reverse)		
Benzoyl chloride	 DANGER (See reverse)	Y12	• Wear eye protection. Wear splash-proof goggles for benzoyl chloride. • Take particular care to avoid skin contact (benzoyl chloride). See activity-specific guidance and/or GL 120. • Use a fume cupboard (benzoyl chloride). Do **not** inhale fumes. • Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance:** • **Hydrolysis of nitriles:** benzonitrile can be used as a safer alternative to ethanenitrile (acetonitrile; volatile and highly flammable). **Disposal**: W4 (benzoyl chloride, see note below) or W2
Benzonitrile	 DANGER (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W4 (benzoyl chloride)**: Use a fume cupboard. Cautiously, add no more than 40 cm^3 of the liquid in small portions (~ 5 cm^3) to 1 litre of 1 M sodium carbonate solution.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

13B Risk Assessment Guidance Phthalic acid and related compounds

Phthalic acid	*benzene-1,2-dicarboxylic acid*	$C_6H_4(COOH)_2$ (166.13)
Terephthalic acid	*benzene-1,4-dicarboxylic acid*	$C_6H_4(COOH)_2$ (166.13)
 WARNING	Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: Some suppliers may indicate no hazards for terephthalic acid.	

Phthalic anhydride	*benzene-1,2-dicarboxylic anhydride*	$C_8H_4O_3$ (148.12)
 DANGER	Harmful if swallowed [H302]. Causes skin irritation [H315]. May cause an allergic skin reaction [H317]. Causes serious eye damage [H318]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. May cause respiratory irritation [H335]. WEL (mg m^{-3}): 4 (LTEL), 12 (STEL); Sen	

Storage	Storage code: **GOrg**	[Colourless/white solids]

Potassium hydrogen phthalate	*potassium hydrogen benzene-1,2-dicarboxylate*	$KHC_8H_4O_4$ (204.22)
Currently not classified as hazardous.		
Storage	Storage code: **GIn**	[White solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (eyes)**: phthalic anhydride.

13B Risk Assessment Guidance **Phthalic acid and related compounds**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
• Phthalic acid • Terephthalic acid	 WARNING (See reverse)	Y9	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **Identifying organic functional groups**: Phthalic acid and terephthalic acid each contain two groups and are useful as 'unknowns' in analysis activities. • **Preparation of solutions (potassium hydrogen phthalate)**: See *Recipe* 18 (buffer solutions) and *Recipe* 94 (standard solutions). **Disposal**: phthalic/terephthalic acids, W2, W4 potassium hydrogen phthalate, W7
Potassium hydrogen phthalate	Currently not classified as hazardous	Y7	
Phthalic anhydride	 DANGER (See reverse)	TT (Y12)	• Wear eye protection. • Ensure laboratory is well-ventilated. Do **not** inhale fumes. Some activities, especially those involving heating, will require use of a fume cupboard. Check activity-specific guidance. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Disposal:** W2

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

13C Risk Assessment Guidance — Other aromatic acids

4-aminobenzoic acid	*p-aminobenzoic acid (PABA), 4-aminobenzenecarboxylic acid,*	$H_2NC_6H_4COOH$ (137.14)
2-aminobenzoic acid	*o-aminobenzoic acid, 2-aminobenzenecarboxylic acid, anthranilic acid*	$H_2NC_6H_4COOH$ (137.14)
⚠ WARNING	Note: Classification and labelling vary. Suppliers may indicate one or more of: Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].	
Storage	Storage code: **GOrg**	[Off-white crystalline solid]

3-nitrobenzoic acid	*3-nitrobenzenecarboxylic acid*	$NO_2C_6H_4COOH$ (141.3)
⚠ WARNING	Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].	
Storage	Storage code: **GOrg**	[Colourless crystalline solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

13C Risk Assessment Guidance

Other aromatic acids

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• 4-aminobenzoic acid • 2-aminobenzoic acid	 WARNING (See reverse)	Y7	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **Identifying organic functional groups**: 4-aminobenzoic acid contains two functional groups and is useful as an 'unknown' in analysis activities. Do not confuse with the other isomer (2-aminobenzoic acid, anthranilic acid) as this exhibits different properties. **Disposal**: W7, see notes below
3-nitrobenzoic acid	 WARNING (See reverse)		• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **3-nitrobenzoic acid**: This is formed by the hydrolysis of methyl 3-nitrobenzoate which schools may have samples of from organic synthesis activities (eg, nitration of methyl benzoate). **Disposal**: W4, W2; see notes below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W7 (2-/4-aminobenzoic acid)**: The solids are not very soluble. Add no more than 4 g to 1 litre of water and rinse down a foul-water drain. • **W4 (3-nitrobenzoic acid)**: Add no more than 10 g of the solid to 1 litre of 1 M sodium carbonate solution. Rinse the resulting solution down a foul-water drain with further dilution.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

14A Risk Assessment Guidance **Boron compounds(1)**

Disodium tetraborate-10-water	*disodium tetraborate decahydrate, borax*	$Na_2B_4O_7.10H_2O$ (381.37)
Boric acid	*boracic acid*	H_3BO_3 (61.83)

 DANGER	May damage fertility. May damage the unborn child [H360FD]. **Boric acid is dangerous in contact with**: • POTASSIUM and ETHANOIC ANHYDRIDE. Vigorous reactions occur when heated. WEL (mg m^{-3}): 5 (LTEL), 15 (STEL); disodium tetraborate-10-water (borax)
Storage	Storage code: **GIn** [Borax: white crystals. Boric acid: colourless crystals] • Avoid using *anhydrous* disodium tetraborate as this is more prone to producing a dust.

Sodium peroxoborate-4-water	*sodium perborate*	$NaBO_3.4H_2O$ (153.86)

 DANGER	May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Causes serious eye damage [H318]. May cause respiratory irritation [H335]. May damage the unborn child. Suspected of damaging fertility [H360Df].
Storage	Storage code: **Ox** [White crystals]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

14A Risk Assessment Guidance — Boron compounds(1)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Borax solid, and solutions ≥ 0.2 M (Saturated solution ~ 0.2M)	DANGER May damage fertility. May damage the unborn child.	TT (Y7)	• Wear eye protection. • Avoid raising a dust when dispensing/transferring solids (eg, when making solutions from solid reagents); **TT only**. Student use of prepared solutions is acceptable only if the teacher is confident that the risks can be adequately controlled. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Weighing the solids/preparing solutions (TT)**: Weigh on a balance placed in a fume cupboard that is **not** switched on. Have sash partially down. • **Making 'slime', 'silly putty' (and similar materials)**: Follow detailed activity-specific guidance (and see *Recipe* 78). Wear disposable gloves if the slime is to be handled. Do **not** allow students to take 'slime' (or similar) out of the laboratory. • **Making 'snowflakes' (crystallisation)**: To avoid the use of borax, see alternative activity in *Snow scene crystals*. **Disposal**: W7, see notes below
Borax solutions < 0.2 M	Currently not classified as hazardous.		
Boric acid solid, and solutions ≥ 0.9 M (Saturated solution: ~ 0.9M)	DANGER May damage fertility. May damage the unborn child.		
Boric acid solutions < 0.9 M	Currently not classified as hazardous.		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W7 (solid)**: Dissolve 1 g of the solid in 1 litre of water. Pour down a foul-water drain with further dilution. (Note: sodium perborate is not very soluble).

Sodium tetrahydridoborate(III) *sodium borohydride* $NaBH_4$ (37.83)

DANGER

In contact with water releases flammable gases which may ignite spontaneously [H260]. Toxic if swallowed [H301]. Causes severe skin burns and eye damage [H314]. May damage fertility or the unborn child [H360FD].

Sodium borohydride is dangerous in contact with:

- ACIDS and ALKALIS, both concentrated and dilute; explosions have been known to occur.
- WATER. Hydrogen gas is produced.

Storage

Storage code: **FW** [White cubic crystals; hygroscopic]

- Hydrogen gas (extremely flammable) is evolved if the solid becomes wet.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **TOXIC (ingestion), CORROSIVE (skin, eyes)**.
- **General spills/clearing up**: **FLAMMABLE WATER REACTIVE**. Collect up dry. Ensure no naked flames or other ignition sources. Hydrogen gas is produced if the solid becomes wet.

14B Risk Assessment Guidance **Boron compounds (2)**

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Sodium borohydride solid	 DANGER (See reverse)	Y12	• Wear splash-proof goggles. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. • Avoid raising dust. • Avoid inadvertent contact with water and ensure no naked flames or other ignition sources when transferring or dispensing. **Other notes; see also detailed activity-specific guidance**: • **Weighing the solid**: Weigh on a balance placed in a fume cupboard that is **not** switched on. Have sash partially down. **Disposal**: WSpec, see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **WSpec**: Use a fume cupboard. Ensure no naked flames or other ignition sources. Add no more than 5 g of the solid, in 0.5 g portions, to at least 400 cm^3 of water in a large beaker. After each addition, allow the reaction to finish before adding the next portion. Pour solution down a foul-water drain with further dilution.

15A Risk Assessment Guidance (see also **15B**)

Bromine liquid, Br_2(l)

Bromine Br_2 (160.0)

DANGER

Fatal if inhaled [H330]. Causes severe skin burns and eye damage [H314]. Very toxic to aquatic organisms [H400].

Bromine liquid is dangerous in contact with:

- AMMONIA solution (concentrated). An explosive product is formed.
- SODIUM, POTASSIUM, ALUMINIUM, MAGNESIUM, MERCURY; ALCOHOLS, ETHERS and other organic compounds. Violent or very violent reactions occur.

WEL (mg m^{-3}): 0.66 (LTEL); 1.3 (STEL). See **Emergencies (inhalation)** below.

Storage

Storage code: **Spec**, see notes below [Dark red-brown volatile liquid; brown-orange fumes]

- Keep the following next to liquid bromine at all times: At least 500 cm^3 of 1 M sodium carbonate and also a container of solid hydrated sodium carbonate (washing soda) for treating spills on hard surfaces.
- **Bromine liquid supplied in bottles**: Place bottle inside another lidded container with soda lime to absorb fumes (renew this regularly; bromine fumes accelerate the corrosion of metal). This container can then be kept on shelves with general inorganics (GIn) in a secure store. Regularly check condition of bottle caps/container lids; they can split. Purchase only small quantities (100 cm^3 or less; or purchase ampoules).
- **Bromine liquid supplied in ampoules**: Keep ampoules (usually 1 cm^3 of bromine/ampoule) in their protective packaging with other corrosives. Take only the required number of ampoules to prep room or laboratory.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **VERY TOXIC (inhalation), BEWARE DELAYED EFFECTS.**
- **CORROSIVE (skin, eyes)**: Liquid and vapour.
- **General spills/clearing up**. If more than 0.2 cm^3: **Immediately evacuate** the spill area, open windows and external doors (if safe to do so), switch on fans etc. Prevent access to the area. Consider if wider evacuation is required. If safe to do so: re-enter after 1 hour and treat the spill area. Much depends on the volume involved (eg, a bottle/ampoule breaking or spilling) but it may be necessary to call the Fire and Rescue Service.

  If less than 0.2 cm^3 (i.e. just a few drops): Add solid hydrated sodium carbonate (or 1 M sodium carbonate solution) then clear up as usual.

15A Risk Assessment Guidance (see also **15B**)

Bromine liquid, $Br_2(l)$

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Bromine liquid	   DANGER (See reverse)	TT (Y12)	• Wear splash-proof goggles. Protect the face when transferring or dispensing the liquid or when opening ampoules. • Use a fume cupboard. Do **not** inhale vapour. • Wear gloves. (If bromine is on gloves, they should be washed and then disposed of as the glove material may have degraded). **Other notes; see also activity-specific guidance**: • **Transferring bromine liquid**: Use a plastic dropper pipette. Hold the teat end with fingertips at the base of teat/top of stem. Do not wrap hand around teat; warmth from the hand or inadvertent pressure can cause bromine to squirt out. • **Opening ampoules of bromine (TT)**: See *Recipe* 17. • **Preparing bromine water (TT)**: See *Hazcard* 15B and *Recipe* 17. • **Diffusion demonstrations (TT)**: See *Safer chemicals, safer reactions*. **Disposal**: W4, see below

BEWARE DELAYED EFFECTS.

Effects of exposure by inhalation can increase over time. Inhalation by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions.

If affected, call the emergency services, informing them of the quantity of bromine liquid involved.

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **W4**: Use a fume cupboard. Wear splash-proof goggles. Protect the face. Wear gloves. Add bromine liquid slowly, in 1 cm^3 portions with stirring, to 1 litre of 1 M sodium carbonate solution in a 2 litre **glass** beaker then pour the mixture down a foul-water drain with further dilution. Deal with no more than a few cm^3 of bromine in this way. **Disposal of bromine liquid in the manner described here should be considered only if absolutely necessary. Disposal via a Registered Waste Carrier is preferred (W2)**.

15B Risk Assessment Guidance (see also **15A**) **Bromine water, $Br_2(aq)$**

Bromine Br_2 (160.0)

DANGER

Fatal if inhaled [H330]. Causes severe skin burns and eye damage [H314]. Very toxic to aquatic organisms [H400].

The hazard information here relates to that of pure bromine (liquid and vapour). See *Hazcard* 15A. Classification of <u>aqueous</u> bromine solutions ('bromine water') depends on concentration (see reverse). Note also Emergencies information (see below).

Bromine (liquid) is dangerous in contact with:

- AMMONIA solution (concentrated). An explosive product is formed.
- SODIUM, POTASSIUM, ALUMINIUM, MAGNESIUM, MERCURY; ALCOHOLS, ETHERS and other organic compounds. Violent or very violent reactions occur.

WEL (mg m^{-3}): 0.66 (LTEL); 1.3 (STEL) as bromine. See also **Emergencies (inhalation)** below.

Storage

Storage code: **GIn** [Orange-pale yellow solution]

- Bromine vapour diffuses from solutions. Fumes affect the respiratory system and will accelerate the corrosion of metals. Do **not** store in metal cabinets.
- Bromine water becomes paler as bromine is lost (by diffusion), especially in warm conditions. Check that the solution gives desired effect for the practical activity being undertaken.
- Prepare aqueous bromine solutions just before use. Store in screw-top glass bottles (avoid using 'polystop' lids). Regularly check the condition of container lids; they will discolour and can split. Replace if necessary.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **VERY TOXIC (inhalation), BEWARE DELAYED EFFECTS:** Bromine vapour.
- **General spills/clearing up**: Much depends on the volume and concentration of solution.

  <u>If safe to do so</u>: Ventilate the area as much as possible. Use disposable paper towels or other absorbent for small spills. If affected by fumes, move out of the area to fresh air and take steps to prevent access to the area of the spill. See also *Hazcard* 15A.

15B Risk Assessment Guidance (see also **15A**) **Bromine water, $Br_2(aq)$**

BEWARE DELAYED EFFECTS. Bromine is acutely toxic by inhalation. Effects of exposure by inhalation of bromine can increase over time. Inhalation by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions. If affected, call the emergency services, informing them of the quantity/concentration of bromine involved.

Bromine vapour diffuses from solutions. At concentrations ≥ 0.01 M, the WEL (STEL) is rapidly approached in localised situations (eg, just above open test-tubes or bottles) and inhalation of vapour would act *at least* as a respiratory irritant. Take this into account in addition to the information below. It is advisable to include a warning to this effect on any labels used on prepared solutions (see suggested control measures for additional guidance on what to include).

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**

Bromine water
≥ 0.2 M
(See **Other notes**)
	
	DANGER
	Corrosive (eyes)
	Irritant (skin)
		TT	**See notes above about bromine vapour**.
			• Wear eye protection. Wear splash-proof goggles for corrosive solutions.
			• Do **not** inhale vapour. Ensure the laboratory is well-ventilated.
			  · Solutions ≥ 0.2 M: Use a fume cupboard.
			  · Solutions < 0.2 M: Use a fume cupboard when transferring or dispensing large volumes and also for storing bottles put out ready for use.
			• Wear gloves when transferring/dispensing large volumes.
			Other notes; see also activity-specific guidance:
			• The solubility of bromine in water is ~ 0.25 M at room temperature.
			• **Preparation of aqueous bromine solutions (‘bromine water’)**: See *Recipe* 17. Three methods are described (Methods 2 and 3 do not require the use of liquid bromine). Seek additional guidance/training before attempting this procedure for the first time.
			• **General use of bromine water**: Use the most dilute solution possible to the obtain desired result (eg, 0.002M is suitable to test for unsaturation and for halogen/halide displacement reactions).
			Disposal: W4 in a fume cupboard

Bromine water < 0.2 M & ≥ 0.06 M	 WARNING Irritant (eyes, skin)	Y9	
Bromine water < 0.06 M	Currently not classified as hazardous	Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Calcium and strontium

Calcium Ca (40.08)

Strontium Sr (87.62)

DANGER

Calcium: In contact with water releases flammable gases [H261].

Strontium: In contact with water releases flammable gases which may ignite spontaneously [H260]. Causes skin irritation [H315].

These substances are dangerous in contact with:

- WATER, ACIDS. Hydrogen gas is given off which may ignite from the heat of reaction (in some circumstances).
- SULFUR. An explosive reaction occurs.
- HYDROXIDES/CARBONATES of SODIUM, POTASSIUM and other ALKALI METALS. Reactions may be explosive.

Storage

Storage code: **FW** [Silver-grey metallic granules or irregular-size/shape pieces]

- **Calcium**: A grey-white oxide layer may form on granules/pieces. Purchase small quantities (eg, 25 g) and store in an air-tight container to minimise oxidation.

  Note: It may be more difficult to purchase calcium metal in the form of the small, almost spherical, granules (~ 1-2 mm diameter) many are familiar with. Instead, the metal may now be supplied as irregularly-sized/shaped pieces (eg, with sizes ranging from 2-6 mm, or over, in the same sample). Variable surface area will affect how quickly the calcium oxidises and also how it reacts with water and other reagents. See **Other notes** (on reverse).

- **Strontium**: Sometimes supplied stored under argon. Once opened, the metal can be stored dry in an air-tight container or stored under medicinal paraffin (as for barium).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes), alkali.**
- **If metals catch fire**: They are difficult to ignite but burn vigorously once lit and are then difficult to extinguish. Extinguish small fires by smothering with clean, **dry** sand (keep a container of sand specifically for this purpose).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

16 Risk Assessment Guidance

Calcium and strontium

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Calcium	 DANGER (See reverse)	TT (Y7)	• Wear eye protection. Splash-proof goggles may be advised for some activities, see activity-specific guidance and/or GL 120. • Take particular care to avoid skin contact. Use forceps or a spatula to transfer the pieces of metal. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Reaction of calcium with water or dilute acid (0.4 M hydrochloric acid):** The reaction is exothermic and can accelerate out of control if insufficient liquid is used or the piece of metal is too large. Very irregular shaped pieces can react unpredictably. These reactions are not suitable for the preparation of hydrogen gas. The resulting solution from the reaction of calcium with water will be alkaline and (at least) irritating to skin/eyes. · **Student activity (Y7):** Use 1-2 pieces no more than 4 mm in size and at least 40-50 cm^3 of liquid in a 100 cm^3 beaker. · **Teacher demonstration**: Pieces of calcium larger than 4 mm may be reacted in **larger** beakers (250-400 cm^3) half-filled with liquid. **Disposal**: W5, see note below
Strontium	 DANGER (See reverse)	TT	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • Use a fume cupboard with no sources of ignition present.

17 Risk Assessment Guidance — Calcium chlorate(I), $Ca(OCl)_2$

Calcium chlorate(I) *calcium hypochlorite, calcium oxychloride, (bleaching powder)* $Ca(OCl)_2$ (142.98)

DANGER

May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Causes severe skin burns and eye damage [H314]. Contact with acids liberates toxic gas [EUH031]. Very toxic to aquatic life [H400].

Calcium chlorate(I) is dangerous in contact with:

- ACIDS. Chlorine gas (toxic) is liberated.
- CONCENTRATED SULFURIC(VI) ACID. A dangerous reaction occurs.
- AMMONIUM SALTS. Explosive products are formed.
- METHANOL, ETHANOL, PROPANE-1,2,3-TRIOL, many other ORGANIC SUBSTANCES and SULFUR. Dangerous reactions occur.
- RUST. Self-accelerating decomposition is catalysed.

WEL (mg m^{-3}): 1.5 (STEL); as chlorine

Storage

Storage code: **Ox** [White-grey solid (granules/powder); strong chlorine smell]

- Chlorine content ('% available chlorine') varies depending on grade purchased.
- Once a bottle is opened, the potential 'available chlorine' gradually decreases (the solid slowly liberates chlorine). Old samples may not behave as expected in practical activities, test for chlorine content before use.
- Old stock may become explosive, especially if contaminated with traces of metal.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

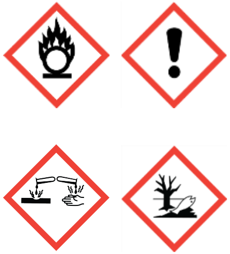
- **CORROSIVE (skin, eyes, inhalation).**
- **General spills (solid)**: **OXIDISING, CORROSIVE**.

  If safe to deal with: Take care to avoid raising dust. Carefully scoop or sweep solid into a clean, dry container. Small quantities may be treated as described in **Disposal** (see reverse).

  Clearing up: Treat as **OXIDISING**.

17 Risk Assessment Guidance **Calcium chlorate(I), $Ca(OCl)_2$**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Calcium chlorate(I)	 DANGER Oxidising. Harmful (ingestion). Corrosive (skin, eyes). Contact with acids liberates toxic gas (chlorine). Very toxic to aquatic life.	TT (Y9)	• Wear splash-proof goggles. • Avoid raising dust. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. • Open containers in a well-ventilated room (or use a fume cupboard). **Other notes; see also detailed activity-specific guidance:** • **General**: Check activity details carefully as many procedures will generate toxic chlorine gas (see *Hazcard* 22A). A fume cupboard may be required depending on the quantities involved. Ensure the room is well-ventilated. • **Preparation of chlorine gas (large-scale; TT)**: See *Recipe* 24. **Disposal:** WSpec, see note below

Disposal	**Follow general guidance *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **WSpec**: Ensure room is well-ventilated or use a fume cupboard. Add no more than 10 g of the solid to 1 litre of water and pour the suspension down a foul-water drain. If the sample is known to have low chlorine content, then more solid can be added to the water.

18 Risk Assessment Guidance **Calcium oxide; calcium and strontium hydroxides**

Calcium oxide	*quicklime*	CaO (56.08)
Calcium hydroxide	*slaked lime*	$Ca(OH)_2$ (74.09)
Strontium hydroxide-8-water	*hydrated strontium hydroxide*	$Sr(OH)_2.8H_2O$ (265.76)

DANGER

Calcium oxide, calcium hydroxide: Causes skin irritation [H315]. Causes serious eye damage [H318].

Strontium hydroxide: Causes severe skin burns and eye damage [H314].

All: May cause respiratory irritation [H335].

Calcium oxide is dangerous in contact with:

- WATER. Vigorous reaction occurs that generates heat. Dust may be ejected and enter eyes. Under some conditions, the temperature rise is sufficient to ignite combustible material.

WEL (mg m^{-3}): 2 (LTEL), 6 (STEL); 1 (LTEL), 4 (STEL), as respirable dust; calcium oxide
5 (LTEL), 15 (STEL); 1 (LTEL), 4 (STEL), as respirable dust; calcium hydroxide

Storage

Storage code: **CS** [White crystalline solids or powders]

- Solids react with atmospheric carbon dioxide and, once the container is opened, will deteriorate quite rapidly. Older samples of the solids may not react as expected in practical activities.
- Calcium oxide also reacts with moisture to form the hydroxide. Containers have been known to burst due to expansion as the oxide becomes hydrated. Storing the container of calcium oxide inside another (eg, plastic, lidded box or a strong plastic bag) will minimise powder spills if the original container bursts.
- Purchase small quantities and only when required. Check state of containers and their contents on a regular basis (eg, once per term). If any signs of deterioration, dispose of as W1.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes, inhalation), alkali:** Solids and solutions.
- **General spills (solid)**: Large-scale spills (eg, a burst container) can be difficult to deal with. Contact CLEAPSS.

18 Risk Assessment Guidance **Calcium oxide; calcium and strontium hydroxides**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Calcium oxide	 DANGER Corrosive (eyes) Irritant (skin) Irritant (respiratory)	Y9	• Wear eye protection. • Avoid raising dust. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Preparation of limewater (TT):** see *Recipe* 20. • **General use of limewater (Y7)**: Currently, limewater solution is not classified as hazardous even though it has a pH of 12.4. It is appropriate to treat it as at least a skin and eye irritant. • **Testing for carbon dioxide with limewater (blowing into limewater):** This activity has caused accidents with the alkaline solution splashing into students' eyes when they blow too hard. Students may also suck rather than blow. • **General use of strontium hydroxide solutions:** Treat as at least skin and eye irritants. **Disposal:** calcium oxide, WSpec; see below calcium/strontium hydroxide, W5
Calcium hydroxide (see **Other notes** for limewater)		Y7	
Strontium hydroxide (See **Other notes** for solutions)	 DANGER Corrosive (skin, eyes)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • **WSpec (calcium oxide solid)**: Add solid in small spatula measures to 1 litre of water. Allow reaction to subside before adding more solid. Treat resulting solution as for calcium hydroxide waste (W5).

19A Risk Assessment Guidance

Calcium and strontium salts (1)

Calcium chloride	*anhydrous calcium chloride*	$CaCl_2$ (110.984)
Calcium chloride-6-water	*hydrated calcium chloride*	$CaCl_2.6H_2O$ (219.08)
Calcium bromide	*anhydrous calcium bromide (there are also various hydrates)*	$CaBr_2$ (199.88)
Strontium chloride-6-water	*hydrated strontium chloride*	$SrCl_2.6H_2O$ (266.62)

⚠ WARNING	Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: Classification/labelling vary and may differ from that given here. **Anhydrous calcium chloride is dangerous in contact with:** • WATER. Anhydrous calcium chloride can cause water to boil.
Storage	Storage code: **GIn** [Colourless/white solids] • These compounds absorb water from the atmosphere (i.e. are hygroscopic).

Calcium fluoride	*also fluorite, fluorspar (eg, Blue John)*	CaF_2 (78.075)

⚠ WARNING	Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: Classification/labelling vary and may differ from that given here. **Calcium fluoride is dangerous in contact with**: • CONCENTRATED ACIDS. Hydrogen fluoride is produced: corrosive, very toxic (inhalation, ingestion, skin). WEL (mg m^{-3}): 2.5 (LTEL), 7.5 (STEL) as fluoride
Storage	Storage code: **GIn** [Colourless/white crystalline solid] • Calcium fluoride is a colourless, almost insoluble compound. The naturally occurring mineral (fluorite/fluorspar) is often deeply coloured due to impurities (eg, Blue John).

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

19A Risk Assessment Guidance — Calcium and strontium salts (1)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solids: - Calcium chloride - Strontium chloride - Calcium bromide	 WARNING (See reverse)	Y7	- Wear eye protection. **Other notes; see also detailed activity-specific guidance:** - **Anhydrous calcium chloride as a drying agent for gases**: Do **not** use calcium chloride to dry ammonia gas. - **Preparation of calcium chloride solutions**: Do **not** use the anhydrous salt. See *Recipe* 19. - **Preparation of strontium chloride solutions**: See *Recipe* 95. **Disposal:** W7, see note below
Solutions (chloride): ≥ 0.9 M (calcium salt) ≥ 0.6 M (strontium salt)	 WARNING Irritant (skin, eyes)		
Solutions (bromide): ≥ 0.5 M			
Calcium fluoride solid	 WARNING (See reverse)		- Wear eye protection. - Avoid inadvertent contact with concentrated acid. **Disposal**: W1, W2

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** - **W7 (calcium/strontium chloride salts):** Add no more than 75 g in small portions to 1 litre of water. Be aware that anhydrous calcium chloride may generate a significant temperature rise. Pour cool solution down a foul-water drain with further dilution.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

19B Risk Assessment Guidance

Calcium and strontium salts (2)

Calcium chromate(VI)-2-water	$CaCrO_4.2H_2O$ (192.10)
 DANGER	Harmful if swallowed [H302]. May cause cancer [H350]. Very toxic to aquatic life with long lasting effects [H400/H410]. WEL (mg m^{-3}): 0.05 (LTEL), 0.15 (STEL) as chromium. Carc, Sen.
Storage	Storage code: **Situ** (see **Other notes** on reverse) [Yellow solid]

Calcium nitrate(V)-4-water	*hydrated calcium nitrate*	$Ca(NO_3)_2.4H_2O$ (236.15)
Strontium nitrate(V)-4-water	*hydrated strontium nitrate*	$Sr(NO_3)_2.4H_2O$ (283.69)

 DANGER	May intensify fire; oxidiser [H272]. Causes serious eye damage [H318]. Note: Classification/labelling vary. Suppliers may indicate Causes serious eye irritation [H319] with the GHS07 pictogram instead of GHS05 (corrosive). Anhydrous strontium nitrate(V) may be listed in suppliers' catalogues rather the hydrated form (molar mass: 211.63).
Storage	Storage code: **Ox** [Colourless/white solids] • These compounds absorb water from the atmosphere (hygroscopic).

Calcium carbonate	*chalk, limestone, marble (chips), calcite*	$CaCO_3$ (100.09)
Calcium sulfate(VI)-0.5-water	*calcium sulfate hemihydrate, plaster of Paris*	$CaSO_4.0.5H_2O$ (145.15)
Calcium sulfate(VI)-2-water	*calcium sulfate dihydrate, gypsum*	$CaSO_4.2H_2O$ (172.17)

Currently not classified as hazardous. WEL (mg m^{-3}): 10 (LTEL), 40 (STEL), calcium carbonate as inhalable dust.

Storage	Storage code: **GIn** [White solids]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (eyes):** nitrate. • **General spills/clearing up: OXIDISING (nitrate**).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

19B Risk Assessment Guidance — Calcium and strontium salts (2)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Calcium chromate(VI)	 DANGER (See reverse)	Y9	• Wear eye protection. • Wear splash-proof goggles for corrosive nitrate(V) solutions. • Take particular care to avoid skin contact (chromate). See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Precipitation reactions involving calcium chromate(VI)**: Use alternatives to chromate(VI) salts whenever possible. Use small volumes (< 1 cm^3). Do not attempt to isolate precipitated calcium chromate(VI). Pour residue down a foul-water drain with plenty of water. • **Using plaster of Paris**: Reaction with water is exothermic; the mixture gets very hot, expands slightly and sets hard. Do **not** make plaster casts of parts of the body as encased parts may become trapped and severely burned. Use alternatives when possible. See *Using plaster of Paris in schools*. • **Preparing calcium/strontium nitrate(V) solutions**: *Recipes* 19 & 95. **Disposal**: chromate(VI), W7; see below nitrate(v), W7 → 0.1 M carbonate, W8 sulfates(VI), see below
Nitrate(V): solids, and solutions ≥ 0.15 M	 (solid)  (solid/solution) DANGER (See reverse)	Y7	
Nitrate(V): solutions < 0.15 M & ≥ 0.05 M	 WARNING Irritant (eyes)		
• Calcium carbonate • Calcium sulfates	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only**: • **W7 for chromate(VI):** Dissolve 1 g in 1 litre of water and flush down a foul-water drain. • **Sulfates(VI), including plaster of Paris: W1** (or via special waste section at local recycling facility) only.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Calcium carbide & calcium phosphide

Calcium carbide

calcium dicarbide, calcium acetylide CaC_2 (64.10)

DANGER

In contact with water releases flammable gases which may ignite spontaneously [H260].

Note: Classification/labelling vary. Some suppliers may also indicate one or more of: Causes skin irritation [H315]. Causes serious eye damage [H318]. May cause respiratory irritation [H335]. The GHS05 pictogram (corrosive) would then be shown.

Calcium carbide is dangerous in contact with:

- WATER. Ethyne (acetylene) gas is produced.

Storage

Storage code: **FW** [Grey-black solid]

- Calcium carbide is usually supplied as granules (see **Other notes** on reverse). If the solid has become white or has a white surface, then it is deteriorating. The white solid is calcium hydroxide.
- Regularly examine tins of calcium carbide for signs of rust.

Calcium phosphide

Ca_3P_2 (182.18)

DANGER

In contact with water releases flammable gases which may ignite spontaneously [H260]. Contact with water liberates toxic gas [EUH029]. Contact with acids liberates very toxic gas [EUH032]. Fatal if swallowed [H300]. Toxic in contact with skin [H311]. Fatal if inhaled [H330]. Causes serious eye damage [H318]. Very toxic to aquatic life [H400].

Calcium phosphide is dangerous in contact with:

- WATER. Phosphine is liberated; spontaneously ignites in air (due to presence of diphosphine).

WEL (mg m^{-3}): 0.14 (LTEL), 0.28 (STEL), phosphine.

Storage

Storage code: **FW** [Red-brown/grey solid]

Emergencies

Follow standard procedures (See *Emergency Hazcards* and GL 120). NOTE:

- **If calcium carbide catches fire:** Treat with a large excess of clean, dry sand.
- **CORROSIVE (eyes):** Calcium carbide.
- **VERY TOXIC (ingestion, inhalation). TOXIC (skin):** Calcium phosphide. **Call 999.**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

19C Risk Assessment Guidance — Calcium carbide & calcium phosphide

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Calcium carbide	 DANGER (See reverse)	TT (Y12)	• Wear splash-proof goggles. • Use in a fume cupboard (calcium phosphide). Ensure laboratory is well-ventilated. Ensure no naked flames or other ignition sources in the vicinity. • Take precautions to avoid inadvertent contact with water or acids. • Take particular care to avoid skin contact. See activity-specific advice &/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Use of calcium carbide.** Sometimes supplied in large lumps rather than granules. Use a hammer to break these up; place the lumps in a strong **dry** bag and protect with several layers of newspaper. Wear eye protection and protect the face. Contact CLEAPSS for further advice if needed. • **Preparation of ethyne (small-scale)**: Use only 2-3 small pieces/granules of calcium carbide in a test-tube. Add 2-3 drops of water. Collect the ethyne gas generated (see *Hazcard* 45C) over water. Do **not** scale up. • **Demonstrations with calcium carbide**: See *Flammable ice.* • **Use of calcium phosphide/generation of phosphine**: Seek additional training or advice before using for the first time. Contact CLEAPSS. **Disposal:** W1, WSpec, see notes below
Calcium phosphide	 DANGER (See reverse)	TT	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **WSpec:** Work in a fume cupboard. Add a few small pieces/granules at a time to at least 1 litre of water. Allow reaction to subside before adding more solid. Flush the resulting solution* down a foul-water drain. ***Calcium carbide**: The resulting solution is alkaline (calcium hydroxide). ***Calcium phosphide**: This reacts with the water to form phosphine gas and calcium hydroxide solution. The phosphine reacts to form phosphorus oxide and water.

20A Risk Assessment Guidance — Carbon dioxide, CO_2

Carbon dioxide (gas) — CO_2 (44.01)

WARNING

Currently not classified as hazardous, but note it is an asphyxiant, lowering the relative oxygen content of the air. If in a gas cylinder, will also be: Contains gas under pressure; may explode if heated [H280].

WEL (mg m^{-3}): 9150 (LTEL), 27400 (STEL)

Storage

Storage code: **Cyl;** or **Situ** (see **Other notes** on reverse) [Colourless, odourless gas]

- **Cyl**: Refillable cylinders can be hired. See *Gas cylinders* for detailed guidance on pressurised gas containers.
  - Ensure the location of all pressurised gas cylinders/canisters is recorded and known to the site manager.
  - **Cylinder (refillable)**: When fitted with a regulator (a single-stage one should be satisfactory for most purposes), the cylinder is considered as ‘being held ready for use’ (rather than ‘stored’). Keep cylinder upright (chained or clamped) and in a cool, well-ventilated area but **not** in the same place where flammables or radioactive materials are stored. Carry out a visual check of the apparatus whenever it is used. Check and follow up-to-date guidance on maintenance.
  - **Canister (non-refillable)**: Store canister on its side (with the mini flow valve/regulator removed) in a suitable container (to stop it rolling), on the shelf of a secure chemical store (**not** in the flammable liquids cupboard).

Carbon dioxide (solid) *Dry ice* — CO_2 (44.01)

Currently not classified as hazardous but see above for the gas. Note that solid carbon dioxide can cause serious frostbite.

Storage

Storage code: **Situ**, see note below. [White solid; various forms]

- Solid carbon dioxide must be bought or made fresh when required. Large amounts may be stored for a few days in an insulated box. Do **not** seal the box. Place the box in large, well-ventilated and cool room.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **If swallowed (dry ice)**: **Call 999.** Causes serious internal damage due to rapid release of CO_2 gas.
- **Minor exposures (frostbite)**: Place affected area in, or flush affected area with, **tepid** (not cold) water.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

20A Risk Assessment Guidance — Carbon dioxide, CO_2

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Carbon dioxide (gas)	Currently not classified as hazardous. Carbon dioxide gas is an asphyxiant. If gas cylinder:  WARNING (See reverse)	TT (Y7)	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **Use of carbon dioxide cylinders (TT)**: See *Gas cylinders*. • **Preparation of CO_2 gas, large-scale (TT)**: See *Recipe* 21. • **Making/testing CO_2 gas**: Use marble chips (**not** powdered calcium carbonate, the reaction is too vigorous) with 2 M hydrochloric acid. • **Using Bunsen burners**: Ensure room is well-ventilated. Carbon dioxide and carbon monoxide levels will rise and oxygen levels decrease. See *Ventilation*. **Disposal**: W6 (gas); see also note below
Carbon dioxide (solid)	Currently not classified as hazardous. Carbon dioxide gas is an asphyxiant. Dry ice can cause serious frostbite.	TT	• Wear eye protection. • Wear thermal gloves (eg, leather gauntlets). Do **not** wear rubber gloves. Manipulate pieces of dry ice using tongs or thermal gloves. • Ensure room is well-ventilated. • **Never** put dry ice into a sealed container. It may cause an explosion. • Do **not** allow students to handle the solid. **Other notes; see also detailed activity-specific guidance:** • **Preparation of dry ice (TT)**: See *Cryogenics* and *Dry ice.* **Disposal**: W6

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE**: • Canisters (non-refillable): it may be possible to dispose of empty canisters into the normal waste or at some local waste recycling centres. The used canister needs to be punctured to make it safe for disposal; a tool to do this safely is available from suppliers. Check supplier’s information.

Carbon disulfide CS_2 (76.14)

DANGER

Highly flammable liquid and vapour [H225]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. Suspected of damaging fertility. Suspected of damaging the unborn child [H360fd]. Causes damage to organs through prolonged or repeated exposure [H372].

Carbon disulfide is dangerous in contact with:

- RUST. It may ignite the vapour.
- ZINC and OTHER METAL POWDERS. Violent reactions occur.
- PHOSPHORUS. The solution is highly dangerous.
- NITROGEN OXIDE. An explosion may occur.

Not recommended for use in schools.

Any procedure involving carbon disulfide requires a Special Risk Assessment. Contact CLEAPSS.

WEL (mg m^{-3}): 15 (LTEL), 45 (STEL), Sk Flash point: – 30 °C

Storage

Storage code: **FL** [Colourless or pale yellow liquid]

- The pure liquid has an ether-like smell but reagent grade samples have a foul ‘rotten-eggs’ odour due to the presence of impurities.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120).

20B Risk Assessment Guidance

Carbon disulfide, CS_2

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Carbon disulfide	 DANGER (See reverse)	TT	**Not recommended for use in schools.** **Any procedure involving carbon disulfide requires a Special Risk Assessment. Contact CLEAPSS.** **Disposal**: W1, but see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • This liquid is highly flammable and very volatile. If disposal of only a few cm^3 is necessary then **W6** (evaporate/vent) can be followed if an efficiently-working, ducted (**not** recirculatory) fume cupboard is available. Ensure no flames or other sources of ignition. Wear gloves and splash-proof goggles.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

21 Risk Assessment Guidance **Carbon monoxide, CO(g)** and **Carbon, C(s)**

Carbon monoxide gas *carbonic oxide, coal gas* CO (28.01)

DANGER

Extremely flammable gas [H220]. Toxic if inhaled [H331]. May damage the unborn child [H360D]. Causes damage to organs through prolonged or repeated exposure (inhalation) [H372].

Carbon monoxide gas has no taste or smell and can be very difficult to detect. It is produced when carbon-based fuels burn without sufficient oxygen to ensure complete combustion.

Inhaled carbon monoxide binds to haemoglobin and impairs the ability of the blood to carry and transfer oxygen. Even 0.01% (by volume) in air can cause headaches and dizziness.

Mixtures with air (between 12% and 74% carbon monoxide by volume) are explosive.

WEL (mg m^{-3}): 23 (LTEL), 117 (STEL)

Storage

Storage code: **Situ** [Colourless, odourless and tasteless gas]

- Gas cylinders are **not** recommended. Prepare small volumes of the gas *in situ* when required. **Be aware that the filters in *recirculatory* fume cupboards do NOT absorb this gas.**

Carbon *activated carbon, (activated/decolorising) charcoal, graphite, carbon black, lampblack* C (12.01)

Currently not classified as hazardous but see other information on this *Hazcard.*

Carbon is dangerous in contact with:

- OXYGEN. Finely divided carbon is a fire hazard and carbon (or charcoal) blocks may catch fire if they are stacked or packed together whilst still hot.

WEL (mg m^{-3}): 3.5 (LTEL), 7 (STEL); carbon black
10 (LTEL), 30 (STEL); graphite (as inhalable dust)

Storage

Storage code: **GIn**, see also **Other notes** on reverse.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills (carbon powders)**: Large-scale spills can be difficult to deal with without raising airborne particles. Contact CLEAPSS for advice.
- **Carbon monoxide**: If a leak is suspected (eg, fume cupboard stops working), evacuate.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

21 Risk Assessment Guidance **Carbon monoxide, $CO(g)$** and **Carbon, $C(s)$**

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Carbon monoxide	 DANGER (See reverse)	Y12 (Y9)	• Wear eye protection. • Use an efficiently-working **ducted** fume cupboard for all activities. • Ensure room is well-ventilated. **Other notes; see also detailed activity-specific guidance**: • **Testing for carbon monoxide**: See *Recipe* 99. • **Carbon monoxide preparation (TT/Y12)**: See also *Recipe* 42. Scale down to prepare minimum quantity required. **Disposal**: W6, see note below
Carbon	Currently not classified as hazardous but see other information on this *Hazcard.*	Y7	• Eye protection and/or other control measures may be advised for some procedures. Check activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Use of carbon (powder/blocks) to reduce metal oxides**: Ensure room is well-ventilated. Allow used blocks to cool completely in air before storing in an air-tight metal tin (eg, clean biscuit tin). Do **not** cool blocks in water. • **Use of decolourising charcoal**: Only very small quantities are needed to adsorb dyes or indicators. **Disposal**: W8

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • **W6 (carbon monoxide)**: Vent the gas in an efficiently-working **ducted** fume cupboard.

22A Risk Assessment Guidance (see **22B** for chlorine water) **Chlorine gas, $Cl_2(g)$**

Chlorine Cl_2 (70.91)

DANGER

May cause or intensify fire; oxidiser [H270]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. Toxic if inhaled [H331]. May cause respiratory irritation [H335]. Very toxic to aquatic organisms [H400].

Chlorine gas is dangerous in contact with:

- HYDROGEN. Attempts to explode mixtures of chlorine and hydrogen are very hazardous because many are prematurely initiated by sunlight or light from fluorescent tubes.
- ETHOXYETHANE (diethyl ether) and other organic liquids. These can ignite on contact.
- AMMONIA, AMMONIUM COMPOUNDS. Explosive nitrogen trichloride may be formed.
- ALUMINIUM, MAGNESIUM, IRON FILINGS, MERCURY. These metals (and many others) may ignite.

WEL (mg m^{-3}): 1.5 (STEL)

Storage

Storage code: **Situ** [Yellow-green gas; sharp, choking odour; more dense than air]

- Cylinders of chlorine gas should **not** be used (or stored) in schools because school fume cupboards cannot cope with a large volume (and rapid) release of chlorine gas under pressure. Prepare small volumes of the gas when required. See **Other notes** (on reverse).
- Chlorine is strongly oxidising. It reacts readily with many substances causing corrosion and degradation.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **GAS RELEASE**: Evacuate laboratory/prep room and adjacent areas if more than ~ 100 cm^3 of chlorine gas is released or if the release is in a confined/poorly-ventilated space.
- **TOXIC, CORROSIVE (inhalation). BEWARE DELAYED EFFECTS.**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

22A Risk Assessment Guidance (see **22B** for chlorine water) **Chlorine gas, $Cl_2(g)$**

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Chlorine gas	 DANGER (See reverse)	TT (Y9)	• Prepare and use in an efficiently-working fume cupboard. • Do **not** inhale the gas. • Wear splash-proof goggles when preparing or using the gas on a large scale (eg, for demonstration activities). Check activity-specific guidance for additional eye protection advice. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparation of chlorine gas (large-scale; TT)**: See *Recipe* 24. • **Activities involving chlorine gas (small-scale; students)**: Many will require the use of a fume cupboard. Ensure the laboratory is well-ventilated. Use the correct technique for smelling gases.

BEWARE DELAYED EFFECTS

Effects of exposure by inhalation may or may not be immediately apparent and can develop and/or increase over time.

Inhalation by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions.

If affected at any time, call the emergency services, informing them of the quantities of chlorine involved.

Disposal: W6, in a fume cupboard

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

22B Risk Assessment Guidance (see **22A** for chlorine gas) **Chlorine water, $Cl_2(aq)$**

Chlorine Cl_2 (70.91)

Aqueous solutions of chlorine ('chlorine water') are currently not classified as hazardous but chlorine gas (toxic) readily diffuses from these solutions. See Emergencies (below) and also *Hazcard* 22A for chlorine gas.

WEL (mg m^{-3}): 1.5 (STEL) as chlorine.

Storage	Storage code: **Situ** [Colourless/pale yellow-green solution] • Chlorine water: aqueous solutions of chlorine should be prepared just before use. The solution does not keep for more than just a few days. Seek additional guidance or training before attempting this procedure for the first time. See *Recipe* 25. • Freshly-made, saturated chlorine water, ~ 0.08 M or 0.6 % (w/v), has a distinct yellow-green colour but this will become paler as chlorine is rapidly lost by diffusion, especially in warm conditions. Check that the prepared solution gives the desired effect for the practical activity being undertaken. • Regularly check the condition of caps/lids on the containers (eg, small dropper bottles) used for dispensing chlorine water; they will become discoloured and can split. Replace if necessary.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **TOXIC, CORROSIVE (inhalation). BEWARE DELAYED EFFECTS.** Chlorine gas. • **General spills/clearing up**: Much depends on the volume and concentration of solution. Consider using disposable paper towels or mineral absorbent for spills of a few cm^3. • If affected by fumes, move out of the area to uncontaminated air and take steps to prevent access to the area of the spill. Ventilate the area as much as possible if safe to do so. Allow fumes to disperse for at least 1 hour before re-entering with caution. Do not put yourself at risk. See also *Hazcard* 22A.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

22B Risk Assessment Guidance (see **22A** for chlorine gas) **Chlorine water, $Cl_2(aq)$**

BEWARE DELAYED EFFECTS. Chlorine is acutely toxic by inhalation. Effects of exposure by inhalation of chlorine gas may or may not be immediately apparent & can develop and/or increase over time. Inhalation by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions. If affected at any time, call the emergency services, informing them of the quantity of chlorine involved.

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Chlorine water	See note below. Refer to *Hazcard* 22A for chlorine gas.	TT (Y7)	• Wear eye protection. • Ensure the room is well-ventilated. Do **not** inhale the gas. • Use a fume cupboard to prepare or dispense chlorine water (and also to temporarily store small containers put out ready for class use). **Other notes; see also detailed activity-specific guidance:** • **Preparation of chlorine water (large-scale; TT)**: See *Recipe* 25 and also *Hazcard* 22A. Seek additional guidance or training before attempting this procedure for the first time. • **Using chlorine water (small-scale; students)**: Wear eye protection. Ensure the laboratory is well ventilated. Use diluted solutions (eg, a saturated solution diluted at least 50:50 with water) for student activities (such as halogen/halide displacement reactions for example. Always use the most dilute solution possible to obtain the desired result.
Chlorine gas readily diffuses from its solutions and the WEL (STEL) could rapidly be approached in localised situations (eg, just above open test-tubes or bottles). Take the hazards associated with chlorine *gas* into account (in addition to the other information on this card). It is advisable to include a warning to these effects on labels used on prepared solutions. See suggested control measures for additional guidance.			**Disposal**: W7 in a fume cupboard

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

23 Risk Assessment Guidance

Chlorobenzene & related compounds

Chlorobenzene	*phenyl chloride*	C_6H_5Cl (112.56)
Bromobenzene	*phenyl bromide*	C_6H_5Br (157.01)

WARNING

Both: Flammable liquid and vapour [H226]. Causes skin irritation [H315]. Toxic to aquatic life with long lasting effects [H411]. **Chlorobenzene**: Harmful if inhaled [H332].

	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})	
chlorobenzene	28	132	4.7 (LTEL), 14 (STEL), Sk	Colourless liquid
bromobenzene	51	156	–	Colourless liquid

1,2-dichlorobenzene	*o-dichlorobenzene*	$C_6H_4Cl_2$ (147.00)
1,4-dichlorobenzene	*p-dichlorobenzene*	$C_6H_4Cl_2$ (147.00)

1,4-dichloro

WARNING

Both: Causes serious eye irritation [H319]. Very toxic to aquatic life with long lasting effects [H410].

1,2-dichlorobenzene: Harmful if swallowed [H302]. Causes skin irritation [H315]. May cause respiratory irritation [H335]. **1,4-dichlorobenzene**: Suspected of causing cancer [H351].

	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})	
1,2-dichloro	66	180	153 (LTEL), 306 (STEL), Sk	Colourless liquid
1,4-dichloro	N/A	N/A	12 (LTEL), 60 (STEL), Sk	White solid

Storage	Storage code: **FL** (Organic) Chlorobenzene and Bromobenzene. Storage code: **GOrg** 1,2-dichlorobenzene and 1,4-dichlorobenzene. • **Bromobenzene**: If limited room in the flammables cabinet, store with GOrg.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

23 Risk Assessment Guidance

Chlorobenzene & related compounds

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• Chlorobenzene • Bromobenzene	   WARNING (See reverse)	Y12 (Y7)	• Wear eye protection. • Ensure no naked flames or other sources of ignition when transferring or dispensing chlorobenzene or bromobenzene. • Avoid inhaling fumes. Ensure laboratory is well-ventilated for open-bench work. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Heating 1,4-dichlorobenzene (eg, for 'cooling curve' activities)**: Melts at 53 °C. Provides an excellent example of a cooling curve. Use a mineral wool plug in the open end of the boiling tube to minimise fumes. Ensure the laboratory is well-ventilated. **Disposal:** W2, but see below
• 1,2-dichlorobenzene • 1,4-dichlorobenzene	  1,4-dichloro  WARNING (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W2**: Do **not** mix organohalogen waste with other waste. Keep in a separate, labelled container. Note: Small amounts of residue from test-tube scale 'hydrolysis' activities may be disposed of as W7 (use detergent to ensure emulsification with water). Check activity-specific guidance.

Chromium, Cr, and Cr(III) compounds

For Cr(VI) compounds (chromates & dichromates), see *Hazcards* 78A-C

Chromium(III) nitrate(V)-9-water *chromium trinitrate* $Cr(NO_3)_3.9H_2O$ (400.15)

WARNING

May intensify fire; oxidiser [H272]. Causes skin irritation [H315]. Causes serious eye irritation [H319].

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); as chromium (Cr)

Storage

Storage code: **Ox** [Purple crystalline solid]

- Absorbs water from the atmosphere (hygroscopic).

Chromium(III) chloride-6-water $CrCl_3.6H_2O$ (266.45)

Chromium(III) potassium sulfate(VI)-12-water *chrome alum* $CrK(SO_4)_2.12H_2O$ (499.40)

WARNING

Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Chromium(III) chloride is also: Harmful if swallowed [H302].

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); as chromium (Cr)

Chromium metal Cr (52.0)

Chromium(III) oxide Cr_2O_3 (151.99)

Chromium(III) sulfate *Various*

Currently not classified as hazardous, although some suppliers may indicate some hazards.

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); as chromium (Cr)

Storage

Storage code: **GIn**

- The chloride (dark green) and chrome alum (dark purple) are hygroscopic crystalline solids.
- Chromium(III) oxide is green; chromium(III) sulfate is variously red or purple.

Emergencies **Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Chromium, Cr, and Cr(III) compounds

For Cr(VI) compounds (chromates & dichromates), see *Hazcards* 78A-C

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid chromium and chromium(III) compounds	WARNING (See reverse)	Y7	• Wear eye protection. **Other notes; see also detailed activity-specific guidance:** • **Preparing chromium(III) solutions:** see *Recipe* 27. • **Growing chrome alum crystals**: Saturated solutions of chrome alum (~ 22 g in 100 cm^3 of water or ~ 0.45 M) are irritating to eyes and skin. The pH is below 7. Do **not** warm the solution to speed up dissolving. Do **not** allow students to take chrome alum crystals out of the laboratory. • **Chromium metal reactions**: Chromium metal reacts slowly with dilute hydrochloric acid (2 M) or sulfuric acid (1 M). **Disposal**: see below
Chromium(III) chloride solutions ≥ 1 M	⚠ WARNING Harmful (ingestion) Irritant (respiratory) Irritant (skin, eyes)		
Chromium(III) chloride solutions < 1 M and ≥ 0.5 M Currently not classified as hazardous < 0.5 M	⚠ WARNING Irritant (skin, eyes)		
Chrome alum and chromium nitrate solutions ≥ 0.4 M Currently not classified as hazardous < 0.4 M	⚠ WARNING Irritant (skin, eyes)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W7 (soluble chromium(III) salts):** Dilute to below 0.1 M. • **W8 (chromium(III) oxide/chromium(III) sulfate (insoluble)/chromium metal).**

25 Risk Assessment Guidance

Cobalt and its compounds

Cobalt(II) nitrate(V)-6-water		$Co(NO_3)_2.6H_2O$ (291.03)
Cobalt(II) chloride-6-water	*hydrated cobalt chloride*	$CoCl_2.6H_2O$ (237.93)
Cobalt(II) sulfate(VI)-7-water	*hydrated cobalt sulfate*	$CoSO_4.7H_2O$ (281.10)
Cobalt(II) carbonate		$CoCO_3$ (118.94)

  nitrate   chloride, sulfate DANGER	**Cobalt(II) nitrate(V)-6-water**: May intensify fire; oxidiser [H272] **Cobalt(II) chloride-6-water and cobalt(II) sulfate(VI)-7-water**: Harmful if swallowed [H302]. **All**: May cause an allergic skin reaction [H317]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. Suspected of causing genetic defects [H341]. May cause cancer by inhalation [H350i]. May damage fertility [H360F]. Very toxic to aquatic life with long lasting effects [H400/410]. WEL (mg m^{-3}): 0.1 (LTEL), 0.3 (STEL), Carc, Sen; as cobalt
Storage	Storage code: **Ox** (nitrate) Storage code: **T** (others) [Pink-red solids]

Cobalt metal	Co (58.93)
 DANGER	May cause an allergic skin reaction [H317]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. May cause long lasting harmful effects to aquatic life [H413]. WEL (mg m^{-3}): 0.1 (LTEL), 0.3 (STEL), Sen; as cobalt Those who have a known sensitisation to metals should avoid skin contact (i.e. do **not** handle).
Storage	Storage code: **GIn** [Grey solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

25 Risk Assessment Guidance

Cobalt and its compounds

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solids: Cobalt metal Cobalt (II) compounds	See reverse	TT (Y9)	Inhalation of cobalt(II) compounds is a remote possibility if significant amounts of dust become airborne. Use correct transfer techniques for solids and liquids. Do **not** allow small volumes of solution to dry out on glassware/lab surfaces; wipe up immediately with a damp cloth/paper towel. • Wear eye protection. • Avoid raising dust. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Weighing solids**: Weigh on a balance placed in a fume cupboard that is **not** switched on. Have sash partially pulled down. Wipe down the work area with a damp paper towel. • **Preparing cobalt(II) solutions (TT):** *Recipe* 30. • **Preparing cobalt(II) chloride papers**: *Recipe* 30. Avoid skin contact. Use tweezers or forceps to handle prepared papers. **Disposal:** W1, W2 (insoluble solids) W7 → 0.001 M (soluble salts)
Cobalt(II) solutions ≥ 0.2 M	DANGER Sensitiser (skin), ≥ 0.2 M Sensitiser (respiratory), ≥ 0.2 M Serious health hazard (CMR)		
Cobalt(II) solutions < 0.2 M and ≥ 0.0015 M		Y7	
Cobalt(II) solutions < 0.0015 M	Currently not classified as hazardous.		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

26 Risk Assessment Guidance

Copper metal, copper carbonate, sulfide & oxides

Copper metal		Cu (63.55)
Copper(II) sulfide	*copper pyrites*	CuS (95.61)
Currently not classified as hazardous.		

Copper(I) oxide	*cuprous oxide*	Cu_2O (143.09)
Copper(II) oxide	*cupric oxide*	CuO (79.55)
Copper(II) carbonate hydroxide	*basic copper carbonate, cupric carbonate, malachite*	$CuCO_3.Cu(OH)_2$ (221.12)

DANGER*

WARNING

All: Harmful if swallowed [H302]. Causes skin irritation [H315]. Harmful if inhaled [H332]. Very toxic to aquatic life with long-lasting effects [H410].

All except copper(I) oxide: Causes serious eye irritation [H319].

***Copper(I) oxide**: Causes serious eye damage [H318].

Note: Some suppliers' classification/labelling may vary from that given here.

Copper(I) and copper(II) oxides are dangerous in contact with:

- ALUMINIUM, MAGNESIUM. Dangerous reactions occur. Explosive mixtures may form.

WEL (mg m^{-3}): 1 (LTEL), 2 (STEL), dust and mists; copper and its compounds (as Cu)

Storage	Storage code: **GIn** • Copper metal: red-brown shiny solid (copper powder may appear very dark). • Copper(I) oxide: reddish powder. Copper(II) oxide, copper(II) sulfide: black powders. • Copper(II) carbonate hydroxide: green powder. Purchased as 'basic copper carbonate' (not pure copper carbonate)
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

26 Risk Assessment Guidance Copper metal, copper carbonate, sulfide & oxides

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
• Copper(I) oxide	 DANGER (See reverse)	Y7	• Wear eye protection. • Avoid raising dust (with powdered reagents). **Other notes; see also detailed activity-specific guidance:** • **Weighing the solid (powders):** Weigh on a balance placed in a fume cupboard that is not switched on. Have sash partially pulled down. • **Heating carbonate/sulfate ores**: Rocks may spit when heated so use small amounts (~ 1 cm^3 in volume). Copper pyrites will produce sulfur dioxide (toxic) when heated; see *Hazcard* 97. • **Reduction of copper(II) oxide with magnesium (TT):** Use a maximum of 0.25 g of each reagent. Do **not** exceed these amounts unless the employer holds an explosives certificate issued by the police and the method has been discussed with CLEAPSS. See also *Fireworks and explosives*.
• Copper(II) oxide • Basic copper(II) carbonate	 WARNING (See reverse)		
• Copper metal • Copper(II) sulfide	Currently not classified as hazardous		**Disposal**: W1/W2; or see notes below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W5 (copper(I) oxide, copper(II) oxide)**: React no more than 24 g in 1 litre of warm 1 M ethanoic acid before pouring the solution and fine copper precipitate down a foul-water drain. • **W5 (copper(II) carbonate hydroxide)**: As for the oxide using no more than 60 g of solid. • **W8 (copper metal, copper(II) sulfide)**.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

27A Risk Assessment Guidance — Copper salts: chlorides and iodide

Copper(I) chloride *cuprous chloride*	CuCl (98.99)
Copper(I) iodide *cuprous iodide*	CuI (190.45)
 WARNING	Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Very toxic to aquatic life with long lasting effects [H410]. Note: Suppliers' classification/labelling may vary from that given here. WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); all copper compounds as dust or mist (as Cu).
Storage	Storage code: **GIn** [White-grey powders] • When exposed to air, the surface layer of copper(I) chloride oxidises → green/green-blue. • Both solids have very low solubility in water.

Copper(II) chloride-2-water *hydrated cupric chloride*	$CuCl_2.2H_2O$ (170.48)
 WARNING	Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. Very toxic to aquatic life with long lasting effects [H400/H410]. Note: Suppliers' classification/labelling may vary from that given here. **Copper(II) chloride is dangerous in contact with**: • HEAT. If heated strongly, brown anhydrous copper(II) chloride decomposes further to produce copper(I) chloride and toxic chlorine gas (see *Hazcard* 22A). WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); all copper compounds as dust or mist (as Cu).
Storage	Storage code: **GIn** [Blue-green crystals]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

27A Risk Assessment Guidance

Copper salts: chlorides and iodide

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solids: • Copper(I) chloride • Copper(II) chloride • Copper(I) iodide	 WARNING (See reverse)	Y7	• Wear eye protection. **Other notes; see also detailed activity-specific guidance:** • **Heating copper(II) chloride**: Use a fume cupboard. The hydrated salt will initially form the brown anhydrous salt but further heating causes decomposition to copper(I) chloride and toxic chlorine gas (see *Hazcard* 22A). • **Electrolysis of aqueous copper(II) chloride solutions**: Ensure that the laboratory is well-ventilated. Chlorine gas (toxic) is produced at the positive electrode; see *Hazcard* 22A. • **Preparing copper(II) chloride solutions**: See *Recipe* 31. **Disposal:** W1/W2; copper(I) chloride/iodide W7 → 0.4 M; copper(II) chloride
Copper(II) chloride solutions: ≥ 0.8 M	 WARNING Irritant (skin, eyes). Harmful (ingestion), ≥ 1.8 M.		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

27B Risk Assessment Guidance **Copper salts: chromate(VI), ethanoate, nitrate(V)**

Copper(II) chromate(VI)	*cupric chromate*	$CuCrO_4.xH_2O$ (–)

DANGER

Harmful if swallowed [H302]. May cause an allergic skin reaction [H317]. May cause cancer by inhalation [H350i]. Very toxic to aquatic life with long-lasting effects [H400/410].

WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); copper compounds dust and mist (as Cu).

WEL (mg m^{-3}): 0.05 (LTEL), 0.15 (STEL), Carc, Sen; as chromium (Cr)

Storage

Storage code: **Situ** [Dark brown-green solid]

- Prepare only what is needed (eg, for the *migration of ions* demo). Dispose after use.

Copper(II) ethanoate-1-water	*hydrated copper (cupric) acetate, verdigris*	$Cu(CH_3COO)_2.H_2O$ (199.65)
Copper(II) nitrate(V)-3-water	*hydrated cupric nitrate*	$Cu(NO_3)_2.3H_2O$ (241.60)

DANGER

Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye damage [H318]. May cause respiratory irritation [H335], copper(II) ethanoate. Very toxic to aquatic life with long lasting effects [H410].

Note: Suppliers' classification/labelling may vary from that given here. Some suppliers also indicate that the nitrate(V) salt is oxidising (with the GHS 03 pictogram).

WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); copper compounds dust and mist (as Cu).

Storage

Storage code: **GIn** [Green or green-blue solids]

- Copper(II) nitrate(V) absorbs moisture from the atmosphere (hygroscopic).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes):** ethanoate, nitrate(V).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

27B Risk Assessment Guidance — Copper salts: chromate(VI), ethanoate, nitrate(V)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Copper(II) chromate(VI)	 DANGER (See reverse)	TT	Note: Inhalation of chromate(VI) salts is a remote possibility if significant amounts of dust become airborne. Use good transfer techniques. Do **not** allow small volumes of solution to dry out on glassware/lab surfaces. Wipe up immediately with a damp cloth/paper towel. Avoid raising dust. • Wear eye protection. Wear splash-proof goggles when transferring or dispensing large quantities of corrosive solutions. • Take particular care to avoid skin contact (chromate). See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Preparing copper(II) nitrate(V) solutions**: See *Recipe* 31. Solutions of 0.1 M are suitable for most purposes. • **Copper(II) ethanoate solutions**: The solubility of the solid in water is only ~ 8 g per 100 cm^3 (~ 0.4 M) at room temperature. Solutions of 0.1 M are suitable for most purposes. • **Using copper(II) chromate(VI)**: See *The movement of ions*. **Disposal**: see notes below
Solids (ethanoate, nitrate), & nitrate(V) solutions: ≥ 1.3 M	 DANGER (See reverse)	TT (Y7)	
Solutions: ethanoate and nitrate(V): ≥ 0.3 M and < 1.3 M	 DANGER Corrosive (skin, eyes)	Y9	
< 0.3 M and ≥ 0.15 M	 DANGER Corrosive (eyes) Irritant (skin)		
< 0.15 M and ≥ 0.05 M	 WARNING Irritant (skin, eyes)	Y7	

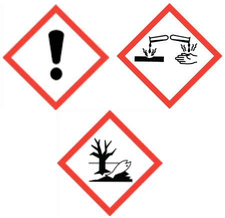
Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W1/W2 (copper chromate).** • **W7 (copper ethanoate/nitrate solutions)**: Dilute to below 0.2 M. • **W7 (copper ethanoate/nitrate solids)**: Dissolve in water (ethanoate salt, no more than 40 g in 1 litre; nitrate salt, no more than 50 g per litre).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

27C Risk Assessment Guidance

Copper salts: sulfates(VI)

Copper(II) sulfate(VI)	*anhydrous copper sulfate*	$CuSO_4$ (159.68)
Copper(II) sulfate(VI)-5-water	*hydrated copper sulfate; copper sulfate pentahydrate*	$CuSO_4.5H_2O$ (249.68)



DANGER

Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye damage [H318]. Very toxic to aquatic life with long lasting effects [H410].

Note: Some suppliers' classification/labelling may vary from that given here. The GHS05 pictogram may be omitted and Causes serious eye irritation [H319] with WARNING may be indicated.

Anhydrous copper(II) sulfate(VI) is dangerous in contact with:

- WATER. Exothermic reaction, heat is generated. Add water to the anhydrous salt with care.

WEL (mg m^{-3}): 1 (LTEL), 2 (STEL), dust and mists; copper and its compounds (as Cu).

Storage

Storage code: **GIn** [White powder/solid (anhydrous); blue crystalline solid (hydrated)]

- **Anhydrous copper(II) sulfate(VI)**: May turn blue if it absorbs water from the atmosphere. Dehydrate in a hot oven (150-650 °C), **not** over a Bunsen.
- There have been problems with the purity of some supplies. Appropriate quality, laboratory grade salt (hydrated) should not leave undissolved solids in the prepared solution (see *Recipe* for method). Purchase the quality of copper(II) sulfate(VI) appropriate to requirements. Liaise with supplier if problems and/or contact CLEAPSS.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120).

27C Risk Assessment Guidance — Copper salts: sulfates(VI)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solids (anhydrous and hydrated)	 DANGER (See reverse)	Y7	• Wear eye protection. Wear splash-proof goggles when transferring or dispensing large volumes of corrosive solutions. **Other notes; see also detailed activity-specific guidance:** • Do **not** allow students to take crystals of hydrated copper(II) sulfate(VI) out of the laboratory. • Where possible, use solutions less than 1 M if suitable. • For precipitation or complexometric reactions, 0.1 M is suitable. • **Heating copper sulfate (solid/solutions)**: Do **not** heat copper(II) sulfate(VI) solutions to dryness; decomposition produces toxic and corrosive fumes. **Gentle** heating of the solid hydrated salt (blue) until it just turns white should not pose a problem.
Solutions ≥ 1.0 M	 DANGER Harmful (ingestion). Corrosive (eyes). Irritant (skin).		
Solutions < 1.0 M and ≥ 0.2 M	 DANGER Corrosive (eyes). Irritant (skin).		
Solutions < 0.2 M and ≥ 0.02 M	 WARNING Irritant (skin, eyes)		
Solutions < 0.02 M	Currently not classified as hazardous.		**Disposal**: see notes below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W7**: Dissolve no more than 64 g of the anhydrous solid or 100 g of the hydrated solid in 1 litre of water (to give ~ 0.4 M solution). Dilute solutions to below 0.2 M then rinse away down a foul-water drain. • **W3 (copper(II) sulfate(VI)-5-water)**: Use crystals prepared by students for making solutions.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Dichloromethane *methylene dichloride, methylene chloride, DCM* CH_2Cl_2 (84.93)

WARNING

Suspected of causing cancer [H351]. Note: Hazard classification and labelling varies. Suppliers may indicate one or more of: Causes skin and serious eye irritation [H315, H319]. May cause respiratory irritation [H335]. May cause drowsiness or dizziness [H336]. May cause damage to organs through prolonged or repeated exposure [H373].

Dichloromethane is dangerous in contact with:

- AIR. HEAT. Flammable in air if heated above room temperature. Emits toxic fumes (hydrogen chloride, carbon monoxide, phosgene) if heated to decomposition or if involved in combustion.
- METHANOL. In the presence of methanol, the mixture is flammable at room temperature.
- REACTIVE METALS (eg, ALKALI METALS, MAGNESIUM, ALUMINIUM). STRONG BASES. STRONG OXIDISING AGENTS. Violent or explosive reactions can occur.
- CONCENTRATED NITRIC(V) ACID. It may dissolve explosively and the solution can be detonated.

WEL (mg m^{-3}): 353 (LTEL), 706 (STEL), Sk

Storage Storage code: **GOrg** [Colourless liquid, ‘sweet’ odour]

Dichloromethane is absorbed through the skin. It degreases the skin, which may lead to secondary inflammation. Exposure through inhalation or ingestion may cause irritation to the respiratory tract, headaches, nausea, confusion, drowsiness and dizziness. Eye contact with the vapour may cause irritation. More severe damage may occur through eye contact with the liquid.

Symptoms may or may not be immediately apparent and can develop and/or increase over time.

Avoid the use of dichloromethane in school practical activities (see reverse).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes):** liquid.
- **BEWARE DELAYED EFFECTS (eyes, inhalation, ingestion).**
- **General spills**: If more than a few cm^3 are spilled outside a fume cupboard, leave the immediate area. Only return when the spill has evaporated and dispersed.

28 Risk Assessment Guidance

Dichloromethane

<table>
<tr><td colspan="4">Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk</td></tr>
<tr><th>General use of:</th><th>Hazard information</th><th>User</th><th>Suggested general control measures and guidance</th></tr>
<tr><td>Dichloromethane</td><td>
WARNING
(See reverse)</td><td rowspan="2">TT
(Y12)</td><td rowspan="2">

- Wear splash-proof goggles.
- The liquid is very volatile. Do **not** inhale vapours. Use a fume cupboard.
- Ensure laboratory is well-ventilated.
- Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120.

Other notes; see also detailed activity-specific guidance:

- **Using dichloromethane**: Some commercial uses (eg, paint strippers) are now subject to EU-wide restrictions but dichloromethane is still found in a wide range of applications (eg, solvents, cleaning agents, adhesives).
  - **Science activities**: Alternatives will be available for most school-based science practical activities.
  - **Design & Technology activities**: See CLEAPSS Design & Technology *Model Risk Assessments*.

Disposal: W2 (organohalogen)
W6, see note below

</td></tr>
<tr><td colspan="2">**Avoid the use of dichloromethane in school practical activities.
Check activity-specific guidance for alternatives.**</td></tr>
</table>

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W6** (evaporate, vent): No more than 20 cm^3 in an efficiently-working fume cupboard.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Dilauroyl peroxide & dibenzoyl peroxide

Dilauroyl peroxide	*di(dodecanoyl) peroxide, lauroyl peroxide* $(CH_3(CH_2)_{10}CO)_2O_2$ (398.63)
 DANGER	Heating may cause a fire [H242]. **Dilauroyl peroxide is dangerous in contact with**: • HEAVY METAL SALTS, ACIDS, ALKALIS, REDUCING AGENTS, COMBUSTIBLE MATERIALS. The reaction can cause fire. • HEAT. Becomes shock sensitive on heating; self-accelerating decomposition sets in at 49 °C.
Storage	Storage code: **Ox** [White solid] • Do **not** store with other organic substances.

Dibenzoyl peroxide	*di(benzenecarbonyl) peroxide, benzoyl peroxide* $(C_6H_5CO)_2O_2$ (242.23)
 DANGER	**Do NOT use this compound. Dilauroyl peroxide is a safer alternative. See notes on reverse.** Heating may cause a fire or explosion [H241]. May cause an allergic skin reaction [H317]. Causes serious eye irritation [H319]. **Dibenzoyl peroxide is dangerous in contact with**: • HEAT. Explodes upon heating strongly. Do **not** grind or subject this chemical to shock or friction. • HEAVY METAL SALTS, ACIDS, ALKALIS, REDUCING AGENTS and COMBUSTIBLE MATERIALS. The reaction can cause fire. WEL (mg m^{-3}): 5 (LTEL), 15 (STEL)
Storage	Storage code: **Ox** [White solid] • **Schools should NOT use this compound, so storage is prior to immediate disposal, W1. Do NOT store with other organic substances. Do NOT grind or subject this chemical to shock or friction.**

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

29 Risk Assessment Guidance — Dilauroyl peroxide & dibenzoyl peroxide

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Dilauroyl peroxide	 DANGER Heating may cause a fire	Y12	• Wear eye protection. **Other notes; see also detailed activity-specific guidance:** • **Use as a polymerisation initiator**: Do **not** use dibenzoyl peroxide. Dilauroyl peroxide can be used to initiate the polymerisation of styrene (phenylethene) and methylmethacrylate (methyl 2-methylpropenoate).
Do NOT use dibenzoyl peroxide in place of dilauroyl peroxide.			**Disposal:** WSpec, see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **WSpec (dilauroyl peroxide)**: Use no more than 10 g of solid in 1 litre of 2 M sodium hydroxide solution. Allow to stand for 2 days before flushing down a foul-water drain with further dilution.

2,4-dinitrophenylhydrazine *2,4-DNPH (used to prepare Brady's reagent)* $(NO_2)_2C_6H_3NHNH_2$ (198.14)

DANGER

Flammable solid [H228]. Harmful if swallowed [H302]. *Some suppliers may also indicate one or more of*: Causes skin irritation [H315]. Causes serious eye irritation [H319].

2,4-dinitrophenylhydrazine is dangerous in contact with:

- OXIDISING AGENTS. METAL OXIDES. Vigorous or explosive reactions may occur.
- IGNITION SOURCE/SPARK. Risk of dust explosion if sufficient quantity of dry powder is in the air.

The storage and use of 2,4-DNPH is affected by the current Explosives Regulations. See *Fireworks and explosives*. Contact CLEAPSS for further advice.

Storage

Storage code: **T** (Organic) [Orange-red solid]

- The solid is supplied 'wetted' to minimise the risk of explosion. To keep the solid damp, stand the bottle inside a larger (labelled) container that also contains a little tap water (~ 1 cm depth). Protect the bottle's label.
- **If incorrectly stored, the solid may have become dry and more sensitive to shock or friction. Do NOT attempt to open the bottle; contact CLEAPSS**.

Phenylhydrazine $C_6H_8N_2$ (108.14)

DANGER

Do NOT use this compound.

Toxic if swallowed, in contact with skin & if inhaled [H301, H311, H331]. Causes skin and serious eye irritation [H315, H319]. May cause an allergic skin reaction [H317]. Suspected of causing genetic defects [H341]. May cause cancer [H350]. Causes damage to organs through prolonged or repeated exposure [H372]. Very toxic to aquatic life [H400].

Storage

Storage code: **T** (Organic) [Colourless-yellow liquid/solid (melting point is ~ 20 ^{o}C)]

- **Storage is prior to disposal, W1.**

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills, 2,4-DNPH:** Keep moist. Scoop into a suitable container. Thoroughly rinse spill area.

30 Risk Assessment Guidance **2,4-dinitrophenylhydrazine**

The storage and use of 2,4-DNPH is affected by the current Explosives Regulations. See *Fireworks and explosives*. Contact CLEAPSS for further advice.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
2,4-dinitrophenyl hydrazine, 2,4-DNPH	 DANGER (See reverse)	TT	• Wear eye protection. • Take particular care to avoid skin contact (see GL 120). Wear gloves when transferring the solid or preparing/dispensing Brady's reagent. Note: Skin is stained yellow which may be followed by dermatitis. • Protect the bench and working area from stains. **Other notes; see also detailed activity-specific guidance:** • **Preparation of Brady's reagent (TT)**: See *Recipe* 33. There are two methods ('recipes') given, each with different hazards. Prepare only when required and just sufficient for the lesson. Do **not** store any unused reagent, dispose of it promptly. • **Identifying carbonyl compounds using Brady's reagent:** See activity-specific guidance for detailed method and disposal of test residues. **Disposal:** W1, 2,4-DNPH W7, unused Brady's reagent; see below.
Brady's reagent	See **Other notes**.	Y12	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W7 (unused Brady's reagent)**: Dilute the solution in a full bucket of water and pour the contents down a foul-water drain. Flush away with more water.

31 Risk Assessment Guidance **Dodecylbenzenesulfonic acid & other sulfonic acids**

Dodecylbenzenesulfonic acid *nansa acid*	$C_{18}H_{29}SO_2OH$ (326.50)
DANGER	Harmful if swallowed [H302]. Causes severe skin burns and eye damage [H314]. **Dodecylbenzenesulfonic acid is dangerous in contact with:** • STRONG OXIDISING AGENTS. Dangerous reactions can occur. Note: It is very viscous and not easy to pour. See **Emergencies** (below) and **Other notes** (on reverse).
Storage	Storage code: **CLa** (Organic) [Yellow-brown liquid]

Benzenesulfonic acid	$C_6H_5SO_2OH$ (158.18)
DANGER	Harmful if swallowed [H302]. Causes severe skin burns and eye damage [H314]. **Benzenesulfonic acid is dangerous in contact with:** • STRONG OXIDISING AGENTS. Dangerous reactions can occur.
Storage	Storage code: **CS** (Organic) [Colourless-grey solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (eyes, skin)**: Solid/liquid acids and solutions. Dodecylbenzenesulfonic acid (nansa acid) is very viscous. It can adhere to the skin and may take some time to wash off with water (although it is soluble).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

31 Risk Assessment Guidance **Dodecylbenzenesulfonic acid & other sulfonic acids**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**		**User**	**Suggested general control measures and guidance**
Dodecylbenzene-sulfonic acid (*nansa acid*)	 DANGER Harmful (ingestion) Corrosive (skin, eyes)		TT (Y9)	- Wear splash-proof goggles. - Protect the face when transferring/dispensing large quantities of the corrosive liquids/solutions. - Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** - **Transferring/dispensing nansa acid (TT)**: The acid is very viscous and not easy to pour. Use a sink when transferring. It is usually preferable to provide students with pre-measured quantities. Accurate volume measurement is difficult but the density of the commercial acid (often a mixture of isomers) is about 1.05-1.2 g cm^{-3} so weighing the container before and after adding a sample of the acid will give an approximate volume. **Disposal**: W4, see note below
Benzenesulfonic acid solid, and solutions ≥ 1.5 M				
Benzenesulfonic acid solutions < 1.5 M and ≥ 0.3 M	 DANGER	Corrosive (skin, eyes)	Y9	
< 0.3 M and ≥ 0.15 M		Corrosive (eyes) Irritant (skin)		
< 0.15 M and ≥ 0.05 M	 WARNING	Irritant (skin, eyes)	Y7	- Wear eye protection even when dilute solutions are used. **Disposal**: W7 → 0.05 M, or W4

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** - **W4 (dodecylbenzenesulfonic acid)**: Follow W4 for quantities ≤ 25 cm^3 (otherwise W2).

Dyes, indicators and stains

These substances are not very pure, especially very old samples (which may have reacted over time). Some are mixtures or particular formulations. Information about the health hazards associated with these substances is, in some cases, limited or incomplete so use ALL dye/indicator/stain materials with great care. Students will only use dilute solutions.

May include one/more of:  DANGER	**One or more of the following H statements may be included**: Fatal/Toxic if swallowed [H300/H301]. Fatal/Toxic in contact with skin [H310/H311]. Fatal/Toxic if inhaled [H330/H331]. Causes severe skin burns and eye damage [H314]. Causes serious eye damage [H318]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. May cause genetic defects [H340]. May cause cancer [H350]. May damage fertility or the unborn child [H360]. Causes damage to organs [H370]. Causes damage to organs through prolonged or repeated exposure [H372]. Dyes/stains/indicators that appear to be classified/labelled at this level include: **Acridine orange, Congo Red** (Direct dye 28), **Crystal violet** (methyl violet, Gentian violet, Gram's stain), **Ethidium bromide**, **Malachite green** (solvent green 1), **Methyl orange**, **Nigrosin**, **Phenolphthalein, Rosaniline, Safranin.**
May include one/more of:  WARNING	**One or more of the following H statements may be included**: Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Harmful if inhaled [H332]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause an allergic skin reaction [H317]. Suspected of causing genetic defects [H341]. Suspected of causing cancer [H351]. Suspected of damaging fertility or the unborn child [H361]. May cause damage to organs [H371]. May cause respiratory irritation [H335]. May cause drowsiness or dizziness [H336]. May cause damage to organs through prolonged or repeated exposure [H373]. Dyes/stains/indicators that appear to be classified/labelled at this level include: **Alizarin** (1,2-dihydroxyanthraquinone), **Alizarin Red S**, **Aluminon** (triammonium aurine tricarboxylate), **Aniline Blue** (cotton/spirit blue), **Brilliant Yellow**, **Cresol Red**, **DCPIP** (2,6-dichlorophenolindophenol, phenol-indo-2,6-dichlorophenol, PIDCP), **Direct Red 23**, **Disperse Yellow 7**, **Dithizone** (diphenylthiocarbazone), **Eosin** (Eosin Y), **Eriochrome Black T** (Solochrome black), **Fluorescein** (& the disodium salt), **Haematoxylin**, **HHSNNA** (Patton & Reeder's indicator), **Indigo**, **Magenta** (basic Fuchsin), **May-Grunwald stain**, , **Methylene blue**, **Methyl green**, **Orcein**, **Phenol red**, **Procion dyes**, **Pyronin**, **Resazurin**, **Sudan I/II/IV**, **Sudan black** (Solvent Black 3), **Thymol blue**, **Xylene cyanol FF**.
Currently not classified as hazardous	Dyes/stains/indicators that appear to be classified/labelled at this level include: **Acid blue 40**, **Blue dextran**, **Bromocresol green**, **Bromophenol blue**, **Bromothymol blue**, **Carmine** (cochineal, Natural Red 4), **Diazine Green** (Janus Green B), **Indigo carmine**, **Litmus**, **Methyl blue**, **Methyl red**, **Murexide** (ammonium purpurate), **Neutral red**, **Rhodizonic acid**, **Soylent green**, **Sudan III**, **Thymolphthalein**, **Toluidine blue**, **Xylenol orange**.
Storage	Storage code: **GOrg** (solids) or **FL** for solutions containing more than 20% ethanol/IDA.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

32 Risk Assessment Guidance

Dyes, indicators and stains

These substances are not very pure, especially very old samples (which may have reacted over time). Some are mixtures or particular formulations. Information about the health hazards associated with these substances is, in some cases, limited or incomplete so use ALL dye/indicator/stain materials with great care. Students will only use dilute solutions.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solids	See reverse. Compositions will affect properties so always trial activities with new stock. Check supplier's information. Contact CLEAPSS if in doubt.	TT	• Check latest guidance. Substitute safer alternatives wherever possible. • Wear eye protection. • Avoid raising or inhaling dust. Use a fume cupboard to transfer or dispense solids and to prepare solutions. See **Other notes**. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. Gloves are advised in many cases, not least to prevent staining of hands. Wash hands thoroughly after use. • Promptly wipe up spills and dispose of any residues. Dried spills raise the risk of dust/dust inhalation but quantities are small, given that solutions are typically ≤ 1 %.
Solutions	Much depends on the formulation of: • the substance itself, • the prepared solution. Check activity-specific guidance, *Recipes* and/or supplier's information.		**Other notes**; **see also detailed activity-specific guidance**: • **Preparing solutions of dyes, indicators or stains (TT only)**: Open containers in a working fume cupboard then switch off the fume cupboard to transfer or weigh out the solid. Have the sash partially pulled down. See *Recipes* and/or other guidance for detailed information about the preparation, labelling and storage of specific dye/indicator/stain solutions. • **Using solutions of dyes, indicators or stains (students)**: Solutions usually contain less than 1 % of the dye/indicator/stain material and so will be less hazardous although the solvent (and/or other reagents) may be flammable and/or present additional hazards.

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W1/W2 (unwanted stock/solids)**. • **W7 (solutions)**: Dilute to below 0.1%.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Enzymes

Enzymes are proteins found in living organisms. They can be extracted & purchased in various forms (eg, powders, solutions).

Hazard classifications for enzymes and enzyme preparations vary but the majority are sensitisers. Many are skin, eye and respiratory irritants and some may cause serious eye damage.

Commercial suppliers may indicate one or more of the following for their enzyme product(s). Some may indicate no hazard classification. Check supplier's information.

 DANGER May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]	 DANGER Causes serious eye damage [H318]	 WARNING Causes skin irritation [H315] Causes serious eye irritation [H319] May cause respiratory irritation [H335]

Storage	Storage code: **Cold** (see notes below) [Supplied in different forms: powders, liquids etc] • **Storage conditions**: Check supplier's information and/or other detailed CLEAPSS guidance. • **Enzymes from natural sources**: Prepare as required. It is important to check activity-specific guidance. • **Commercial sources of enzymes**: Properties may differ markedly depending on the source organism. Check before purchase that the enzyme is suitable for the intended use. • Discard enzymes when out of date or no longer active.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **General spills:** Large-scale spills (eg, a burst container of a fine powder) can be difficult to deal with. Do **not** put yourself in danger of exposure to enzymes by skin/eye contact or by inhalation. If unsure how to proceed, contact CLEAPSS.

33 Risk Assessment Guidance **Enzymes**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance

Solid enzymes (eg, powders) may be one or more of:  DANGER / WARNING (See reverse)		TT	• Wear eye protection.
			• Avoid inhalation. Do not raise a dust/create an aerosol. Use a fume cupboard to weigh out/transfer the solid. Never spray any liquid enzyme preparation. Do not allow liquid preparations to dry up. Immediately wipe up/rinse spills.
			• Take particular care to avoid skin contact.
			  · Wear gloves when making up solutions from powders (**TT**).
			  · Gloves may also be advised for other practical procedures or for users with wounds, skin conditions or sensitivity to enzymes. Check activity-specific guidance and/or GL 120.
			Other notes; see also detailed activity-specific guidance:
			• **Enzymes (general guidance)**: See *Sourcing, storing and handling enzymes* and other detailed CLEAPSS guidance. Enzyme activity varies considerably with age, source and storage conditions. Carry out trials to check whether the enzyme is 'active' and produces the desired effect.
			• **Using enzyme powders (TT)**: Open container in a working fume cupboard then switch off fume cupboard to carry out weighing/transfer of powders. Have sash partially down. If powder spills, switch fume cupboard back on to vent loose particles then wipe over surfaces with a damp cloth. Rinse cloth.
			Disposal: W7 → 1% w/v (solutions)
			WSpec (solids), see below.

Liquid enzyme preparations and diluted solutions: • Most enzyme solutions < 1% (w/w) are currently not classified as hazardous. Classification will depend on the specific enzyme and its preparation. • Check supplier's information. • See also *Recipe* 37.		TT (Y7)	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **WSpec (solids)**: Add no more than 10 g of solid to 1 litre of water. Rinse down a foul-water drain. • **Organic material**: Small amounts of any organic material (eg, liver) used as a source of enzyme should **not** be poured down a sink; it should be collected, wrapped in paper and placed in the normal waste.

Ethanal *acetaldehyde* CH_3CHO (44.05)

DANGER

Extremely flammable liquid and vapour [H224]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Suspected of causing cancer [H351].

Ethanal is dangerous in contact with:

- SULFURIC(VI) ACID AND OTHER ACIDS. Violent polymerisation reactions may occur.
- SILVER NITRATE SOLUTION. Explosive products are formed.

Note:	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})
	−39	21	37 (LTEL); 92 (STEL)

Storage

Storage code: **FL** (Organic) [Colourless liquid, pungent, irritating odour]

- Ethanal's boiling point is low ('room temperature') and it has been known to spontaneously boil away during storage and on opening. Only open bottles in a fume cupboard; for a safe procedure see **Other notes** on reverse.
- Ethanal gradually oxidises to ethanoic acid during storage.

Metaldehyde *ethanal tetramer, 2,4,6,8-tetramethyl-1,3,5,7-tetraoxacyclooctane* $(CH_3CHO)_4$ (176.22)

WARNING

Flammable solid [H228]. Harmful if swallowed [H302].

Storage

Storage code: **FS** (Organic) [Solid]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills (ethanal): EXTREMELY FLAMMABLE, VOLATILE.**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

34 Risk Assessment Guidance

Ethanal and its tetramer

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Ethanal	 DANGER (See reverse)	Y12	• Wear eye protection. Protect the face when opening containers (see below). • Transfer or dispense in a fume cupboard. Do **not** inhale vapour. • Ensure no naked flames or other sources of ignition. • Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance:** • **To open a bottle (TT):** Use an efficiently-working fume cupboard. Wear gloves and splash-proof goggles. Protect the face. Before opening, place bottle inside a plastic bag (to protect the label) and cool in an ice bath. Open with care (ethanal has been known to spurt out of its bottle as the pressure is released. • **Test-tube reactions of aldehydes**: When possible, use propanal as an alternative to ethanal. Use a mineral wool plug in the open end of a test tube to minimise fumes. Carry out warming in a hot water bath. **Disposal:** W7, see note below
Metaldehyde	 WARNING (See reverse)	Y9	• Wear eye protection. • Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance:** • **Metaldehyde as a fuel**: Safer alternatives are available. **Disposal**: W6 in a fume cupboard

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W7 (ethanal):** Add 10 cm^3 to 1 litre of water. Pour down a foul-water drain with further dilution.

35A Risk Assessment Guidance Ethanamide, and other amides (1)

Ethanamide	*acetamide*	CH_3CONH_2 (59.07)
 WARNING	Suspected of causing cancer [H351]. **Ethanamide is dangerous in contact with:** • SODIUM CHLORATE(I) or CALCIUM CHLORATE(I). An explosive product is formed. • SODIUM NITRATE(III) (SODIUM NITRITE). An explosion can occur during heating.	

***N*-phenylethanamide**	*acetanilide, antifebrin*	$CH_3CONHC_6H_5$ (135.16)
Thiooxamide	*dithiooxamide, rubeanic acid*	$H_2NCS\text{-}CSNH_2$ (120.19)
 WARNING	**Both**: Harmful if swallowed [H302]. **Thiooxamide**: Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: some suppliers also indicate these for N-phenylethanamide.	

Carbamide	*urea*	H_2NCONH_2 (60.06)
Currently not classified as hazardous.		

Storage	Storage code: **GOrg** • Ethanamide, N-phenylethanamide, carbamide: colourless-white solids. • Thiooxamide (rubeanic acid): dark red solid.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

35A Risk Assessment Guidance

Ethanamide, and other amides (1)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Ethanamide	 WARNING (See reverse)	Y12	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **Hydrolysis of ethanamide**: Ammonia gas is produced. Carry out on a test-tube scale in a well-ventilated laboratory. • **Preparation of ethanamide**: The reaction between ethanoic acid and ammonium carbonate is preferable to that between ethanoyl chloride and ammonia. • **Preparation of urea-based resins:** Do **not** use methods involving hydrochloric acid.
• Thiooxamide • *N*-phenylethanamide	 WARNING (See reverse)	Y7	
Carbamide	Currently not classified as hazardous		**Disposal:** W2 (thiooxamide, N-phenylethanamide) W7, W8 (ethanamide, carbamide); see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **Ethanamide, W7**: Dissolve no more than 10 g of solid in 1 litre of water. Rinse down a foul-water drain with further dilution. • **Carbamide**, **W8** (solid) or **W7** (solid/solution).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

35B Risk Assessment Guidance — **Other amides (2)**

Phenylthiocarbamide	*N-phenylthiourea, PTC, PTU* $H_2NCSNHC_6H_5$ (152.22)
 DANGER	Fatal if swallowed [H300]. May cause an allergic skin reaction [H317].
Storage	Storage code: **T** (Organic) [White-yellow solid]

Propenamide	*2-propenamide, acrylamide* $CH_2CHCONH_2$ (71.08)
 DANGER	Toxic if swallowed [H301]. Harmful in contact with skin [H312]. Causes skin irritation [H315]. May cause an allergic skin reaction [H317]. Causes serious eye irritation [H319]. Harmful if inhaled [H332]. May cause genetic defects [H340]. May cause cancer [H350]. Suspected of damaging fertility [H361f]. Causes damage to organs through prolonged or repeated exposure [H372]. WEL (mg m^{-3}): 0.3 (LTEL), 0.9 (STEL), Carc, Sk **CLEAPSS advises against the use of propenamide in science practical work. If you think that there is no alternative to the use of this compound, please contact CLEAPSS to discuss the proposed activity.**
Storage	Storage code: **T** (Organic) [White solid]
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **VERY TOXIC (ingestion, may be fatal)**: Refers to phenylthiocarbamide solid, **not** purchased taste test strips (which should contain very small quantities of PTC/PTU). If the pure solid is ingested call 999.

35B Risk Assessment Guidance Other amides (2)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Phenylthio-carbamide	 DANGER (See reverse)	TT (Y7)	- Wear eye protection. - Avoid raising dust. Avoid skin contact. - Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: - **Tasting investigations**: Do **not** prepare your own PTC strips. Follow method in *Taste tests: PTU (phenythiourea)/PTC (phenylthiocarbamide) strips*. **Disposal**: W2
Propenamide	 DANGER (See reverse)	TT	**CLEAPSS advises against the use of propenamide in science practical work.** **If you think that there is no alternative to the use of this compound, please contact CLEAPSS to discuss the proposed activity.** **Disposal**: W1, W2

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

36A Risk Assessment Guidance **Ethanedioic acid and its salts**

Ethanedioic acid	*oxalic acid*	HOOCCOOH (90.04)
Ethanedioic acid-2-water	*oxalic acid dihydrate*	$HOOCCOOH.2H_2O$ (126.07)
 WARNING	Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Note: some suppliers indicate: Causes serious eye damage [H318], with the GHS 05 pictogram and DANGER. See reverse. WEL (mg m^{-3}): 1 (LTEL), 2 (STEL), ethanedioic acid	
Storage	Storage code: **GOrg**	[Colourless solid]

Ammonium ethanedioate-1-water	*ammonium oxalate*	$(NH_4)_2C_2O_4.H_2O$ (142.11)
Potassium ethanedioate-1-water	*potassium oxalate*	$K_2C_2O_4.H_2O$ (184.23)
Potassium hydrogenethanedioate	*potassium hydrogen oxalate, potassium bisethanedioate*	KHC_2O_4 (128.13)
Potassium tetraoxalate	*potassium hydrogenethanedioate-1-ethanedioic acid-2-water*	$KH_3(C_2O_4)_2.2H_2O$ (254.19)
Sodium ethanedioate	*sodium oxalate*	$Na_2C_2O_4$ (133.99)
 WARNING	Harmful if swallowed [H302]. Harmful in contact with skin [H312].	
Storage	Storage code: **GIn**	[White or colourless solids]

Ethanedioic acid and its salts are dangerous in contact with:

- OXIDISING AGENTS. Violent reactions occur. Note (ammonium oxalate): do **not** mix or grind ammonium salts with potassium manganate(VII) or potassium chlorate(V) (or other chlorates); explosive mixtures can form.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

36A Risk Assessment Guidance **Ethanedioic acid and its salts**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Ethanedioic acid solid (*oxalic acid*)	⚠ WARNING Harmful (ingestion, skin) Irritant/corrosive (eyes)*	Y9	*Oxalic acid: Suppliers may not indicate this as irritant [H319] or corrosive [H318] to eyes, but it is prudent to treat the solid and solutions as at least irritating to eyes. • Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **General use of solutions:** Salt solutions at or below 0.3 M will be adequate for many purposes. Oxalic acid solutions are saturated at ~ 1 M (room temperature). • **Action of heat on ethanedioic acid**: Carbon monoxide gas (toxic) is produced along with carbon dioxide. Use no more than 0.5 g of acid in a test-tube and ensure that the laboratory is well-ventilated. For larger quantities use a ducted (**not** filter/recirculatory) fume cupboard. **Disposal**: W4, oxalic acid; see below W7 → 0.1 M, oxalate salts
Ethanedioic acid solutions: < 1 M and ≥ 0.1 M	⚠ WARNING Irritant (eyes)*	Y7	
Oxalate salts (solids)	⚠ WARNING Harmful (ingestion, skin)		
Oxalate salt (solutions)	Currently not classified as hazardous. Note: Potassium oxalate is Harmful if swallowed ≥ 1.5 M.		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W4 (oxalic acid)**: Add no more than 30 g to 1 litre of 1 M sodium carbonate solution.

36B Risk Assessment Guidance **Other polybasic organic acids & their salts (1)**

Malonic acid	*propanedioic acid*	$HOOCCH_2COOH$ (104.06)
Succinic acid	*butanedioic acid, butane-1,4-dioic acid*	$HOOCCH_2CH_2COOH$ (118.09)
Maleic acid	*cis-butenedioic acid*	HOOCCHCHCOOH (116.07)
Fumaric acid	*trans-butenedioic acid*	HOOCCHCHCOOH (116.07)

WARNING

Note: Classification/labelling vary. Suppliers may indicate the following:

All: One or more of; Causes skin irritation [H315], Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

Malonic acid, **maleic acid**: Harmful if swallowed [H302].

Maleic acid: May cause an allergic skin reaction [H317].

Additionally, suppliers may indicate: Causes serious eye damage [H318]. If this is the case, the GHS 05 pictogram with DANGER will be included.

Storage	Storage code: **GOrg**	[White or colourless solids]

These substances are dangerous in contact with:

- OXIDISING AGENTS. Violent reactions may occur.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

36B Risk Assessment Guidance **Other polybasic organic acids & their salts (1)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**		**User**
Solid acids	⚠	WARNING (See reverse)	Y9
Maleic *and* Malonic acid solutions ≥ 2 M	⚠ WARNING	As below plus: Harmful (ingestion)	
Maleic *and* Malonic acid solutions < 2 M and ≥ 1 M		Irritant (skin, eyes)	
Maleic acid solutions < 1 M and ≥ 0.1 M		Sensitiser (skin)	
Solutions of • Maleic acid < 0.1 M • Malonic acid < 1 M • Fumaric acid • Succinic acid	Currently not classified as hazardous.		Y7

Suggested general control measures and guidance

- Wear eye protection.
- Take particular care to avoid skin contact (maleic acid). See activity-specific guidance and/or GL 120.

Other notes; see also detailed activity-specific guidance:

- Do **not** inhale vapours, if substances are heated.
- **Cis-trans isomers of butenedioic acid**: maleic acid (*cis*-) and fumaric acid (*trans*-) exhibit significantly different properties:

	Melting point (^{o}C)	Solubility (g /100 cm^3 water at 20 ^{o}C)
Maleic acid	~ 135	~ 50
Fumaric acid	~ 287	~ 0.5

Disposal: W4

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

36C Risk Assessment Guidance **Other polybasic organic acids & their salts (2)**

Malic acid	*2-hydroxysuccinic acid, 2-hydroxybutanedioic acid*	$HOOCCH(OH)CH_2COOH$ (134.09)
Tartaric acid	*2,3-dihydroxybutanedioic acid*	$HOOCCH(OH)CH(OH)COOH$ (150.087)
Citric acid	*2-hydroxypropane-1,2,3-tricarboxylic acid*	$HOOCCH_2C(OH)(COOH)CH_2COOH$ (192.12)
Citric acid-1-water	*citric acid monohydrate*	$HOOCCH_2C(OH)(COOH)CH_2COOH.H_2O$ (210.14)
 WARNING	Causes serious eye irritation [H319]. Causes skin irritation [H315]. May cause respiratory irritation [H335]. Note: Classification/labelling vary. Some suppliers indicate: May cause serious eye damage [H318] along with the GHS 05 pictogram, DANGER.	
Storage	Storage code: **GOrg**	[White crystalline solids]

Potassium sodium tartrate	*Rochelle salt, potassium sodium 2,3-dihydroxybutanedioate-4-water*	$KNaC_4H_4O_6.4H_2O$ (282.1)
Sodium citrate-2-water		$C_6H_5O_7Na_3.2H_2O$ (294.10)
Currently not classified as hazardous.		
Storage	Storage code: **GIn**	[White crystalline solids]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

36C Risk Assessment Guidance **Other polybasic organic acids & their salts (2)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solids, and solutions ≥ 0.7 M (malic acid) ≥ 0.7 M (tartaric acid) ≥ 0.5 M (citric acid)	 WARNING Irritant (skin, eyes) Irritant (respiratory)	Y7	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **Buffer solutions**: See *Recipe* 18 and *pH measurement* (R35). **Disposal:** W7 → 0.5 M (solutions) W4 (solids)
Solutions < 0.7 M (malic acid) < 0.7 M (tartaric acid) < 0.5 M (citric acid)	Currently not classified as hazardous.		
Solids & solutions • Potassium sodium tartrate • Sodium citrate-2-water	Currently not classified as hazardous.		• Eye protection and/or other control measures may be advised for some procedures. Check activity-specific guidance and/or GL 120. **Disposal**: W7

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

37A Risk Assessment Guidance — Ethane-1,2-diol & Other polyols (1)

Ethane-1,2-diol *1,2-ethanediol, ethylene glycol,* CH_2OHCH_2OH (62.07)

WARNING

Harmful if swallowed [H302]. Note: Some suppliers may also indicate: May cause damage to organs (kidneys) through prolonged or repeated exposure (oral) [H373]. The GHS 08 pictogram would be included (see GL 120).

	Flash point ($^{\circ}$C)	Boiling point ($^{\circ}$C)	WEL (mg m^{-3})
ethane-1,2-diol	~ 111	198	52 (LTEL), 104 (STEL), Sk

Propane-1,2-diol *1,2-propanediol, propylene glycol, α-propylene glycol* $CH_3CH(OH)CH_2OH$(78.09)

Propane-1,3-diol *1,2-propanediol, propylene glycol, β-propylene glycol* $CH_2OHCH_2CH_2OH$ (78.09)

Propane-1,2,3-triol *1,2,3-propanetriol, glycerol, glycerine, triethylene glycol* $CH_2OHCH(OH)CH_2OH$ (92.09)

Currently not classified as hazardous.

	Flash point ($^{\circ}$C)	Boiling point ($^{\circ}$C)	WEL (mg m^{-3})
propane-1,2-diol	~ 99	187	474 (LTEL), 1422 (STEL), Sk
propane-1,3-diol	–	215	–
propane-1,2,3-triol	~ 199	289	10 (LTEL), 30 (STEL); as mist

These polyols are dangerous in contact with:

- OXIDISING AGENTS such as potassium dichromate(VI), perchloric acid and potassium manganate(VII). Explosive or vigorously-burning mixtures are formed. Note: the mixture with PROPANE-1,2,3-TRIOL (glycerol) self-ignites after a delay (which can be unpredictable). Under controlled conditions, this reaction can be safely demonstrated.

Storage

Storage code: **GOrg** [Colourless liquids of varying viscosity]

- Ensure bottles are securely stoppered. These liquids absorb water from the atmosphere.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120).

37A Risk Assessment Guidance **Ethane-1,2-diol & Other polyols (1)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Ethane-1,2-diol	 WARNING Harmful (ingestion) See also reverse	Y7	• Wear eye protection. **Other notes; see also detailed activity-specific guidance:** • **Viscosity investigations**: ethane-1,2-diol, propane-1,2-diol and propane-1,2,3-triol may be used and have the advantage (eg, over commercial motor oils*) of being water-soluble. Apparatus and glassware can easily be cleaned. Take steps to contain spills to avoid slip hazards. *If commercial motor oils are investigated, they must be fresh/**unused**. • **Heating baths (eg, for melting point determinations)**: Use propane-1,2,3-triol (glycerol) instead of dibutyl phthalate as a heating medium. Note that old stocks of glycerol will contain water (absorbed from the atmosphere) and bubbles of water vapour will appear on heating above 100 ^{o}C. Do **not** return used liquid to the stock bottle. For temperatures > 150 ^{o}C, use medicinal paraffin in the heating bath. **Disposal**: W7, see note below
• Propane-1,2-diol • Propane-1,3-diol • Propane-1,2,3-triol	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • Add no more than 250 cm^3 of the polyol to 1 litre of water before pouring away down a foul-water drain with further dilution.

37B Risk Assessment Guidance **Other polyols (2)**

Phenoxytol	*phenoxetol, 2-phenoxyethanol*	$C_8H_{10}O_2$ (138.16)
Propylene phenoxytol	*propylene phenoxetol*	$C_9H_{12}O_2$ (152.19)

 WARNING	Harmful if swallowed [H302]. Causes serious eye irritation [H319]. Note: Classification/labelling varies. Some suppliers may also indicate: Causes skin irritation [H315].

Storage	Storage code: **GOrg** [Colourless or colourless-pale yellow liquids] • These ether glycols are used as components in some ‘odourless’ preserving fluids (eg, Opresol). Check supplier’s information for details as commercially available fluids may also contain other substances that can affect the hazard classification of the overall mixture. • Propylene phenoxytol (or phenoxetol): this name may be used for different isomers or a mixture of these (eg, 1-phenoxy-2-propanol, 2-phenoxy-1-propanol).

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

37B Risk Assessment Guidance **Other polyols (2)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
- Phenoxytol - Propylene phenoxytol	 WARNING (See reverse)	TT (Y7)	- Wear eye protection. **Other notes; see also detailed activity-specific guidance**: - **Preserving fluids for biological specimens**: Phenoxytols have been used as alternatives to formalin (methanal solutions); see *Hazcard* 63. Do **not** mix phenoxytols with formalin. Refer to detailed guidance for any activity involving preserving fluids. See also *Recipe* 74.
Solutions of phenoxytols	Solutions usually involve other components. Refer to activity-specific guidance for in-house prepared solutions. See supplier's information for purchased solutions.		**Disposal**: W2, W7; see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** - **W7**: These ether glycols are not particularly soluble. Add no more than 25 cm^3 to 1 litre of water. Flush away down a foul-water drain.

38A Risk Assessment Guidance — Ethanoic acid, methanoic acid and their salts

Ethanoic acid	*acetic acid, (vinegar, is an ~ 0.8 M solution of ethanoic acid)*	CH_3COOH (60.05)
Methanoic acid	*formic acid*	$HCOOH$ (46.02)

ethanoic

DANGER

Flammable vapour and liquid [H226], ethanoic acid. Causes severe skin burns and eye damage [H314].

The concentrated acids are dangerous in contact with:

- CHROMIUM(VI) OXIDE, MANGANATES(VII), NITRIC(V) ACID, PEROXIDES. Explosive reactions occur.
- PHOSPHORUS(V) OXIDE. Rapid evolution of carbon monoxide (methanoic acid).

Flash point (^{o}C):	39 (ethanoic acid); 68 (methanoic acid)
WEL (mg m^{-3}):	25 (LTEL), 50 (STEL); ethanoic acid 9.6 (LTEL), 28.8 (STEL); methanoic acid

Storage

Storage code: **CLa** (Organic) [Colourless liquids, pungent odours]

- **Ethanoic acid (concentrated)**: Liquid solidifies on cool days (melting point: 17 ^{o}C). Solid looks like ‘cracked ice’ (i.e. ‘glacial’). To melt solid, place bottle in a plastic bag (to protect label), undo the lid slightly and stand in warm water.
- **Methanoic acid**: Usually supplied as a 90% solution.

Sodium ethanoate	*sodium acetate, anhydrous sodium ethanoate/acetate*	CH_3COONa (82.03)
Sodium ethanoate-3-water	*sodium acetate-3-water, hydrated sodium ethanoate*	$CH_3COONa.3H_2O$ (136.08)
Sodium methanoate	*sodium formate*	$HCOONa$ (68.03)

Currently not classified as hazardous. Some suppliers may indicate: Causes serious eye irritation (H319).

Storage

Storage code: **GIn** [Colourless or white solids; powders or crystals]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE (concentrated acids):

- **CORROSIVE (skin, eyes).**
- **General spills: FLAMMABLE (ethanoic), CORROSIVE. Odours are pungent and unpleasant**.

  If safe to deal with: Ventilate spill area as much as possible. Ensure no ignition sources. Add absorbent and/or solid anhydrous sodium carbonate to the spill (this will neutralise the acid and reduce fumes).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

38A Risk Assessment Guidance — Ethanoic acid, methanoic acid and their salts

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Concentrated acids: • 90% (methanoic) • glacial (ethanoic)	DANGER Flammable (ethanoic) Corrosive (skin, eyes)	TT (Y9)	• Wear splash-proof goggles. Protect the face when transferring or dispensing large volumes. • Avoid inhaling vapour. Use a fume cupboard. • Ensure laboratory is well-ventilated. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • Unless very concentrated (~ 12 M), aqueous solutions of ethanoic acid are not classified as flammable. • **Preparation of solutions (TT)**: *Recipe* 39 (ethanoic) and *Recipe* 59. **Disposal**: W7 → 0.1 M; or W4
Solutions: ≥ 2.2 M (methanoic) ≥ 4 M (ethanoic)	DANGER Corrosive (skin, eyes)		
< 2.2 M and ≥ 0.4 M (methanoic) < 4 M and ≥ 1.7 M (ethanoic)	WARNING Irritant (skin, eyes)	Y7	• Wear eye protection, even when dilute solutions are used. • Avoid inhaling vapour. Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance**: • Solutions below 4 M (ethanoic acid) or below 2 M (methanoic acid) will be adequate for many pre-16 practicals. **Disposal**: W7 → 0.1 M; or W4
< 0.4 M (methanoic) < 1.7 M (ethanoic) Solutions of the salts.	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for the more-concentrated acids**: • **W4, W7**: Use a fume cupboard. Avoid inhaling fumes.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

38B Risk Assessment Guidance **Ethanoic acid: related 'higher' monobasic acids**

Propanoic acid	*propionic acid*	CH_3CH_2COOH (74.08)
DANGER	Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335]. Flammable liquid and vapour [H226]. Flash point: 52 °C WEL (mg m^{-3}): 31 (LTEL), 46 (STEL)	
Storage	Storage code: **CLa** (Organic)	[Colourless liquid, pungent odour]

Butanoic acid	*n-butyric acid*	$CH_3(CH_2)_2COOH$ (88.11)
Pentanoic acid	*n-valeric acid*	$CH_3(CH_2)_3COOH$ (102.13)
Hexanoic acid	*n-hexoic acid; caproic acid*	$CH_3(CH_2)_4COOH$ (116.16)
DANGER	Causes severe skin burns and eye damage [H314]. Note: All have extremely obnoxious odours. Avoid bulk use; see **Other notes** (on reverse). Assume these organic acids are also harmful to aquatic life, with long lasting effects.	
Storage	Storage code: **CLa** (Organic)	[Colourless liquids, pungent odour]

Dodecanoic acid	*lauric acid*	$CH_3(CH_2)_{10}COOH$ (200.32)
Hexadecanoic acid	*palmitic acid*	$CH_3(CH_2)_{14}COOH$ (256.42)
WARNING	Causes serious eye irritation [H319]. Causes skin irritation [H315]. May cause respiratory irritation [H335].	
Octadecanoic acid	*stearic acid*	$CH_3(CH_2)_{16}COOH$ (284.48)
Cis-octadec-9-enoic acid	*oleic acid*	$CH_3(CH_2)_7CHCH(CH_2)_7COOH$ (282.46)
Currently not classified as hazardous.		
Storage	Storage code: **GOrg**	[Crystaline/waxy white white solids; *oleic acid* is a pale yellow oily liquid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE (skin, eyes):** propanoic, butanoic, pentanoic and hexanoic acid. • **General spills/clearing up**: **CORROSIVE LIQUID, acid**. The odours of the concentrated liquid acids are particularly pungent and unpleasant. If safe to do so, ventilate the area of the spill as much as possible.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

38B Risk Assessment Guidance Ethanoic acid: related 'higher' monobasic acids

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Butanoic acid Pentanoic acid Hexanoic acid	 DANGER (See reverse)	TT	• **For the concentrated acids including propanoic acid solutions ≥ 3.4 M**: · Wear splash-proof goggles. · Protect the face when transferring or dispensing large volumes. · Use in a fume cupboard. Avoid inhaling vapour. Avoid naked flames. · Wear a laboratory coat (butanoic, pentanoic, hexanoic acids). · Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. • **For propanoic acid solutions < 3.4 M**: · Wear eye protection even when dilute solutions are used. · Avoid inhaling vapour. · Solutions < 1.4 M will be adequate for many pre-16 activities. **Other notes; see also detailed activity-specific guidance:** • Butanoic, pentanoic and hexanoic acids have *extremely* obnoxious odours. They are difficult to remove from contaminated clothing or if spilt. The odour persists, including in drains. CLEAPSS advice is that students do **not** use these acids. TT use is only with great care (eg, to make esters). **Disposal**: W4 or W7, see notes below
Propanoic acid (conc.)	 DANGER (See reverse)	TT (Y9)	
Propanoic acid solutions ≥ 3.4 M	 DANGER Corrosive (skin, eyes) Irritant (respiratory)		
< 3.4 M and ≥ 1.4 M	 WARNING Irritant (skin, eyes) Irritant (respiratory)	Y9	
< 1.4 M	Currently not classified as hazardous	Y7	
Dodecanoic acid Hexadecanoic acid	 WARNING (See reverse)	Y7	• Wear eye protection. **Disposal**: W2, W4 (dodecanoic/hexadecanoic) W8 (oleic/stearic)
Stearic & oleic acids	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • **W4 (concentrated acids):** Use a fume cupboard. • **W7 (diluted acid solutions)**: Dilute further to below 0.1 M.

38C Risk Assessment Guidance **Chloroethanoic acids**

Chloroethanoic acid	*monochloroethanoic acid, monochloroacetic acid*	$ClCH_2COOH$ (94.50)
Dichloroethanoic acid	*dichloroacetic acid*	$Cl_2CHCOOH$ (128.94)
Trichloroethanoic acid	*trichloroacetic acid*	Cl_3CCOOH (163.39)

chloroethanoic

DANGER

All: Causes severe skin burns and eye damage [H314]. Very toxic to aquatic life [H400] and, for trichloroethanoic acid, with long lasting effects [H410].

Chloroethanoic, **trichloroethanoic acids**: May cause respiratory irritation [H335].

Chloroethanoic acid: Toxic if swallowed/in contact with skin/if inhaled [H301/H311/H331].

WEL (mg m^{-3}): 1.2 (LTEL), 3.6 (STEL), Sk; monochloroethanoic acid

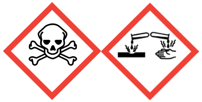
Storage			
	Storage code:	**T** (Organic), chloroethanoic acid	[Colourless solid, sharp odour]
		CLa (Organic), dichloroethanoic acid	[Colourless liquid, sharp odour]
		CS (Organic), trichloroethanoic acid	[Colourless solid]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **TOXIC (skin, eyes, ingestion, inhalation)**: chloroethanoic acid.
- **General spills/clearing up: CORROSIVE LIQUID/SOLID, acids.**

38C Risk Assessment Guidance **Chloroethanoic acids**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk			
General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid/liquid acids, and solutions of chloroethanoic acid ≥ 3.5 M)	 DANGER (See reverse)	TT (Y12)	• Wear eye protection. Wear splash-proof goggles for solid/liquid reagents and corrosive solutions. • Use or dispense in a fume cupboard. Avoid inhaling vapour. • Ensure laboratory is well-ventilated. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Use of chloroethanoic acid solutions**: The compounds are useful for demonstrating the effect of the chlorine group on acid properties. Use 0.1 M solutions. **Disposal:** W4
Chloroethanoic acid solutions < 3.5 M and ≥ 0.5 M	 DANGER Corrosive (skin, eyes). Irritant (respiratory). Harmful (ingestion). Harmful (skin), ≥ 1.5 M	Y12	
Solutions < 0.5 M & ≥ 0.3 M ≥ 0.2 M (di- and tri- acids)	 DANGER Corrosive (eyes) Irritant (skin) Irritant (respiratory)		
Solutions < 0.3 M and ≥ 0.1 M < 0.2 M and ≥ 0.05 M for the di- and tri- acids	 WARNING Irritant (skin, eyes) Irritant (respiratory), tri-		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

38D Risk Assessment Guidance **Lactic acid and other organic acids**

2-hydroxypropanoic acid	*lactic acid*	$CH_3CH(OH)COOH$ (90.08)
 DANGER	Causes skin irritation [H315]. Causes serious eye damage [H318].	
Storage	Storage code: **CLa** or **CS** (Organic)* *Lactic acid exists in different isomeric forms. Physical state and properties vary.	[Colourless-yellow liquid/solid*]

Amino acids		(various)
Ascorbic acid	*Vitamin C*	$C_6H_8O_6$ (176.12)
Gibberellic acid		$C_{19}H_{22}O_6$ (346.37)
Hormone rooting powders		(various)
Indol-3-ylethanoic acid	*indolylacetic acid, indoleacetic acid, IAA*	$C_{10}H_9NO_2$ (175.18)
Indol-3-ylbutanoic acid	*indolylbutyric acid, indolebutyric acid, IBA*	$C_{12}H_{13}NO_2$ (203.24)

Currently not classified as hazardous.

Note: Classification and labelling vary. Some suppliers may indicate one or more of: Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

Storage	Storage code: **GOrg**	[Colourless/white solids]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

38D Risk Assessment Guidance Lactic acid and other organic acids

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Lactic acid solid, and solutions ≥ 1 M	 DANGER Corrosive (eyes) Irritant (skin)	Y7	• Wear eye protection. • Wear splash-proof goggles when transferring or dispensing large volumes of lactic acid solution ≥ 0.3 M. **Other notes; see also detailed activity-specific guidance**: • **Preparation of plant hormone solutions (TT)**: Follow instructions from commercial suppliers when making up solutions. Prepared solutions are usually very dilute and may be used by Y7 and older students.
Lactic acid solutions < 1 M and ≥ 0.3 M	 DANGER Corrosive (eyes)		
Lactic acid solutions < 0.3 M and ≥ 0.1 M	 WARNING Irritant (eyes)		
Other organic acids listed on this *Hazcard*	Currently not classified as hazardous		**Disposal:** W4 (lactic acid) W7, W8 (other acids)

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Ethanoic anhydride	*acetic anhydride* $(CH_3CO)_2O$ (102.09)
 DANGER	Flammable liquid and vapour [H226]. Harmful if swallowed or if inhaled [H302, H332]. Causes severe skin burns and eye damage [H314]. **Ethanoic anhydride is dangerous in contact with**: • WATER. The hydrolysis reaction is very vigorous. In the presence of ethanoic acid (which is formed anyway), the reaction can become violent. • ETHANOL. If acid is present, the reaction is vigorous. • BORIC ACID, CHROMIUM(VI) OXIDE, MANGANATES(VII), NITRIC(V) ACID, PEROXIDES. Violent or explosive reactions may occur. WEL (mg m^{-3}): 2.5 (LTEL), 10 (STEL) Flash point: 49 ^{o}C
Storage	Storage code: **CW** (Organic) [Colourless liquid, pungent odour] • Purchase small quantities. Regularly check the condition of bottle tops/caps, replace if required. • Place the bottle inside another container that also contains soda lime (to absorb any fumes).

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120)**. **NOTE:** • **CORROSIVE (eyes, skin).** • **CORROSIVE (inhalation). BEWARE DELAYED EFFECTS.** • **General spills**: **FLAMMABLE, CORROSIVE-WATER REACTIVE. Odours are pungent & unpleasant**. If safe to deal with: Ventilate the area as much as possible. Cover spill with absorbent. Scoop into a **dry** bucket and take to a fume cupboard. Treat with a large excess of water (eg, use 4 L for a 100 cm^3 spill). Leave to hydrolyse for at least 12 hours. [Thoroughly mop spill area.] After 12 hours, decant the liquid (now a solution of ethanoic acid) down a foul-water drain and rinse away with more water. Place rinsed absorbent in the waste.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

39 Risk Assessment Guidance

Ethanoic anhydride

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Ethanoic anhydride	DANGER Flammable. Harmful (ingestion, inhalation). Corrosive (skin, eyes)	Y12	• Wear splash-proof goggles. • Dispense in a fume cupboard. Avoid inhaling vapour. • Ensure laboratory is well-ventilated. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • Practical procedures involving ethanoic anhydride will often require the use of a fume cupboard and/or a well-ventilated laboratory. **Disposal**: W4 or WSpec; see below
Ethanoic anhydride in mixtures at: < 25% and ≥ 5% (w/w)	DANGER Corrosive (eyes) Irritant (skin, respiratory)		
Ethanoic anhydride in mixtures at: < 5% and ≥ 1% (w/w)	WARNING Irritant (eyes)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **W4 or WSpec (in a fume cupboard)**: Add ethanoic anhydride in small volumes (eg, 3-5 cm^3) to 1 M sodium carbonate [W4] or to excess water [WSpec]. Use at least 0.5 litre of 1 M sodium carbonate or 1 litre of water for no more than 25 cm^3 of ethanoic anhydride in total.

40A Risk Assessment Guidance Ethanol (and IDA)

Pure ethanol is expensive and schools and colleges usually buy Industrial Denatured Alcohol (IDA) but label it ‘ethanol’. Denatured alcohol is alcohol that has been treated to make it unsuitable for drinking. IDA (once called Industrial Methylated Spirits, IMS) contains ethanol plus 5% of, usually, wood naphtha (mainly methanol), which results in the additional health hazard classification.

Note: Completely denatured alcohol (CDA) consists of (since 2013) a mixture of ethanol, propan-2-ol and methyl ethyl ketone. A bitter-tasting compound is added and, sometimes, a purple dye. CDA (sometimes referred to as mineralised methylated spirits) is not suitable for school science activities.

Ethanol *Ethyl alcohol* CH_3CH_2OH (46.07)

DANGER

Pure ethanol: Highly flammable liquid and vapour [H225].

IDA is also: Harmful if swallowed [H302]. May cause damage to organs [H371]. (GHS 07 & GHS 08 pictograms).

This substance (ethanol or IDA) is dangerous in contact with:

- BROMINE. Violent reaction may occur.
- MERCURY(II) and SILVER NITRATE(V). Explosive fulminates may be formed.
- OXIDISING AGENTS. Uncontrollable reactions take place, especially with NITRIC(V) ACID.
- PLATINUM. Finely divided metal (eg, platinised electrodes, catalysts) may cause ethanol to burst into flame.
- POTASSIUM. An explosive reaction will occur.

WEL (mg m^{-3}): 1920 (LTEL), 5760 (STEL); ethanol
266 (LTEL), 333 (STEL), Sk; methanol

Flash point: 13 °C

Storage

Storage code: **FL** (Organic) [Colourless liquid]

- Keep main stock containers under lock and key. Records need to be kept of the volume of IDA ordered and used by the school (normally covered by good stocktaking procedures).
- To purchase and use more than 5 litres per year of IDA, the school will need to provide a supplier with a copy of the Excise Notice 473 authorisation it has obtained from HM Revenue & Customs (HMRC). See *Ethanol – HM Revenue & Customs (HMRC) – Application Form* in the *Useful Links* section of the CLEAPSS science website.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **If swallowed:** Monitor for signs of intoxication. If more than a few cm^3 have been swallowed or if concerned, call the emergency services and tell them the quantity of chemical(s) involved.

40A Risk Assessment Guidance — Ethanol (and IDA)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Ethanol	 DANGER Highly flammable	Y7	• Wear eye protection. • Transferring/dispensing large volumes (TT): Use a fume cupboard. • Ensure no naked flames or other sources of ignition. • Ensure the laboratory is well ventilated for open-bench work. **Other notes; see also detailed activity-specific guidance**: • **Heating**: Do **not** use a naked flame to heat a highly flammable liquid. Use hot water from a kettle or use electrically-heated baths. Boiling point of ethanol: 78.3 °C. If ethanol vapour in a container catches fire, cover the container with a heatproof mat or a damp cloth. • **Use as a fuel**: Do **not** allow students to fill/refill crucibles or spirit burners, TT only. The use of a spirit burner should be dedicated to a specific alcohol. Ensure the wick fits tightly in its holder and the holder fits tightly in the container. See *Safer chemicals, safer reactions* and *spirit burners*. • **Evaporation/cooling experiments**: Alcohol-based hand gels may be used to experience the cooling effect of evaporation. Check the health warnings provided with such products BEFORE use. Apply only a small quantity to the back of a hand. Do **not** use surgical spirits. • Do **not** use methanol in place of ethanol (or IDA) where the latter is specified for chemical reactions. **Disposal**: W7 → 5% v/v
IDA	 DANGER Highly flammable. Harmful (ingestion). May cause damage to organs.		
Aqueous solutions of ethanol/IDA	See *Recipe* 2		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

40B Risk Assessment Guidance — Methanol and phenylmethanol

Methanol	*methyl alcohol, wood alcohol*	CH_3OH (32.04)
   DANGER	Highly flammable liquid and vapour [H225]. Toxic if swallowed [H301]. Toxic in contact with skin [H311]. Toxic if inhaled [H331]. Causes damage to organs if swallowed, through contact with the skin, or if inhaled [H370]. **Methanol is dangerous in contact with:** • BROMINE. Violent reaction may occur. • OXIDISING AGENTS. Uncontrollable reactions take place, especially with NITRIC(V) ACID. • MERCURY(II) and SILVER NITRATE(V). Explosive fulminates may be formed. • PLATINUM. Finely divided metal (eg, platinised electrodes, catalysts) may cause methanol to burst into flame. • POTASSIUM. An explosive reaction will occur. WEL (mg m^{-3}): 266 (LTEL), 333 (STEL); Sk Flash point: 11 °C	
Storage	Storage code: **FL** (Organic)	[Colourless liquid]

Phenylmethanol	*benzyl alcohol*	$C_6H_5CH_2OH$ (108.14)
 WARNING	Harmful if swallowed [H302]. Harmful if inhaled [H332]. Note: Flash point: 93 °C	
Storage	Storage code: **GOrg**	[Colourless liquid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE for methanol**: • **If swallowed:** if methanol is ingested (or ingestion is suspected), call the emergency services. Tell them the quantity of methanol involved.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

40B Risk Assessment Guidance **Methanol and phenylmethanol**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Methanol	 DANGER (See reverse)	TT (Y7)	• Wear eye protection. • Use a fume cupboard to: transfer/dispense large volumes (TT), heat methanol, temporarily store methanol-filled spirit burners put out ready for use. Ensure no naked flames/other sources of ignition. • Avoid inhaling fumes. Ensure laboratory is well ventilated. • Take particular care to avoid skin contact. Gloves are advised when transferring or dispensing large volumes. See also activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Heating**: Do **not** use a naked flame to heat a highly flammable liquid. Use hot water from a kettle or use electrically-heated baths. Boiling point = 64.6 °C. If methanol vapour in a container catches fire, cover the container with a heatproof mat or a damp cloth. • **Use as a fuel**: Do **not** allow students to fill or refill crucibles or spirit burners, TT only. Do **not** use spirit burners used for methanol for any other fuel. Ensure wick fits tightly in its holder and the holder fits tightly in container. See *Safer chemicals, safer reactions* and *spirit burners*. • Do **not** use methanol in place of ethanol (or IDA) where latter is specified. **Disposal**: W2; W7 → 1% (v/v)
Aqueous solutions of methanol	See *Recipe* 2		
Phenylmethanol	 WARNING (See reverse)	Y7	• Wear eye protection. • Avoid inhaling fumes. Ensure laboratory is well ventilated. **Disposal**: W2; W7 → 3% (v/v)

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

40C Risk Assessment Guidance Carbohydrates

D-fructose	*laevulose, fruit sugar*	$C_6H_{12}O_6$	(180.16)
D-galactose		$C_6H_{12}O_6$	(180.16)
D-glucose	*dextrose, grape sugar*	$C_6H_{12}O_6$	(180.16)
D-glucose-1-phosphate (dipotassium salt)		$C_6H_{11}O_6.PO_3K_2.2H_2O$	(336.32)
D-glucose-1-phosphate (disodium salt)		$C_6H_{11}O_6.PO_3Na_2.2H_2O$	(304.10)
D-lactose	*milk sugar*	$C_{12}H_{22}O_{11}.H_2O$	(360.31)
D-maltose	*malt sugar*	$C_{12}H_{22}O_{11}.H_2O$	(360.31)
Sucrose	*sugar, table sugar, cane/beet sugar*	$C_{12}H_{22}O_{11}$	(342.30)
Cellulose		-	-
Starch (amylose/amylopectin)	*(also contained in flour, cornflour)*	-	-
Dextrin		-	-

Currently not classified as hazardous.

WEL (mg m^{-3}): 10 (LTEL), 20 (STEL), as inhalable dust / 4 (LTEL), 12 (STEL), as respirable dust; cellulose
10 (LTEL), 30 (STEL), Sen; flour dust
10 (LTEL), 20 (STEL); sucrose
10 (LTEL), 30 (STEL), as inhalable dust / 4 (LTEL), 12 (STEL), as respirable dust; starch

Storage	Storage code: **GOrg**	[White solids]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

40C Risk Assessment Guidance **Carbohydrates**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
D-fructose D-galactose D-glucose D-glucose-1-phosphate (disodium/dipotassium salts) D-lactose D-maltose Sucrose Cellulose Starch (amylose/amylopectin) Dextrin	Currently not classified as hazardous. See notes on reverse.	Y7	• Eye protection and/or other control measures may be advised for some procedures. Check activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Heating**: Products are not poisonous but the odour can be unpleasant. Use as small an amount as possible. Ensure laboratory is well-ventilated. • **Fermentation activities**: If carried out in a laboratory, do **not** allow products to be tasted or to be taken home. • **Nitrocellulose (TT)**: See *Making and burning nitrocellulose ('gun cotton')*. • **Dust explosions (TT)**: See *Dust explosions using cornflour, custard powder, icing sugar, lycopodium powder, etc*. **Disposal**: W8

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

41 Risk Assessment Guidance — Ethanoyl chloride and other acid chlorides

Ethanoyl chloride	*acetyl chloride*	CH_3COCl (78.50)
Hexanedioyl dichloride	*adipoyl chloride*	$ClCO(CH_2)_4COCl$ (183.03)
Decanedioyl dichloride	*sebacoyl chloride*	$ClCO(CH_2)_8COCl$ (239.14)

ethanoyl-

decanedioyl-

DANGER

All: Causes severe skin burns and eye damage [H314].

Ethanoyl chloride: Highly flammable liquid and vapour [H225]. Flash point: 4 °C.

Ethanoyl chloride, hexanedioyl dichloride: Reacts violently with water [EUH014].

Decanedioyl dichloride: Harmful if swallowed [H302], some suppliers indicate Toxic if swallowed [H301] with the GHS 06 pictogram. May cause respiratory irritation [H335].

Acid chlorides are dangerous in contact with:

- WATER. The reaction is violent, forming choking fumes of hydrogen chloride.
- AMMONIA, AMINES. Reaction is violent. Dense, choking, white fumes of ammonium chloride form.

Storage

Storage code: **FL** (Organic), ethanoyl chloride [Colourless liquid, pungent odour]

Storage code: **CW** (Organic), hexanedioyl- /decanedioyl- [Brown/colourless liquids, pungent odours]

- These acid (or acyl) chlorides react with water vapour in air to form toxic hydrogen chloride gas that can accelerate the corrosion of metals and may also cause white deposits on bottles in the store.
- Solid material in the liquid hexanedioyl/decanedioyl dichlorides indicates that hydrolysis has occurred.
- Store bottle(s) inside an outer container that also contains soda lime or anhydrous calcium chloride.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes).**
- **TOXIC, CORROSIVE (inhalation), BEWARE DELAYED EFFECTS.** Due to hydrogen chloride gas formed.
- **General spills/clearing up: HIGHLY FLAMMABLE** (ethanoyl chloride)**, CORROSIVE-WATER REACTIVE.**

  If safe to do so: Use a fume cupboard for treating a collected spill. Treat with a large excess of water and leave to hydrolyse. Neutralise the mixture with sodium carbonate. Decant liquid portion down a foul-water drain. The rinsed solid absorbent can be bagged and placed in the normal refuse.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

41 Risk Assessment Guidance

Ethanoyl chloride and other acid chlorides

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk			
General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
• Ethanoyl chloride • Hexanedioyl chloride • Decanedioyl dichloride	  ethanoyl-  decanedioyl- DANGER (See reverse)	TT (Y9)	• Wear splash-proof goggles. • Use a fume cupboard. Ensure laboratory is well-ventilated. • Avoid inadvertent contact with water. • Ensure no naked flames or other ignition sources (ethanoyl chloride). • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **'Nylon rope' experiment**: This requires a solution of (usually) decanedioyl dichloride in an organic solvent (cyclohexane). See *Recipe* 62 for guidance on the safe preparation and storage of this solution and instructions for carrying out the 'nylon-rope' practical (large and small scale). **Disposal**: W4, see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W4: Use a fume cupboard.** Add the acid chloride liquid in small portions (~ 1 cm^3) to 1 M sodium carbonate solution. Allow reaction to subside before adding more acid chloride. Use 0.5 litre of 1 M sodium carbonate solution to treat no more than ~ 35 cm^3 of an acid chloride. Note: see activity-specific guidance for disposal of residues from the 'nylon rope' practical.

42 Risk Assessment Guidance

Ethoxyethane and other ethers

Ethoxyethane — *diethyl ether, ether* — $C_2H_5OC_2H_5$ (74.12)

DANGER

Extremely flammable liquid and vapour [H224]. Harmful if swallowed [H302]. May cause drowsiness or dizziness [H336]. May form explosive peroxides [EUH019]. Repeated exposure may cause skin dryness or cracking [EUH066].

Ethoxyethane is dangerous in contact with:

- OXIDISING AGENTS. Risk of explosive reactions.
- BROMINE AND CHLORINE. Explosive reactions occur. Ignition occurs on contact with chlorine.

WEL (mg m^{-3}): 310 (LTEL), 620 (STEL)   Flashpoint: – 45 °C

Do **not** have naked flames in the same room as ethoxyethane. This liquid has a low boiling point (~ 34 °C) and the vapour (more dense than air) may rapidly spread over a wide area and/or collect in pockets. 'Flashback' from any ignition source may occur. Ethoxyethane contains tiny amounts of peroxide (explosive), which will increase when exposed to air after bottle is opened; it is normally sold with inhibitors to reduce this risk.

Methoxybenzene — *anisole, methyl phenyl ether* — $CH_3OC_6H_5$ (108.14)

WARNING

Flammable liquid and vapour [H226]. May cause drowsiness or dizziness [H336]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. Repeated exposure may cause skin dryness or cracking [EUH066].

Flashpoint: 52 °C

Storage

Storage code: **FL** (Organic)   [Colourless liquids with 'sweet' odours]

- **Ethoxyethane**: Do **not** put anything treated with ether into a refrigerator that is not specially spark-proofed; the door switch may ignite the vapour. Dispose of any ethoxyethane older than 2 years.
- **Methoxybenzene**: The 'aniseed-like' odour can linger. If there is not enough room in the flammables **cabinet**, this chemical can be stored with **GOrg**.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120).

42 Risk Assessment Guidance

Ethoxyethane and other ethers

<table>
<tr><td colspan="4">Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk</td></tr>
<tr><th>General use of:</th><th>Hazard information</th><th>User</th><th>Suggested general control measures and guidance</th></tr>
<tr><td>Ethoxyethane</td><td>
DANGER
(See reverse)</td><td rowspan="2">TT
(Y9)</td><td rowspan="3">**Never** heat ethoxyethane or boil solutions to dryness because any peroxide present may explode. Do **not** attempt to remove peroxides unless the ether is to be used immediately; the peroxide removal process also removes the inhibitors.
See *Testing for peroxide in ethers* and *Removal of peroxides from ethers*.
• Wear eye protection.
• Do **not** have naked flames or other ignition sources in the vicinity.
• Use a fume cupboard to dispense and transfer liquids.
• Ensure laboratory is well-ventilated. Do not inhale vapours.
Other notes; see also detailed activity-specific guidance:
• **Use of ethoxyethane as a solvent**: Where possible use alternatives.
• **Use of methoxybenzene**: Can be used to illustrate the reactions of the aromatic ring. Reactions occur more readily than with benzene due to the effect of the –OCH_3 group.
Disposal: W6 (ethoxyethane)
W2 (methoxyethane)</td></tr>
<tr><td>Methoxybenzene</td><td>
WARNING
(See reverse)</td></tr>
<tr><td colspan="3">Ethoxyethane has a low boiling point (~ 34 °C) and the vapour (more dense than air) may rapidly spread over a wide area and/or collect in pockets. ‘Flashback’ from any ignition source may occur.
Ethoxyethane contains tiny amounts of peroxide (explosive), which increase when exposed to air after the bottle is opened; it is normally sold with inhibitors to reduce this risk.</td></tr>
</table>

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

43A Risk Assessment Guidance

Ethyl ethanoate & related esters

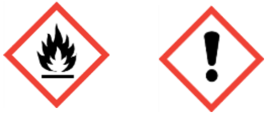
Methyl ethanoate	*methyl acetate*	CH_3COOCH_3 (74.08)
Ethyl ethanoate	*ethyl acetate*	$CH_3COOC_2H_5$ (88.11)
Propyl ethanoate	*n-propyl acetate*	$CH_3COOC_3H_7$ (102.13)

DANGER

Highly flammable liquid and vapour [H225]. Causes serious eye irritation [H319]. May cause drowsiness or dizziness [H336]. Repeated exposure may cause skin dryness or cracking [EUH066].

Note:	Flash point (^oC)	Boiling point (^oC)	WEL (mg m^{-3})
methyl ethanoate	– 10	56.9	616 (LTEL), 770 (STEL)
ethyl ethanoate	– 4	77.1	733 (LTEL), 1465 (STEL)
propyl ethanoate	13	101.5	849 (LTEL), 1060 (STEL)

Butyl ethanoate	*n-butyl acetate*	$CH_3COOC_4H_9$ (116.16)
Pentyl ethanoate	*n-pentyl acetate, n-amyl acetate, n-amyl ethanoate*	$CH_3COOC_5H_{11}$ (130.19)
(3-methylbutyl) ethanoate	*isopentyl acetate, iso-amyl acetate, iso-amyl ethanoate*	$CH_3COOC_5H_{11}$ (130.19)



(butyl ethanoate)

WARNING

Flammable liquid and vapour [H226]. Repeated exposure may cause skin dryness or cracking [EUH066]. May cause drowsiness or dizziness [H336], butyl ethanoate.

	Flash point (^oC)	Boiling point (^oC)	WEL (mg m^{-3})
butyl ethanoate	~ 25	126.1	724 (LTEL), 966 (STEL)
pentyl ethanoate (n-/iso-)	~ 25	149.2 / 142.5	270 (LTEL), 541 (STEL)

Storage	Storage code: **FL** (Organic)	[Colourless liquids, pleasant 'fruity' odours]
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**	

43A Risk Assessment Guidance

Ethyl ethanoate & related esters

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• Methyl ethanoate • Ethyl ethanoate • Propyl ethanoate	 DANGER (See reverse)	Y9	• Wear eye protection. • Ensure no naked flames or other sources of ignition. • Use a fume cupboard for transferring/dispensing large volumes. • Ensure laboratory is well ventilated. Avoid inhaling fumes. • Use the correct technique for smelling vapours. **Other notes; see also detailed activity-specific guidance:** • Do **not** use a naked flame to heat a highly flammable liquid. Use hot water from a kettle or use electrically-heated baths. • **Ester preparation**: For a small-scale (test-tube) method for a range of esters see *Making esters*. Guidance for larger-scale synthesis and purification procedures for specific esters is also available. **Disposal**: W2, W7; see notes below
• Butyl ethanoate • Pentyl ethanoate(s)	 butyl ethanoate WARNING (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W7 (methyl ethanoate, ethyl ethanoate):** Add no more than 50 cm^3 to 1 litre of water and pour away down a foul-water drain. • **W7 (propyl/butyl/pentyl ethanoates)**: These esters are not very soluble in water but very small quantities (eg, test-tube scale ester preparation mixtures, ~ 1-2 cm^3 per preparation) may be washed down a foul-water drain with further dilution. • Do **not** mix with organohalogen waste.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

43B Risk Assessment Guidance (see also **43A**)

Esters: methyl methacrylate

Methyl 2-methylpropenoate *methyl methacrylate* $H_2C=C(CH_3)COOCH_3$ (100.12)

DANGER

Highly flammable liquid and vapour [H225]. Causes skin irritation [H315]. May cause an allergic skin reaction [H317]. May cause respiratory irritation [H335].

The vapour is lachrymatory; it irritates and causes eyes to water.

Note:

Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})
10	100.5	208 (LTEL), 416 (STEL)

Storage

Storage code: **FL** [Colourless liquid; pungent, nauseating odour]

- Over time, the liquid polymerises and becomes viscous and will eventually solidify to a resin. Heat, light and other initiators accelerate the polymerisation.

  It is supplied with an inhibitor to slow the polymerisation process.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills/clearing up**: **HIGHLY FLAMMABLE. Vapour is irritating. Odour is acrid and unpleasant**. Ventilate the area if safe to do so. Ensure no naked flames or other sources of ignition. If affected by fumes, immediately vacate the area.

43B Risk Assessment Guidance (see also **43A**) **Esters: methyl methacrylate**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Methyl methacrylate	 DANGER Highly flammable. Irritant (skin, respiratory). Sensitiser (skin). Note: lachrymatory vapour.	Y12	• Wear splash-proof goggles. • Wear gloves. • Use a fume cupboard. • Ensure no naked flames or other sources of ignition. **Other notes; see also detailed activity-specific guidance:** • Do **not** use a naked flame to heat this highly flammable liquid. Use hot water from a kettle or use electrically-heated baths. **Disposal**: W1/W2 but see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • If the liquid has polymerised into a resin (solid), then **W8**.

44A Risk Assessment Guidance — Halogenoalkanes: chloroalkanes

1-chloropropane	*n-propyl chloride*	C_3H_7Cl (78.541)
1-chlorobutane	*n-butyl chloride*	C_4H_9Cl (92.57)
2-chlorobutane	*sec-butyl chloride*	$CH_3CH_2CHClCH_3$ (92.57)
2-chloro-2-methylpropane	*tert-butyl chloride*	$(CH_3)_3CCl$ (92.57)

chloropropane

DANGER

All: Highly flammable liquid and vapour [H225]. **1-chloropropane is also**: Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Harmful if inhaled [H332].

These substances are dangerous in contact with:

- SODIUM. Explosive reactions may occur.

Note:	Flash point (°C)	Boiling point (°C)
• 1-chloropropane	−19	46
• 1-chlorobutane	−12	78
• 2-chlorobutane	−10	68
• 2-chloro-2-methylpropane	−30	51

Storage

Storage code: **FL** (Organic) [Colourless liquids, 'sweet' odours]

Benzyl chloride	*(chloromethyl)benzene, α-chlorotoluene, tolyl chloride*	$C_6H_5CH_2Cl$ (126.58)

DANGER

Harmful if swallowed [H302]. Toxic if inhaled [H331]. Causes skin irritation [H315]. Causes serious eye damage [H318]. May cause respiratory irritation [H335]. May cause cancer [H350]. May cause damage to organs through prolonged or repeated exposure [H373].

Note:	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})
	67	174	2.6 (LTEL); 7.9 (STEL), Carc

Storage

Storage code: **T** [Colourless liquid, unpleasant odour]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120).

44A Risk Assessment Guidance

Halogenoalkanes: chloroalkanes

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• 1-chloropropane • 1-chlorobutane • 2-chlorobutane • 2-chloro-2-methyl propane	  chloropropane DANGER (See reverse)	Y12	• Wear eye protection. • Ensure no naked flames or other sources of ignition. • Avoid inhaling vapours. Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance**: • Do **not** use a naked flame to heat a highly flammable, volatile liquid. Use hot water from a kettle or use electrically heated baths. **Disposal**: W1, W2; but see below
Benzyl chloride	   DANGER (See reverse)	TT	• Wear eye protection. Wear splash-proof goggles when transferring or dispensing large quantities. • Use in an efficiently-working fume cupboard. Do **not** inhale vapour. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL120. **Disposal**: W1, W2; but see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W2 (organohalogen)**: Do **not** mix with other waste residues. Keep in a separate, labelled container. • **W7 (chloropropane, chlorobutanes)**: Residues from test-tube/drop-scale 'rates of hydrolysis' activities may be flushed away because the quantities are so small. Check activity-specific guidance. • **W7 (benzyl chloride)**: No more than 5 cm^3 may be rinsed away thoroughly down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

44B Risk Assessment Guidance — Halogenoalkanes: bromo- & iodoalkanes

Bromoethane	*ethyl bromide*	C_2H_5Br (108.97)
1-bromobutane	*n-butyl bromide*	C_4H_9Br (137.02)
2-bromobutane	*sec-butyl bromide*	$CH_3CH_2CHBrCH_3$ (137.02)
2-bromo-2-methylpropane	*tert-butyl bromide*	$(CH_3)_3CBr$ (137.02)

bromoethane

DANGER

- **All:** Highly flammable liquid and vapour [H225].
- **Bromoethane**: Harmful if swallowed or if inhaled [H302, H332]. Suspected of causing cancer [H351]. The following may also be indicated: Harms public health and the environment by destroying ozone in the upper atmosphere [H420].
- **n-/sec-/tert- butyl bromides**: One or more of the following may also be given: Causes skin irritation [H315], Causes serious eye irritation [H319], May cause respiratory irritation [H335], Toxic (or Harmful) to aquatic life with long lasting effects [H411/H412].

Storage	Storage code: **Situ**, bromoethane Storage code: **FL** (Organic), other bromoalkanes	[Colourless-yellow liquid, ether-like odour] [Colourless-yellow liquids, strong odours]

Iodoethane	*ethyl iodide*	C_2H_5I (155.97)
1-iodopropane	*n-propyl iodide*	C_3H_7I (169.99)
1-iodobutane	*n-butyl iodide*	C_4H_9I (184.02)

WARNING

Flammable liquid & vapour [H226]. Harmful if swallowed, in contact with skin & if inhaled [H302, H312 & H332]. Causes skin & serious eye irritation; may cause respiratory irritation [H315, H319 and H335].

Classification/labelling vary. Suppliers may indicate one or more of the following: Toxic if inhaled [H331], May cause an allergic skin reaction [H317], May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. The GHS 06 and/or GHS 08 pictograms would be included with 'DANGER'.

Storage	Storage code: **FL** or **GOrg** (see **Other notes**)	[Colourless liquids, discolour on standing]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

44B Risk Assessment Guidance — Halogenoalkanes: bromo- & iodoalkanes

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• bromoethane • 1-bromobutane • 2-bromobutane • 2-bromo-2-methylpropane	 bromoethane DANGER (See reverse)	Y12	• Wear eye protection. • Ensure no naked flames or other sources of ignition. • Avoid inhaling vapours. Use a fume cupboard to dispense or transfer the liquids. Ensure laboratory is well-ventilated. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL120. **Other notes; see also detailed activity-specific guidance**: • Do **not** use a naked flame to heat a highly flammable, volatile liquid. Use hot water from a kettle or use electrically heated baths. • **Storage**: If limited space in the flammables cabinet, store iodoalkanes as **GOrg**.
• iodoethane • 1-iodopropane • 1-iodobutane	 WARNING (See reverse)		

Note:	Flash point (°C)	Boiling point (°C)
bromoethane	−20	38
1-bromobutane	18	101
2-bromobutane	21	91
2-bromo-2-methylpropane	16	73
iodoethane	53	72
1-iodopropane	44	102
1-iodobutane	31	130

Disposal: W1/W2; but see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only**: • **W2 (organohalogen):** Do **not** mix with any other waste residues. Keep in a separate, labelled container. • **W7 (bromobutane, iodopropane, iodobutane)**: Residues from test-tube/drop-scale activities (eg, 'rates of hydrolysis') may be rinsed away as quantities are so small. Check activity-specific guidance.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

45A Risk Assessment Guidance

Hydrocarbons: aliphatic, saturated (1)

Methane *natural gas, marsh gas* CH_4 (16.04) | **Ethane** C_2H_6 (30.07) | **Propane** C_3H_8 (44.10) | **Butane** C_4H_{10} (58.12)

DANGER

Extremely flammable gas [H220]. These gases are also asphyxiants. Propane and butane, the constituents of liquid petroleum gas (LPG) are denser than air. All form explosive mixtures with air or oxygen.

WEL (mg m^{-3}): 1450 (LTEL), 1810 (STEL); butane

Storage Storage code: **Situ** [Colourless, odourless gases]

Pentane *n-pentane* C_5H_{12} (72.15)

Hexane *n-hexane* C_6H_{14} (86.18)

Heptane *n-heptane* C_7H_{16} (100.20)

Petroleum spirit 40-60 °C, 60-80 °C, 80-100 °C, 100-120 °C *petroleum ether 40-60 °C, 60-80 °C, 80-100 °C, 100-120 °C*

DANGER

Highly flammable liquid and vapour [H225]. May be fatal if swallowed and enters airways [H304]. May cause drowsiness or dizziness [H336]. Plus:

- Repeated exposure may cause skin dryness or cracking [EUH066]: **pentane**
- Causes skin irritation [H315]: **hexane**, **heptane**
- Suspected of damaging fertility [H361f]: **hexane**
- May cause damage to organs through prolonged or repeated exposure [H373]: **hexane**
- Very toxic or Toxic to aquatic life with long lasting effects [H410/H411]: **all**

Note: **petroleum spirits** are mixtures of alkanes (eg, pentane, hexane, heptane) with variable composition. As a general rule, assume the same hazards apply as for the hydrocarbons (alkanes) with similar boiling point(s).

	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3}):	
• n-pentane	– 40	36.1	1800 (LTEL);	5400 (STEL)
• n-hexane	– 22	68.7	72 (LTEL);	216 (STEL)
• n-heptane	– 4	98.4	2085 (LTEL);	6255 (STEL)

Storage Storage code: **FL** (Organic) [Colourless liquids]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **If liquid hydrocarbon is swallowed**: If vomiting occurs, call 999.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

45A Risk Assessment Guidance — Hydrocarbons: aliphatic, saturated (1)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Hydrocarbon gases	 DANGER (See reverse)	TT (Y7)	• Wear eye protection. Do **not** inhale gases or vapours. • Ensure no naked flames or other sources of ignition when transferring or dispensing. • Use a fume cupboard to transfer/dispense any volume of the low-boiling liquids (eg, pentane, hexane) or large volumes of the other liquids. • Ensure the laboratory is well-ventilated. Minimise the escape of vapour (eg, use mineral-wool plugs in test-tubes). • Take particular care to avoid skin contact. See activity-specific guidance and/or GL120. **Other notes; see also detailed activity-specific guidance:** **<u>Hydrocarbon gases</u>:** • **Bunsen burners**: Type depends on fuel (methane or LPG). LPG is denser than air so leaking gas will accumulate in sinks/low-level areas. Luminous flames of LPG are smokier than methane flames. See *Heating equipment* and *Bunsen burner*. **<u>Hydrocarbon liquids</u>:** • **As solvents**: Y7 may use heptane, cyclohexane or petroleum spirits 80-100 ^{o}C (or higher). Y12 can use lower-boiling solvents dispensed from a fume cupboard. Avoid hexane if alternatives can be used. • **As fuels**: Do **not** allow students to fill or refill spirit burners (TT). See *Safer chemicals, safer reactions* and *Spirit burners.* • **'Crude oil' (synthetic/artificial)**: see *Recipe* 32. **Disposal**: see below
Liquid hydrocarbons (Low boiling, see **Other notes**)	 DANGER (See reverse)	Y12	
Liquid hydrocarbons (High boiling, see **Other notes**)		Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • Gases and liquid hydrocarbons/hydrocarbon mixtures: **W6** (if a few cm^3 only) or **W2**.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

45B Risk Assessment Guidance — Hydrocarbons: aliphatic, saturated (2)

Cyclohexane C_6H_{12} (84.16)

Paraffin *kerosene/kerosine, paraffin oil, kerosene/kerosine oil (eg, lamp oil)* –

White spirit *turpentine substitute* –

DANGER

May be fatal if swallowed and enters airways [H304]. May cause drowsiness or dizziness [H336].

The compositions of paraffin and white spirit vary. Additional hazard classifications are likely to include:

- Highly flammable liquid and vapour [H225]: **cyclohexane.**
- Flammable liquid and vapour [H226]: **paraffin, white spirit.**
- Causes skin irritation [H315]: **cyclohexane**, **paraffin**.
- Repeated exposure may cause skin dryness or cracking [EUH066]: **white spirit and paraffin**.
- Very toxic or Toxic to aquatic life with long lasting effects [H410/H411]: **all**.

Note:	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})
cyclohexane	– 20	80.7	350 (LTEL), 1050 (STEL)
white spirit	~ 38-41 (varies)	~ 150-200 (varies)	Depends on composition
paraffin/kerosene	~ 47-58 (varies)	~ 130-290 (varies)	Depends on composition

Storage Storage code: **FL** (Organic) [Colourless liquid]

Paraffin liquid *liquid paraffin, medicinal paraffin, paraffin liquid light, paraffin liquid heavy, 'mineral oil', Vaseline oil*

Petroleum jelly *petroleum jelly-white, paraffin soft white, petrolatum, Vaseline*

Paraffin wax

- Not usually classified as hazardous but classification depends on the manufacturing process (i.e. to ensure the absence of certain hazardous chemicals such as benzene). Schools should try to purchase non-hazardous versions from suppliers.
- Paraffin liquids are available with varying viscosities (eg, 'medicinal paraffin' is quite 'syrupy'; liquid paraffin light is more 'runny').

WEL (mg m^{-3}): 2 (LTEL), 6 (STEL), paraffin wax (fume).

Storage Storage code: **GOrg**

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **If cyclohexane/white spirit/paraffin (kerosene) is swallowed**: If vomiting occurs, call 999.

45B Risk Assessment Guidance **Hydrocarbons: aliphatic, saturated (2)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• Cyclohexane • Paraffin/kerosene • White spirit	 DANGER (See reverse)	Y7	• Wear eye protection. Avoid inhaling fumes. • Ensure no naked flames or other sources of ignition when transferring/dispensing. • Use a fume cupboard to transfer/dispense large volumes of the liquids. • Ensure the laboratory is well-ventilated. Minimise the escape of vapour (eg, use mineral-wool plugs in test-tubes). **Other notes; see also detailed activity-specific guidance**: • **Burning samples**: Use no more than 1 cm^3 absorbed onto mineral wool or placed in a crucible. Do **not** use commercial fuels; these contain other additives. **Disposal**: W1, W2 only
• Paraffin liquid • Petroleum jelly • Paraffin wax	Not usually classified or labelled as hazardous. See reverse.		• Wear eye protection. Avoid inhaling fumes. • Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance**: • **Nightlights/candles**: Ensure that these are stable and that students do not lean or reach over flames. • **Cracking a hydrocarbon**: Use liquid/medicinal paraffin as the hydrocarbon. • **Melting point determinations**: Liquid/medicinal paraffin can be used as the heating medium up to ~ 250 ^{o}C. **Disposal**: see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W8:** Paraffin wax. • **WSpec**: Liquid/medicinal paraffin or petroleum jelly: Add to an absorbent and place in normal waste.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

45C Risk Assessment Guidance **Hydrocarbons: aliphatic, unsaturated**

Ethene *ethylene* C_2H_4 (28.05) | **Propene** *propylene* C_3H_6 (42.08) | **Ethyne** *acetylene* C_2H_2 (26.04)	
ethene DANGER	**All**: Extremely flammable gas [H220]. **Ethyne**: May react explosively even in the absence of air [H230]. **Ethene**: May cause drowsiness or dizziness [H336].
Storage	Storage code: **Situ** [Colourless gases]

Cyclohexene		C_6H_{10} (82.14)
Hex-1-ene	*hexene (or hexylene), 1-hexene, n-hexene*	C_6H_{12} (84.16)
Oct-1-ene	*1-octene, n-octene*	C_8H_{16} (112.24)
cyclohexene DANGER	**All**: Highly flammable liquid and vapour [H225]. May be fatal if swallowed and enters airways [H304]. Toxic/Very Toxic to aquatic life with long lasting effects [H411 or H410]. **Cyclohexene**: Harmful if swallowed [H302]. Some suppliers may also indicate one or more of: Causes skin irritation [H315]; Causes serious eye irritation [H319]; Repeated exposure may cause skin dryness or cracking [EUH066]. **Cyclohexene (and other alkenes) is dangerous in contact with**: • CONCENTRATED SULFURIC(V) ACID. An exothermic reaction occurs which may spray acid. Flash points: –12 °C (cyclohexene); –26 °C (hexene); 21 °C (octene)	
D-(+)-dipentene	*limonene*	$C_{10}H_{16}$ (136.23)
WARNING	Flammable liquid & vapour [H226]. Causes skin irritation [H315]. May cause allergic skin reaction [H317]. Very toxic to aquatic life with long lasting effects [H410]. Some suppliers indicate: May be fatal if swallowed and enters airways [H304] with DANGER. Flash point: 45 °C	
Storage	Storage code: **FL** (Organic) [Colourless liquids] • Peroxides form during storage. Do not evaporate liquids near to, or to, dryness (risk of explosion). • Limonene has a citrus-like odour. The other liquids have unpleasant odours.	

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **If liquid hydrocarbon is swallowed:** If vomiting occurs, call 999.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

45C Risk Assessment Guidance Hydrocarbons: aliphatic, unsaturated

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information** (see reverse)		**User**	**Suggested general control measures and guidance**
Ethyne		DANGER	Y12	• Wear eye protection. Avoid inhaling vapour. • Ensure no naked flames/ignition sources when transferring/dispensing. • Use a fume cupboard to transfer or dispense liquids. • Ensure laboratory is well-ventilated. Minimise the escape of vapour (eg, use mineral-wool plugs in test-tubes). • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Burning samples**: use no more than 0.5-1 cm^3 absorbed onto mineral wool or placed in a crucible. Do **not** use commercial fuels which contain other additives. Ensure room is well ventilated to disperse smoke/fumes. • **Small-scale reactions of liquid alkenes**: Use only small volumes (eg, 1-5 drops) of the liquid alkenes (i.e. cyclohexene, hexene, octene, limonene). Reactions between concentrated sulfuric acid and alkenes are dangerously exothermic; use no more than 3 drops of the acid added to 3 drops of the alkene. • **Small-scale reactions of ethyne**: Check activity-specific guidance. **Disposal**: see below
Ethene	 	DANGER	Y9	
Propene				
Cyclohexene	   			
• Hexene • Octene				
Limonene	   WARNING		Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W6 (ethene, propene, ethyne).** • **W1** or **W2 (cyclohexene, hexene, octene, limonene)**.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

46A Risk Assessment Guidance **Hydrocarbons: aromatic (1)**

Benzene *benzol* C_6H_6 (78.11)

Methylbenzene *toluene* $C_6H_5CH_3$ (92.14)

DANGER

Benzene: Highly flammable liquid and vapour [H225]. May be fatal if swallowed and enters the airways [H304]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause genetic defects [H340]. May cause cancer [H350]. Causes damage to organs through prolonged or repeated exposure [H372].

Flash point: –11 °C; Boiling point: 80 °C WEL (mg m^{-3}): 3.25 (LTEL), 9.75 (STEL); Carc, Sk
Benzene is a known human carcinogen.

Methylbenzene (toluene): Highly flammable liquid and vapour [H225]. May be fatal if swallowed and enters the airways [H304]. Causes skin irritation [H315]. May cause drowsiness or dizziness [H336]. Suspected of damaging the unborn child [H361d]. May cause damage to organs through prolonged or repeated exposure [H373].

Flash point: 4 °C; Boiling point: 111 °C WEL (mg m^{-3}): 191 (LTEL), 384 (STEL); Sk

Storage Storage code: **FL** (Organic) [Colourless liquids, characteristic odours]

Dimethylbenzene (isomers) *o-, m- and p-xylene (1,2-, 1,3- and 1,4-dimethylbenzene)* $C_6H_4(CH_3)_2$ (106.17)

WARNING

Flammable liquid and vapour [H226]. Harmful in contact with skin [H312]. Causes skin irritation [H315]. Harmful if inhaled [H332].

	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})
• *o-xylene*	32	144.5	All the xylene isomers: 220 (LTEL), 441 (STEL), Sk
• *m-xylene*	27	139.1	
• *p-xylene*	27	138.3	

Storage Storage code: **FL** (Organic) [Colourless liquids, characteristic odours]

Emergencies **Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**:
- **If liquid hydrocarbon is swallowed**: If vomiting occurs, call 999.

46A Risk Assessment Guidance

Hydrocarbons: aromatic (1)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Methylbenzene (*toluene*)	 DANGER (See reverse)	Y12	• Wear eye protection. • Ensure no naked flames or ignition sources when transferring/dispensing. • Use a fume cupboard to transfer/dispense large volumes of the liquids. • Avoid inhaling vapour. Minimise the escape of vapour (eg, use mineral-wool plugs in test-tubes). • Ensure laboratory is well-ventilated. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL120. **Other notes; see also detailed activity-specific guidance:** • **Fractional distillation of 'crude oil' (synthetic/artificial)**: See *Safer chemicals, safer reactions* and *Recipe* 32. • **Comparing 'winter' and 'summer' fuels**: Use petroleum spirit 40-60 °C (as 'winter') and petroleum spirit 80-100 °C (as 'summer') to compare the seasonal variation in volatility/flammability of combustion-engine fuels. • **Viscosity of engine oils**: Do **not** use 'used' oil (it may have broken down into more hazardous components). Avoid skin contact and do **not** heat the oil above ~ 65 °C. See *Viscosity of motor oils* for a useful small-scale method for carrying out this activity. Propane-1,2,3-triol (glycerol) provides a safer alternative to motor oil. • **Nitration of aromatic rings**: Use methylbenzoate in place of methylbenzene (toluene) or benzene. **Disposal**: W1, W2 only
Dimethylbenzene (*xylene*)	 WARNING (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

46B Risk Assessment Guidance **Hydrocarbons: aromatic (2)**

Naphthalene	$C_{10}H_8$ (128.17)
 WARNING	Harmful if swallowed [H302]. Suspected of causing cancer by inhalation [H351]. Very toxic to aquatic life with long lasting effects [H410]. Some suppliers may indicate: Flammable solid [H228]. Flash point: ~ 80 °C
Storage	Storage code: **GOrg** [White solid]

Acenaphthene	*1,2-dihydroacenaphthylene* $C_{12}H_{10}$ (154.21)
 WARNING	Causes serious eye irritation [H319]. Very toxic to aquatic life with long lasting effects [H410]. Some suppliers may indicate: Causes skin irritation [H315], May cause respiratory irritation [H335].
Storage	Storage code: **GOrg** [White/off-white solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

46B Risk Assessment Guidance — Hydrocarbons: aromatic (2)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Naphthalene	 WARNING (See reverse)	Y7	• Wear eye protection. • Avoid raising dust. • Ensure laboratory is well-ventilated. Do **not** inhale vapour. **Other notes; see also detailed activity-specific guidance**: • **Heating naphthalene (eg, cooling curve/melting point activities)**: Use hot water from a kettle for melting naphthalene (melting point: 80 °C). Do **not** heat naphthalene in open boiling tubes on a whole-class scale; minimise vapour levels during heating by using a loose mineral wool plug in the open end of the tube. For alternatives to naphthalene and more-detailed guidance see *Safer chemicals, safer reactions*. **Disposal**: W1, W2 only
Acenaphthene	 WARNING (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

47A Risk Assessment Guidance **Hydrochloric acid**

Hydrochloric acid HCl(aq) (36.46)

DANGER

Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335].

Note: Some suppliers also indicate: May be corrosive to metals [H290]. The GHS 05 pictogram (and WARNING) may then be indicated on solutions below 6.8 M (see reverse).

Hydrochloric acid (concentrated) is dangerous in contact with:

- REACTIVE METALS (e.g. SODIUM, MAGNESIUM, CALCIUM, ALUMINIUM). Violent reactions can occur.
- POTASSIUM MANGANATE(VII). Explosions can occur.
- SULFURIC(VI) and PHOSPHORIC(V) ACIDs (concentrated). Hydrogen chloride gas may be released.

WEL (mg m^{-3}): 2 (LTEL), 8 (STEL); hydrogen chloride gas and aerosol mist.
Hydrogen chloride gas (toxic, corrosive) diffuses from concentrated acid solutions.

Storage

Storage code: **CLa** [Colourless - yellowish liquid]

- Usually purchased as a 35-38% (w/w) solution.
- Once bottles are opened, hydrogen chloride gas can leak out into the store and accelerate metal corrosion. Firmly close bottles after use. Older bottles of acid may not be the expected concentration.
- Hydrogen chloride gas can also diffuse through plastic; labels on containers will fade and eventually disintegrate. Containers themselves may become damaged and/or the acid discoloured. Check the state of containers, lids and labels on a regular basis. If required, decant solutions into fresh containers.
- Hydrogen chloride gas reacts with ammonia and amines. A white powder (chloride salts) will deposit on bottles and elsewhere in the chemical store indicating (i) leaking bottles or lids (ii) acid or ammonia/amine vapours diffusing through plastic bottles (iii) inadequate ventilation in the store.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes)**.
- **CORROSIVE, TOXIC (inhalation)**. Procedures or reactions may liberate hydrogen chloride gas and/or produce chlorine gas. See also *Hazcards* 49 and 22A.

47A Risk Assessment Guidance — Hydrochloric acid

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Concentrated acid and solutions ≥ 6.8 M	  DANGER Corrosive (skin, eyes). Irritant (respiratory).	TT (Y9)	• Wear splash-proof goggles. • Protect the face when opening bottles of the concentrated acid (pressure may have built up) or when transferring or dispensing large volumes. • Avoid inhaling fumes. Use a fume cupboard. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL120. **Other notes; see also detailed activity-specific guidance**: • **Preparation of solutions (TT)**: See *Recipe* 43. Solutions below 2 M are adequate for many *pre-16* practicals. • **Preparation of chlorine gas (TT)**: See *Recipe* 24. **Disposal**: W7 → 0.1 M; or W4. See below.
Solutions < 6.8 M and ≥ 2.7 M	 WARNING Irritant (skin, eyes). Irritant (respiratory).		
Solutions < 2.7 M	Currently not classified as hazardous	Y7	• Wear eye protection even when dilute solutions are used. **Other notes; see also detailed activity-specific guidance**: • Experience of the use of this acid in school science activities indicates that it is appropriate to apply the control measures given here. It is advisable to include a warning to this effect on the label. **Disposal**: W7 → 0.1 M; or W4

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for more-concentrated acid solutions:** • **W4**: Use a fume cupboard. Avoid inhaling fumes.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

47B Risk Assessment Guidance **Halide salts: Group 1 chlorides, bromides & iodides**

Lithium chloride	LiCl (42.39)
 WARNING	Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319].

Sodium chloride	*halite, rock salt*	NaCl (58.44)
Potassium chloride	*muriate of potash*	KCl (74.55)
Rubidium chloride	*See Storage*	RbCl (120.92)
Caesium chloride	*cesium chloride*	CsCl (168.36)
Sodium bromide		NaBr (102.89)
Potassium bromide		KBr (119.00)
Sodium iodide		NaI (149.89)
Potassium iodide		KI (166.00)

- Not usually classified as hazardous but classification/labelling varies. Some suppliers indicate (mainly for bromides and iodides) one or more of: Causes skin irritation [H315]; Causes serious eye irritation [H319]; Causes/May cause damage to organs through prolonged or repeated exposure [H372/H373].

Storage	Storage code: **GIn** [White/colourless, crystalline solids] • LiCl, RbCl, CsCl, KBr and NaI all absorb water from the air (i.e. are hygroscopic) and become wet-looking. • Rubidium chloride: the naturally occurring isotope ^{87}Rb (abundance 27.8%) is radioactive although the energy released is low. If kept **only** for carrying out flame tests, store as GIn. If also kept for radioactivity practicals, see *Managing Ionising Radiations and Radioactive Substances in Schools and Colleges*; guide L93. • Sodium iodide and potassium iodide often turn yellow in storage. See **Other notes** (on reverse).
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

47B Risk Assessment Guidance **Halide salts: Group 1 chlorides, bromides & iodides**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Lithium chloride solid, and solutions ≥ 5 M	⚠ WARNING Harmful (ingestion) Irritant (skin, eyes)	Y7	• Wear eye protection. **Other notes; see also detailed activity-specific guidance:** • **Preparation of solutions:** The iodides often turn yellow on storage. Make up solutions as normal and then add 1-2 crystals of sodium thiosulfate-5-water to remove any colour. • **Enthalpy changes in solution**: When some of the halide salts dissolve in water there is a noticeable temperature change. Potassium chloride is a safer alternative to ammonium nitrate(V) to illustrate an endothermic process (temperature fall). • **Electrolysis of salt solutions**: Ensure the room is well ventilated. Consult the relevant *Hazcard* for the halogen produced at the anode (positive electrode). • **Electrolysis of molten salts**: See *Safer chemicals, safer reactions* and other activity-specific guidance. • **Flame tests**: various methods are available using either nichrome wires or wooden splints. **Disposal**: W7 → 2 M, lithium chloride W7, other salts listed
Lithium chloride solutions ≥ 2.5 M	⚠ WARNING Irritant (skin, eyes)		
• Sodium chloride • Potassium chloride • Rubidium chloride • Caesium chloride • Sodium bromide • Potassium bromide • Sodium iodide • Potassium iodide	Currently not classified as hazardous (but see note on front of this card).		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

47C Risk Assessment Guidance — Hydrobromic and hydriodic acids

Hydrobromic acid	$\mathrm{HBr(aq)}$ (80.91)
Hydriodic acid	$\mathrm{HI(aq)}$ (127.91)

hydrobromic acid

DANGER

Both: Causes severe skin burns and eye damage [H314].

Hydrobromic acid: May cause respiratory irritation [H335].

These substances are dangerous in contact with:

- REACTIVE METALS (eg, SODIUM, MAGNESIUM, CALCIUM, ALUMINIUM). Violent reactions can occur. Follow detailed guidance for reactions of reactive metals with acids.
- POTASSIUM MANGANATE(VII). Explosions can occur.
- SULFURIC(VI) and PHOSPHORIC(V) ACIDS (concentrated). Hydrogen halide gases may form.

WEL (mg m^{-3}) 10 (STEL); as hydrogen bromide gas

Storage

Storage code: **CLa** [Colourless to pale yellow liquids; pungent odours]

- Usually purchased as ~ 48 % w/w (hydrobromic) and ~ 57 % w/w (hydriodic) solutions.
- Once bottles are opened, hydrogen halide gases can leak out into the store and accelerate the corrosion of metals. Ensure bottles are firmly closed after use.
- Hydrogen halide gases can diffuse through plastic; labels on containers will fade and eventually disintegrate. Containers themselves may become damaged and/or the acid discoloured. Check containers, lids and labels on a regular basis. If required, decant solutions into fresh containers.
- Hydrogen halide gases react with ammonia and amines to form white solids (halide salts) that will deposit on containers in poorly-ventilated stores. See also *Hazcards* 9A and 49.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes):**
- **CORROSIVE, IRRITANT (inhalation)**. Hydrogen halide gases diffuse from solutions. See *Hazcard* 49.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

47C Risk Assessment Guidance — Hydrobromic & hydriodic acids

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Concentrated acids, and solutions ≥ 5 M (hydrobromic) ≥ 1 M (hydriodic)	 DANGER Corrosive (skin, eyes). Irritant (respiratory), hydrobromic	TT (Y9)	• Wear splash-proof goggles. • Protect the face when opening bottles of the concentrated acids (pressure may have built up) or when transferring and/or dispensing large volumes. • Avoid inhaling fumes. Use a fume cupboard. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Disposal**: W7 → 0.1 M; or W4. See below.
Solutions < 5 M and ≥ 1 M (hydrobromic) < 1 M and ≥ 0.7 M (hydriodic)	 WARNING Irritant (skin, eyes). Irritant (respiratory), hydrobromic	Y9	• Wear eye protection even when dilute solutions are used. • Avoid inhaling vapour. Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance:** • **Preparation of solutions (TT):** See *Recipe* 43 for the procedure and control measures. · For a 1 M hydrobromic acid solution: Dilute 113 cm^3 of the concentrated (~48%) solution to 1 litre with water. · For a 1 M hydriodic acid solution: Dilute 137 cm^3 of the concentrated (~57%) solution to 1 litre with water. **Disposal**: W7 → 0.1 M; or W4. See below.
Solutions < 1 M (hydrobromic) < 0.7 M (hydriodic)	Currently not classified as hazardous	Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for more-concentrated acid solutions:** • **W4**: Use a fume cupboard. Avoid inhaling fumes.

Hydrogen H_2 (2.02)

DANGER

Extremely flammable gas [H220]. If cylinder/canister: Contains gas under pressure; may explode if heated [H280].

Hydrogen gas is dangerous in contact with:

- OXYGEN, CHLORINE. Explosive reactions occur.
- TRANSITION METALS and TRANSITION METAL OXIDES. These substances, under certain circumstances, lower the activation energy and ignition temperature of the reaction between hydrogen and oxygen.

- Hydrogen/air mixtures are explosive over the range of 4% - 75% by volume of hydrogen. The ignition temperature of these mixtures is 500 °C, which is lower than the temperature of a Bunsen burner flame. Ignition can occur well below this temperature in the presence of transition metals or their oxides.
- **Never** oil or grease gas cylinder valves or fittings.
- **Never** attempt to breathe hydrogen to change the pitch of the voice.

Storage

Storage code: **Cyl** or **Situ** [Colourless, odourless gas. Less dense than air.]

- **Cyl**: Refillable cylinders may be hired. Non-refillable canisters are available to purchase. Depending on requirements, non-refillable canisters offer advantages (storage, manual handling, small quantities) and may be a viable alternative. See *Gas cylinders* for detailed guidance on pressurised gas containers.
  - Ensure the location of all pressurised gas cylinders/canisters is recorded and known to the site manager.
  - **Cylinder (refillable)**: When fitted with a regulator, the cylinder is considered as 'being held ready for use' (rather than 'stored'). Keep cylinder upright (chained or clamped) and in a cool, well-ventilated area but **not** in the same place where flammables or radioactives are stored. Carry out a visual check of the apparatus whenever it is used. Check and follow up-to-date guidance on maintenance.

    A two-stage regulator (i.e. a needle valve + pressure-reducing valve) is recommended as it provides the fine control of gas flow and gas pressure necessary for some practical procedures that use hydrogen gas.
  - **Canister (non-refillable)**: Store on its side (with mini flow valve/regulator removed) in a suitable container (so it does not roll), on the shelves of a secure chemical store. Do **not** place the canister in the flammables cupboard.
- **Situ:** Chemically-generated hydrogen gas is **not** appropriate for some situations. See **Other notes** on reverse.

Emergencies **Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Hydrogen, $H_2(g)$

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Hydrogen gas	 DANGER Extremely flammable If gas cylinder: 	TT (Y7)	• Eye protection is essential. Splash-proof goggles and face protection (eg, face shield) will be needed for many activities. • Work in a well-ventilated area and ensure there are no naked flames (or other sources of ignition) in the vicinity when hydrogen is being generated and/or collected or when setting up a hydrogen cylinder/canister. **Other notes; see also detailed activity-specific guidance:** • **Hydrogen gas explosions (demonstrations; TT):** Check *Safer chemicals, safer reactions* for a range of effective and safe approaches. · **hydrogen/air:** Wear splash-proof goggles or face-shield (demonstrator). Use safety screens. Students should be at least 2 m away, wearing eye protection. · **hydrogen/oxygen**: The noise can damage hearing. In a standard-sized laboratory, do **not** exceed 300 cm^3 of contained gas mixture (eg, in a balloon or plastic bottle designed for **fizzy** drinks). Wear splash-proof goggles/face-shield and ear defenders (demonstrator). Use safety screens. Open some windows. Students should be at least 5 m away, hands over ears, wearing eye protection. Do **not ignite** balloons/plastic bottles near combustible materials (eg, ceiling tiles, wall posters). Warn others in the vicinity about loud noises. • **Preparation of hydrogen gas (large-scale; TT):** See *Recipe* 44. Wear splash-proof goggles or a face-shield. If the gas is required to be dry, use anhydrous calcium chloride as the drying agent. Do **NOT** use concentrated sulfuric acid. **Disposal**: W6 (gas); see also note below

Chemically-generated hydrogen gas

Failure to flush all air from gas generating apparatus results in impure hydrogen being collected which, if ignited, could explode. It is difficult to fill balloons using a gas generator.

For these reasons, the use of hydrogen gas cylinders/canisters will be advised for some practical procedures.

Check detailed activity-specific guidance.

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE**: • Canisters (non-refillable): it may be possible to dispose of empty canisters into the normal waste or at some local waste recycling centres. The used canister needs to be punctured to make it safe for disposal; a tool to do this safely is available from suppliers. Check supplier's information.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

49 Risk Assessment Guidance Hydrogen halide gases

Hydrogen chloride	HCl (g) (36.46)
 DANGER	Causes severe skin burns and eye damage [H314]. Toxic if inhaled [H331]. **Hydrogen chloride gas is dangerous in contact with**: • AMMONIA. Irritating, dense fumes are produced. WEL (mg m^{-3}): 2 (LTEL), 8 (STEL)

Hydrogen bromide	HBr (80.19)
Hydrogen iodide	HI (127.91)
 DANGER	Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335]. **These substances are dangerous in contact with**: • AMMONIA. Irritating, dense fumes are produced. WEL (mg m^{-3}): 10 (STEL); hydrogen bromide

Storage	Storage code: **Situ**	[Colourless gas]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **GAS RELEASE**: Evacuate the area if more than ~ 200 cm^3 of hydrogen halide gas is released or if release is in a confined/poorly-ventilated space. • **CORROSIVE, TOXIC (inhalation). BEWARE DELAYED EFFECTS.**

49 Risk Assessment Guidance

Hydrogen halides gases

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Hydrogen chloride	 DANGER Corrosive (skin, eyes). Toxic (inhalation).	TT (Y9)	**BEWARE DELAYED EFFECTS** **Effects of exposure by inhalation may or may not be immediately apparent and can develop and/or increase over time.** **Inhalation by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions.** **If affected at any time, call the emergency services, informing them of the quantity of hydrogen halide involved**. • Prepare and use in an efficiently-working fume cupboard. • Do **not** inhale the gas. • Wear splash-proof goggles when preparing or using the gas on a large scale (eg, for demonstration activities). Check activity-specific guidance for additional eye protection advice. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL120. **Other notes; see also detailed activity-specific guidance**: • **Preparation of hydrogen chloride gas (TT)**: See *Recipe* 42. • **Organic reaction by-product (Y12)**: Preparative organic chemistry may involve reactions that generate hydrogen chloride gas. Use a fume cupboard or pass the gas into water via an inverted funnel (avoids suck-back) **Disposal**: W6 in a fume cupboard
Hydrogen bromide Hydrogen iodide	 DANGER Corrosive (skin, eyes). Irritating (respiratory).		

Disposal	**Follow general guidance in *About Hazcards* (GL 120)**.

Hydrogen peroxide, H_2O_2

Hydrogen peroxide *Solutions at or above 28 ‘vol’ (7.7 % w/v, 2.3 M) and up to 100 ‘vol’ (30%).* H_2O_2 (34.02)

DANGER

Causes serious eye damage [H318].

Note: Some suppliers may indicate (with GHS 07) Harmful if swallowed [H302]. See **Emergencies**.

Hydrogen peroxide is dangerous in contact with:

- ORGANIC COMPOUNDS (eg, propanone, ethanol, glycerol). Dangerous/explosive reactions can occur.
- METALS, METAL OXIDES (especially if finely divided), TIN(II) CHLORIDE. Violent decomposition occurs.

WEL (mg m^{-3}): 1.4 (LTEL), 2.8 (STEL)

Hydrogen peroxide *Solutions at or above 18 ‘vol’ (5% w/v, 1.5 M), up to 28 ‘vol’*

WARNING

Causes serious eye irritation [H319]

Storage

Storage code: **CLb** (solutions ≥ 28 vol); **GIn** (solutions < 28 vol) [Colourless liquid]

- **Concentrated solutions** (≥ 28 vol): Store in an opaque container. Take care when removing the cap as pressure may have built up. Suppliers’ containers may have a vented screw-top cap.
- **Diluted solutions**: Place prepared solutions in **clean** bottles. Solutions decompose quite quickly (to water and oxygen), especially in warm conditions. Keep solutions cool (not necessarily in a ‘fridge’) to slow the decomposition. Prepare dilute solutions when needed. Do not store for long periods.
- Buying ready-made dilute solutions may be appropriate if only lower secondary teaching.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **Dangerous if swallowed**: **Call 999**. Causes serious internal damage due to rapid release of oxygen gas.
- **CORROSIVE (eyes, skin)**. Makes skin turn white; can be sore.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

50 Risk Assessment Guidance

Hydrogen peroxide, H_2O_2

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solutions: ≥ 28 vol and ≤ 100 vol (100 vol is ~ 8.3 M or 30%)	 DANGER Corrosive (eyes)	Y12	• **Solutions ≥ 28 vol** · Wear splash-proof goggles. · Protect the face when opening bottles as pressure may have built up (hydrogen peroxide decomposes to oxygen gas and water). · Take particular care to avoid skin contact. See activity-specific guidance and or GL 120. • **Solutions < 28 vol** · Wear eye protection even when dilute solutions are used. · Beware that hydrogen peroxide solutions can cause skin irritation (even though it is not classified as a skin irritant at/below 100 ‘vol’). **Other notes; see also detailed activity-specific guidance**: • **Preparing dilute solutions (TT)**: See *Recipe* 45. 20 ‘vol’ solutions or lower are adequate for many pre-16 activities. Prepare dilute solutions *immediately* before use because the inhibitor that slows down decomposition will also be diluted. Dilute solutions deteriorate quite rapidly and may be more dilute than labelled. Check that solutions produce the expected result before using. • Check that the solution selected does not give rise to excess frothing (eg, catalysis and enzyme investigations). **Disposal**: W7 → 30 ‘vol’ or lower
< 28 vol and ≥ 18 vol (28 vol is ~ 2.3 M or 8%)	 WARNING Irritant (eyes)	Y7	
< 18 vol (18 vol is ~ 1.5 M or 5%)	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

51A Risk Assessment Guidance

Hydrogen sulfide gas and solution

Hydrogen sulfide

H_2S (34.08)

DANGER

Extremely flammable gas [H220]. Fatal if inhaled [H330]. Very toxic to aquatic organisms [H400].

Hydrogen sulfide gas is dangerous in contact with:

- MANY REAGENTS including: PEROXIDES, many OXIDISING AGENTS and some METAL OXIDES. These can cause the gas to ignite.
- AIR. Explosive mixtures may form.
- SODA LIME. The gas is absorbed exothermically. If air is present the soda lime may become red hot.

WEL (mg m^{-3}): 7 (LTEL), 14 (STEL)

Hydrogen sulfide gas is extremely toxic. It affects the nervous, cardiovascular and respiratory systems as well as causing eye/skin irritation.

The pungent smell is usually sufficient to ensure that rapid evasive action is taken but be aware that above a certain concentration the ability to detect hydrogen sulfide by smell is lost.

Storage

Storage code: **Situ** [Colourless gas, denser than air; rotten eggs odour]

- Prepare small volumes of hydrogen sulfide gas **only** when required. Do **not** use cylinders as school fume cupboards will not cope with a rapid and large volume release of this gas under pressure.
- Check that the fume cupboard is working efficiently **before** preparing and using this gas.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). **NOTE**:

- **GAS RELEASE**: If a leak occurs/is suspected (eg, fume cupboard stops working), evacuate.
- **If inhaled: Immediately call 999**.

51A Risk Assessment Guidance Hydrogen sulfide gas and solution

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Hydrogen sulfide gas	 DANGER (See reverse)	TT (Y12)	- Wear eye protection. - Prepare, use and dispose of the gas **only** in an efficiently-working fume cupboard. Do **not** inhale the gas. **Other notes; see also detailed activity-specific guidance**: - **Preparation of hydrogen sulfide gas**: See *Recipe* 42. Use a small gas-generating apparatus (eg, with a 250 cm^3 or 500 cm^3 flask). Do **not** use Kipp's apparatus as this stores a large volume of the gas. **Disposal:** W6 in an efficient fume cupboard
Hydrogen sulfide solutions. See **Other notes**.	 DANGER Hydrogen sulfide gas is acutely toxic (inhalation). It diffuses from solutions.	TT (Y9)	- Wear eye protection. - Use a fume cupboard to prepare and dispense solution into test tubes. Stopper the test tubes. Ensure the laboratory is well-ventilated. - **NEVER** inhale directly above the solutions. **Other notes; see also detailed activity-specific guidance**: - **Preparation of hydrogen sulfide solutions (TT)**: Use a fume cupboard. Solutions do not keep; sulfur precipitates and stains the glassware. A saturated solution is ~ 0.1 M at 20 °C. - **Other sulfide solutions**: See *Hazcard* 51B. **Disposal**: W7 in an efficient fume cupboard

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

51B Risk Assessment Guidance — **Hydrogen sulfide: soluble salts**

Sulfide salts absorb moisture and gases from the atmosphere and produce hydrogen sulfide gas. Hydrogen sulfide gas is extremely toxic. It affects the nervous, cardiovascular and respiratory systems and causes eye/skin irritation. See *Hazcard* 51A.

Ammonium sulfide (available as ~ 20 % (w/v) solution)	$(NH_4)_2S$ (68.14)
 DANGER	Flammable liquid and vapour [H226]*. Causes severe skin burns and eye damage [H314]. Contact with acids liberates toxic gas [EUH031]. Very toxic to aquatic organisms [H400]. * May not be indicated; flash point depends on composition. Check supplier's information.
Storage	Storage code: **CLb** [Colourless-yellow liquid] • At room temperature ammonium sulfide is only stable in aqueous solution. The solution is actually a mixture containing ammonium hydrogen sulfide and ammonia.

Potassium sulfide	K_2S (110.26)
Sodium sulfide-9-water	$Na_2S.9H_2O$ (240.22)
 DANGER	Harmful if swallowed [H302]. Toxic in contact with skin [H311]. Causes severe skin burns and eye damage [H314]. Contact with acids liberates toxic gas [EUH031]. Very toxic to aquatic organisms [H400]. **Potassium sulfide is NOT suitable for use in schools.**
Storage	Storage code: **CS** [Colourless-yellow solid] • Solid absorbs moisture and gases from the atmosphere and produces hydrogen sulfide gas. Store bottle inside another container with anhydrous calcium chloride (**not** soda lime).

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE (skin, eyes)**: Solid, solutions. Solutions are strongly alkaline. • **If hydrogen sulfide gas is inhaled, call 999**. See also *Hazcard* 51A.

51B Risk Assessment Guidance — Hydrogen sulfide: soluble salts

Sulfide salts absorb moisture and gases from the atmosphere and produce hydrogen sulfide gas. Hydrogen sulfide gas is extremely toxic. It affects the nervous, cardiovascular and respiratory systems and causes eye/skin irritation. See *Hazcard* 51A.

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance

Ammonium sulfide solution: ≥ 20% (~ 3M)	 DANGER (See reverse)	TT	• Solutions are strongly alkaline. Wear eye protection even when using dilute solutions. Wear splash-proof goggles for corrosive solutions and protect the face when transferring/dispensing large volumes.
			• Use an efficiently-working fume cupboard when opening containers and to prepare and dispense/transfer solutions.
			• Ensure room is well-ventilated. Do **not** inhale directly above solutions.
			• Take particular care to avoid skin contact (solids, concentrated solutions). See activity-specific guidance and/or GL 120.
			Other notes; see also detailed activity-specific guidance:
			• **Preparation of 0.1 M sulfide solutions (TT)**: Use a fume cupboard to prepare solutions and dispense into stoppered test tubes.
			  · **Ammonium sulfide**: Dilute 3.3 cm^3 of recently-purchased 20% solution to 100 cm^3 with water.
			  · **Sodium sulfide**: Dissolve 2.4 g of the hydrated salt. Make up to 100 cm^3 with water.
			• **Using 0.1 M sulfide solutions**: 0.1 M solutions may be used to precipitate metal sulfides for drop-scale qualitative analysis. See *Recipe* 101.
			Disposal: W7 → below 0.1 M. Use a fume cupboard.

Ammonium sulfide solution* ~ 0.1 M	 WARNING Irritant (skin, eyes)	Y9	
Sodium sulfide hydrated solid	 DANGER (See reverse)	TT	
Sodium sulfide solution* 0.1 M	 WARNING Irritant (skin, eyes)	Y9	

*Solutions ≥ 0.4 M are CORROSIVE

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Salicylic acid, aspirin & related compounds

2-hydroxybenzoic acid	*2-hydroxybenzenecarboxylic acid, salicylic acid*	HOC_6H_4COOH (138.12)
 DANGER	Harmful if swallowed [H302]. Causes serious eye damage [H318].	
Storage	Storage code: **GOrg**	[White solid]

2-ethanoyloxybenzoic acid	*2-acetyloxybenzoic acid, o-acetylsalicylic acid, aspirin*	$CH_3COOC_6H_4COOH$ (180.16)
Methyl 2-hydroxybenzoate	*methyl salicylate, oil of wintergreen*	$C_6H_4(OH)COOCH_3$ (152.15)
Methyl 4-hydroxybenzoate	*methyl paraben, nipagin*	$HOC_6H_4COOCH_3$ (152.15)
Phenyl 2-hydroxybenzoate	*phenyl salicylate, salol*	$C_6H_4(OH)COOC_6H_5$ (214.21)
3,5-dinitrosalicylic acid	*DNSA*	$C_7H_4N_2O_7$ (228.12)
 salol WARNING	Note: Classification/labelling vary. Suppliers may indicate the following. • **All** Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. • **2-ethanoyloxybenzoic acid, methyl 2-hydroxybenzoate, DNSA**: Harmful if swallowed [H302]. • **Phenyl 2-hydroxybenzoate (salol)**: Some suppliers also classify/label this as: Toxic to aquatic life with long lasting effects [H411]. WEL (mg m^{-3}): 5 (LTEL), 15 (STEL), *o*-acetylsalicylic acid (aspirin)	
Storage	Storage code: **GOrg**	[White solids; except 'oil of wintergreen' which is a liquid (strong odour)]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (eyes)**: Salicylic acid.

52 Risk Assessment Guidance

Salicylic acid, aspirin & related compounds

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• 2-hydroxybenzoic acid (*salicylic acid*)	 DANGER (See reverse)	Y7	• Wear eye protection. • Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance**: • **Melting salol ('cooling curve' activities)**: The solid melts at about 41 °C and releases a significant amount of vapour when heated. Heat in a hot-water bath and use a mineral wool plug in the open end of the test-tube to minimise fumes. Ensure the laboratory is well-ventilated. See *Safer chemicals, safer reactions* for guidance and suggestions for alternative substances that may be used. • **Solubility**: The majority of the compounds listed here are not particularly soluble in water (ranging from about 0.5 g to 4 g per litre of water at room temperature). DNSA is soluble. • **DNSA reagent (test for reducing sugars)**: See *Recipe* 34. **Disposal:** W4, salicylic acid W1/W2, others
• 2-ethanoyloxybenzoic acid (*aspirin*) • methyl 2-hydroxybenzoate (*oil of wintergreen*) • methyl 4-hydroxybenzoate (*methyl paraben/nipagin*) • phenyl 2-hydroxybenzoate (*salol*) • 3,5-dinitrosalicylic acid (*DNSA*)	 WARNING (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Hydroxylammonium and hydrazine salts

Hydroxylammonium chloride	*hydroxylamine hydrochloride, hydroxyammonium chloride*	NH_3OHCl (69.49)
Hydroxylammonium sulfate(VI)	*hydroxylamine sulfate, hydroxyammonium sulfate*	$(NH_3OH)_2SO_4$ (164.14)
WARNING	May be corrosive to metals [H290]. Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Causes skin irritation [H315]. May cause an allergic skin reaction [H317]. Causes serious eye irritation [H319]. Suspected of causing cancer [H351]. May cause damage to organs through prolonged or repeated exposure [H373]. Very toxic to aquatic life [H400]. **These substances are dangerous in contact with**: • HEAT. The salts are explosive if heated to high temperatures.	
Storage	Storage code: **GIn**	[White crystals]

Dimethylglyoxime	*diacetyldioxime, butanedione dioxime*	$CH_3C(NOH)C(NOH)CH_3$ (116.12)
DANGER	Flammable solid [H228]. Toxic if swallowed [H301]. Note: some suppliers indicate: Harmful if swallowed [H302] with GHS 07 pictogram and WARNING.	
Storage	Storage code: **GOrg**	[White solid]

Hydrazine hydrate and its salts	$NH_2NH_2.xH_2O$
DANGER	Flammable solid [H226]. Toxic if swallowed, in contact with skin and if inhaled [H301, H311, H331]. Causes severe skin burns and eye damage [H314]. May cause an allergic skin reaction [H317]. May cause cancer [H350]. May cause damage to organs through prolonged or repeated exposure [H373]. Very toxic to aquatic life with long-lasting effects [H410]. **Not recommended for school use. Storage code: T, pending disposal, W1.**

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

53 Risk Assessment Guidance — Hydroxylammonium and hydrazine salts

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Hydroxylammonium chloride solid Hydroxylammonium sulfate(VI) solid	 DANGER (See reverse)	Y12	• Wear eye protection. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Reaction with iron(III) salts:** Nitrogen oxides (toxic) are formed. Ensure the laboratory is well-ventilated. • **Preparation of oximes:** These have useful diagnostic melting points. **Disposal**: W7 → 0.1 M
Solutions of these salts (above): < 0.5 M and ≥ 0.1 M	 WARNING Serious Health Hazard (CMR) Sensitiser (skin).		
Dimethylglyoxime solid	 DANGER (See reverse)	TT	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **Dimethylglyoxime solutions:** The solid is only slightly soluble in water. An ethanolic (IDA) solution (1 g in 100 cm^3) can be used to test for nickel(II) ions, see *Recipe* 101 and *Hazcard* 40A. **Disposal**: W2, or see activity-specific guidance
Dimethylglyoxime solution in ethanol. See **Other notes**.	 DANGER	Y9	

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Iodine I_2 (253.80)

WARNING

Harmful in contact with skin [H312]. Harmful if inhaled [H332]. Very toxic to aquatic life [H400].

Iodine is dangerous in contact with:

- SODIUM, POTASSIUM, ALUMINIUM, MAGNESIUM, ZINC. Violent reactions occur. [Iodine solid]
- AMMONIA solution. An explosive solid is formed. [Iodine solid and solutions]

WEL (mg m^{-3}): 1.1 (STEL) as iodine

Storage

Storage code: **CS** (solid); **GIn** (solutions) [Metallic grey solid, violet vapour]

- Solutions of iodine in other solvents (eg, ethanol) will have additional hazards. Consult *Hazcards*.
- The concentration of solutions decreases with storage; dilute solutions are particularly affected. Store in screw-top glass bottles (avoid ‘polystop’ bottles). Plastic bottles (and caps) become discoloured.
- Vapour from iodine solid or solutions can escape out of poorly-sealed bottles; it accelerates the corrosion of metals in the room and discolours labels. Place the bottle of solid iodine inside another lidded container (which also contains a layer of soda lime). Regularly check condition of containers and for signs of leakage. Replace if necessary.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **If spilt on skin (or clothes)**: Brush off solids immediately. After thorough irrigation, clothing may be treated with 0.1 M sodium thiosulfate solution to remove any brown stains. Rinse again with water. Note: solid/concentrated solutions can have a corrosive action on skin causing burns if left untreated.
- **BEWARE DELAYED EFFECTS (eyes).** If vapour affects the eyes, discomfort may be delayed for some hours.
- **General spills/clearing up**: Ventilate the area as much as possible.
  - **Solids**: Scoop into 1 M sodium thiosulfate solution. Spread 0.5-1 M sodium thiosulfate solution over the area of the spill. Leave for an hour. Mop up and rinse area. See **Disposal**.
  - **Solutions**: Add absorbent. Wash area of spill with 0.5-1 M sodium thiosulfate solution if needed.

54 Risk Assessment Guidance **Iodine (solid and solutions), I_2**

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid, and aqueous solutions* ≥ 1 M	 WARNING Harmful (skin, inhalation) Very toxic to aquatic life.	TT (Y7)	• Wear eye protection even when dilute solutions are used. • Avoid inhaling vapour. Use a fume cupboard if necessary. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. Gloves are advised when transferring or dispensing large quantities of the solid or more-concentrated solutions. **Other notes; see also detailed activity-specific guidance**: • **Preparation of iodine solutions:** See *Recipe* 50. • **General use of iodine/iodine solutions**: Iodine is harmful by inhalation and in contact with the skin. Even dilute solutions will stain skin. Consider these hazards even at low concentrations (it is advisable to include warnings to these effects on labels). Note: 0.01 - 0.1 M solutions are suitable for many activities (eg, testing for starch, work with enzymes, titrations with sodium thiosulfate). • **Weighing the solid**: weigh in a small beaker or weighing boat, not on paper. Iodine rapidly corrodes balance pans. • **Heating the solid (eg, sublimation)**: Use no more than 0.25 g in a test tube that has a mineral wool plug. For larger quantities, use a fume cupboard. **Disposal**: Wspec, see below
Aqueous solutions* < 1 M	Currently not classified as hazardous but see **Other notes**.	Y7	

**Solutions prepared using potassium iodide.*

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **WSpec**: Wear eye protection and gloves. Avoid inhaling vapour use a fume cupboard if necessary. Add the solid (no more than 10 g) or the solution to 1 litre of 1 M sodium thiosulfate solution. The pale-coloured solution can then be further diluted and poured down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

55A Risk Assessment Guidance (also **55B** & **55C**) **Iron, its carbonate, oxides & sulfides**

Iron metal (powder)		Fe (55.85)
 WARNING	Flammable solid [H228]. **Avoid contact with eyes. Iron oxidises rapidly in a saline environment and can cause severe irritation.**	
Storage	Storage code: **GIn**	[Black/grey powder]

Iron metal (filings, foil, wire)		Fe (55.85)
Iron(II) carbonate (saccharated)		$FeCO_3$ (115.85)
Iron(III) oxide	*ferric oxide, haematite*	Fe_2O_3 (159.69)
Iron(II) iron(III) oxide	*magnetite, ferrosoferric oxide*	Fe_3O_4 (231.53)
Iron(II) sulfide	*ferrous sulfide*	FeS (87.91)
Iron(II) disulfide	*pyrites ('fool's gold')*	FeS_2 (119.98)

Currently not classified as hazardous.

- **Iron(II) carbonate**: 'saccharated' means that a reducing sugar is present to slow down oxidation.
- **Iron filings**: **Avoid contact with eyes. Iron oxidises rapidly in a saline environment and can cause severe irritation.**

WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); all iron salts (as Fe); also 5 (LTEL), 10 (STEL); iron(III) oxide fume (as iron)

Storage	Storage code: **GIn** • Iron filings/powder: dark grey/grey solid • Iron(II) carbonate: grey-brown solid • Iron(II) oxide/iron(II) iron(III) oxide/iron(II) sulfide, black solids	• Iron(III) oxide: red/brown solid • Iron(II) disulfide: pale yellow/metallic-look solid

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE (eyes)**: iron powder or iron filings.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

55A Risk Assessment Guidance — Iron and its carbonates, oxides and sulfides

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance

Iron powder	
	WARNING
	(See reverse)
		Y7	**For iron powder/filings: Avoid contact with eyes (eg, do not rub eyes with contaminated fingers). Iron oxidises rapidly in a saline environment and can cause severe irritation.**
			• Wear eye protection.
			• Take care not to rub eyes with fingers contaminated with iron particles.
			Other notes; see also detailed activity-specific guidance:
			• **Using iron filings with magnets**: Cover magnet with *Clingfilm*, to enable easy removal of filings. Alternatively, place filings in a sealed container.
			• **Reaction of iron (eg, filings) with dilute acids**: 0.4 M hydrochloric acid is suitable. Be aware that surface oils and/or sulfide impurities in the metal can lead to very unpleasant smells being produced.
			• **Cleaning rust-stained test-tubes**:
			  ◦ Method 1: Fill with 0.5 M ethanedioic (oxalic) acid. Leave overnight.
			  ◦ Method 2: Use a fume cupboard. Add a small spatula measure of sodium metabisulfite to 1 M hydrochloric acid in the test-tubes. Leave for a couple of hours/overnight. Rinse down the fume cupboard sink to a foul-water drain.
			Disposal: W3, W5 or W8; see notes below

Iron filings and the other iron compounds listed on this *Hazcard*	Currently not classified as hazardous		

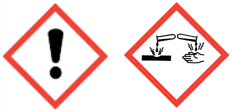
Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W5 (iron powder)**: Use a fume cupboard. • **W3 or W8 (iron filings/foil/wire, other iron compounds listed on this *Hazcard*)**.

55B Risk Assessment Guidance (also 55A and 55C) Iron(II) salts

Iron(II) sulfate(VI)-7-water	*hydrated ferrous sulfate, ferrous sulfate heptahydrate*	$FeSO_4.7H_2O$ (278.01)
Diammonium iron(II) sulfate(VI)-6-water	*ferrous ammonium sulfate, Mohr's salt*	$(NH_4)_2Fe(SO_4)_2.6H_2O$ (392.14)

 WARNING	**Both**: Causes skin irritation [H315]. Causes serious eye irritation [H319]. **Iron(II) sulfate-7-water**: Harmful if swallowed [H302]. **Diammonium iron(II) sulfate-6-water**: May cause respiratory irritation [H335]. WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); all iron salts, as Fe.
Storage	Storage code: **GIn** [Green solids] • Iron(II) sulfate(VI)-7-water loses water of crystallisation (effloresces) and turns white. • Both compounds are oxidised in moist air and turn brown. See also **Other notes** on reverse.

Iron(II) chloride-4-water	*hydrated ferrous chloride, iron(II) chloride tetrahydrate*	$FeCl_2.4H_2O$ (198.81)
Anhydrous iron(II) chloride	*ferrous chloride*	$FeCl_2$ (126.75)

 DANGER	Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye damage [H318]. Note: Classification and labelling vary. Some suppliers may indicate one or more of: Causes severe skin burns and eye damage [H314] and May be corrosive to metals [H290]. WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); all iron salts, as Fe.
Storage	Storage code: **GIn**, hydrated iron(II) chloride [Pale green solid] Storage code: **Situ**, anhydrous iron(II) chloride [Off-white solid] • Anhydrous iron(II) chloride absorbs water from the atmosphere (is hygroscopic). Both solids oxidise in air and turn brown. See also **Other notes** on reverse.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE (eyes):** Iron(II) chloride solid and solutions.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

55B Risk Assessment Guidance (also **55A** and **55C**) **Iron(II) salts**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**		**User**	**Suggested general control measures and guidance**
Iron(II) sulfate solid	 WARNING	See reverse	Y7	• Wear eye protection. • Wear splash-proof goggles when transferring/dispensing large quantities of corrosive iron(II) chloride solutions. **Other notes; see also detailed activity-specific guidance**: • **Preparing iron(II) salt solutions (TT)**: see *Recipe* 51. Do **not** warm solutions to speed up dissolving, higher temperatures accelerate the oxidation of iron(II) to iron(III). • **Use of iron(II) solutions**: Iron(II) chloride solutions oxidise rapidly during storage (becoming brown). Acidic iron(II) sulfate and diammonium iron(II) sulfate solutions are more stable and may be preferable for many activities. Rinse glassware thoroughly before placing in the dishwasher. Iron(II) solutions accelerate 'pitting' in stainless steel and can also badly stain porcelain.
Iron(II) sulfate solutions* ≥ 1.5 M		Irritant (skin, eyes)		
< 1.5 M and ≥ 0.5 M		Irritant (eyes)		
Iron(II) chloride solid	See reverse		TT (Y9)	
Iron(II) chloride solutions* ≥ 2 M	 DANGER	As below, plus Harmful (ingestion)	Y9	
< 2 M and ≥ 0.25 M		Corrosive (eyes) Irritant (skin)		
< 0.25 M and ≥ 0.1 M		WARNING Irritant (skin, eyes)	Y7	**Disposal:** sulfate, W7 → 0.2 M chloride, W4; see below

*Solutions made up in dilute acid (see *Recipe* 51). Includes ammonium iron(II) sulfate(VI) solutions.

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W4**: Add no more than 100 g of iron(II) chloride-4-water to 1 litre of 1 M sodium carbonate solution. Separate off the precipitate of hydrated iron(II) hydroxide (which turns from green to brown as it oxidises in air). Place the solid in the normal waste. Rinse remaining liquid down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

55C Risk Assessment Guidance (also **55A** and **55B**)

Iron(III) salts

Iron(III) sulfate(VI)-9-water	*hydrated ferric sulfate*	$Fe_2(SO_4)_3.9H_2O$ (562.02)
Ammonium iron(III) sulfate(VI)-12-water	*iron(III) ammonium sulfate(VI), ferric alum, iron alum*	$NH_4Fe(SO_4)_2.12H_2O$ (482.19)
Iron(III) nitrate(V)-9-water	*hydrated ferric nitrate*	$Fe(NO_3)_3.9H_2O$ (403.99)

nitrate

WARNING

All: Causes skin irritation [H315]. Causes serious eye irritation [H319].

Iron(III) sulfate(VI)-9-water: Harmful if swallowed [H302].

Iron(III) nitrate(V)-9-water: May intensify fire; oxidiser [H272].

Note: Classification and labelling vary by supplier.

WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); all iron salts, as Fe.

Iron(III) chloride-6-water	*hydrated ferric chloride*	$FeCl_3.6H_2O$ (270.30)
Anhydrous iron(III) chloride	*ferric chloride*	$FeCl_3$ (162.20)

DANGER

Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye damage [H318].

Note: Classification and labelling vary by supplier.

WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); all iron salts, as Fe.

Storage

Storage codes: **GIn** (sulfates); **Ox** (nitrate); **CW** (chlorides)

- Appearance of salts: sulfate (white/yellow); ammonium sulfate (lilac); chlorides (yellow-green or green-brown); nitrate (colourless/pale lilac).
- The solids absorb water from the atmosphere. Keep jar/bottle inside an outer container that also contains soda-lime. See also **Other notes** on reverse.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes)**. Iron(III) chloride solid and solutions.
- **General spills: OXIDISING**, iron(III) nitrate; **CORROSIVE WATER-REACTIVE**, iron(III) chlorides.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

55C Risk Assessment Guidance (also **55A** and **55B**) **Iron(III) salts**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**		**User**	**Suggested general control measures and guidance**
Solid iron(III) salts (not the chlorides)	See reverse		Y7	- Wear eye protection. - Wear splash-proof goggles when transferring/dispensing large quantities of corrosive solutions. **Other notes; see also detailed activity-specific guidance:** - **Preparing iron(III) salt solutions (TT)**: See *Recipe* 52. Do **not** warm solutions to speed up dissolving; higher temperatures cause the formation of colloids. The ammonium iron(III) sulfate(VI) salt is suitable for most applications. Do **not** use the anhydrous salt for making iron(III) chloride solutions. - **Use of iron(III) solutions**: Iron(III) solutions do not keep well (even when made up in acidic solution). Rinse glassware thoroughly before placing it in the dishwasher. Iron(III) solutions accelerate ‘pitting’ in stainless steel.
Iron(III) solutions* (not chlorides) ≥ 0.3 M		WARNING Irritant (skin, eyes) Harmful (ingestion), ≥ 0.6 M, sulfate		
Iron(III) chloride solid	See reverse		TT (Y9)	
Iron(III) chloride solutions* ≥ 0.6 M	 DANGER	Corrosive (eyes) Irritant (skin) Harmful (ingestion), ≥ 1.5 M	Y9	
< 0.6 M and ≥ 0.2 M		Corrosive (eyes)		
< 0.2 M and ≥ 0.1 M		WARNING Irritant (eyes)	Y7	**Disposal:** sulfates and nitrate, W7 → 0.2 M chloride, W4; see below

*Solutions made up in dilute acid (see *Recipe* 52).

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts of chloride only:** - **W4**: Add solid/solution to excess 1 M sodium carbonate solution. Separate off the brown precipitate (solid) of hydrated iron(III) hydroxide. Place solid in the normal waste. Rinse remaining liquid down a foul-water drain. For solid: Add no more than 100 g of solid to 1 litre of sodium carbonate solution. For solution: Use ~ 100 cm^3 of 1 M sodium carbonate solution per 100 cm^3 of a 0.1 M solution.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

56 Risk Assessment Guidance

Lead metal, carbonate, oxides and sulfide

Lead metal		Pb (207.2)
Lead(II) carbonate	*cerrusite*	$PbCO_3$ (267.2)
Lead(II) carbonate hydroxide	*basic lead carbonate, white lead*	$2PbCO_3.Pb(OH)_2$ (775.6)
Lead(II) oxide	*lead monoxide, yellow lead, litharge/massicot*	PbO (223.2)
Lead(IV) oxide	*lead dioxide*	PbO_2 (239.2)
Dilead(II) lead(IV) oxide	*red lead*	Pb_3O_4 (685.6)
Lead(II) sulfide	*galena*	PbS (239.3)

DANGER

Harmful if swallowed [H302]. Harmful if inhaled [H332]. May damage the unborn child. Suspected of damaging fertility [H360Df]. May cause damage to organs through prolonged or repeated exposure [H373]. Very toxic to aquatic life with long lasting effects [H410].

Lead oxides are dangerous in contact with:

- ALUMINIUM, MAGNESIUM powders & ORGANIC material. Vigorous or explosive reactions may occur.

In schools these substances are used infrequently and in small quantities. Exposure through ingestion or inhalation is, therefore, low and controlled, if the risk assessment advice is followed. Lead and its compounds may be of concern to those who are pregnant (see *Pregnant, new and breastfeeding mothers and school science*).

Storage

Storage code: **T**

- **Lead metal**: soft, dense silvery-grey metal (lead metal powder may appear very dark).
- **Lead(II) carbonates**: colourless-white solids. **Lead(II) sulfide**: black solid (galena ore is silvery).
- **Lead oxides**: red/red-brown solids (lead(II) oxide can exist in two forms, one is yellow).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills:** Avoid raising dust. Scoop and/or wipe up as much solid as possible. Retain **all** solid waste and contaminated cloths/paper towels for disposal via a Registered Waste Carrier. Rinse the area with water and clear up. The diluted washings may be flushed away down a foul-water drain.

56 Risk Assessment Guidance

Lead metal, carbonate, oxides and sulfide

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Lead and the lead compounds listed on this card	 DANGER (See reverse)	Y7	• Wear eye protection. • Avoid raising dust if using powdered solids. • Use correct transfer techniques (eg, when weighing the solids) to minimise risk of exposure through inhalation or ingestion. • Take particular care to avoid skin contact. Wash hands thoroughly after use. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Weighing the solids**: Weigh solid on a balance placed in a fume cupboard that is **not** switched on. Have sash partially pulled down. • **Using lead metal (eg, foil)**: The metal will rub off on skin. Use tweezers or forceps to manipulate pieces of foil. Lumps of lead may be wrapped in plastic film. **Disposal**: W1, W2 only

Lead and its compounds may be of concern to those who are pregnant (see *Pregnant, new and breastfeeding mothers and school science*).

However, in schools these substances are used infrequently and in small quantities.

Exposure through ingestion or inhalation is, therefore, low and controlled, if the risk assessment advice is followed.

Disposal	Follow general guidance in *About Hazcards* (GL 120).

57A Risk Assessment Guidance **Lead salts: halides, nitrate(V) & sulfate(VI)**

Lead(II) bromide	*lead dibromide*	$PbBr_2$ (367.01)
Lead(II) chloride	*lead dichloride*	$PbCl_2$ (278.10)
Lead(II) iodide	*lead diiodide*	PbI_2 (461.01)
Lead(II) nitrate(V)	*lead dinitrate*	$Pb(NO_3)_2$ (331.21)
Lead(II) sulfate(VI)		$PbSO_4$ (303.26)

DANGER

Harmful if swallowed [H302]. Harmful if inhaled [H332]. May damage the unborn child and suspected of damaging fertility [H360Df]. May cause damage to organs through prolonged or repeated exposure [H373]. Very toxic to aquatic life with long lasting effects [H410].

In schools these substances are used infrequently and in small quantities. Exposure through ingestion or inhalation is, therefore, low and controlled, if the risk assessment advice is followed.

Lead and its compounds may be of concern to those who are pregnant (see *Pregnant, new and breastfeeding mothers and school science*).

Storage Storage code: **T** [White solids, powder or crystalline; lead (II) iodide is yellow]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills (solids):** Avoid raising dust. Scoop and/or wipe up as much solid as possible. Retain **all** solid waste and contaminated cloths/paper towels for disposal via a Registered Waste Carrier. Rinse the area with water and clear up. The diluted washings may be flushed away down a foul-water drain.

57A Risk Assessment Guidance — Lead salts: halides, nitrate(V) & sulfate(VI)

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid lead salts Lead(II) nitrate(V) solutions ≥ 1 M	 DANGER Harmful (inhalation, ingestion) Serious health hazard (CM**R**, RE)	TT (Y9)	• Wear eye protection. • Avoid raising dust if using solids (powders). • Use correct transfer techniques (eg, when weighing the solids) to minimise risk of exposure through inhalation or ingestion. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. Wash hands thoroughly after use, even when low concentrations are used. • Clear up spills and wipe over surfaces after using lead salts. **Other notes; see also detailed activity-specific guidance:** • Inhalation is a remote possibility if significant amounts of dust become airborne or if vapours are released on heating. • **Weighing the solid**: If necessary, weigh solid on a balance placed in a fume cupboard that is **not** switched on. Have sash partially pulled down. • **Preparing solutions**: see *Recipe* 53. Solutions < 0.01 M will be suitable for many activities (eg, precipitation reactions). **Disposal**: W2, see below
Lead(II) nitrate(V) solutions < 1 M and ≥ 0.015 M	 DANGER Serious health hazard (CM**R**), ≥ 0.1 M Serious health hazard (RE), ≥ 0.2 M		
Lead(II) nitrate(V) solutions < 0.015 M	Currently not classified as hazardous. Experience of the use of lead salts in school science activities indicates that it is appropriate to apply the control measures given on this *Hazcard*.	Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W2**: Collect all unwanted lead compounds and small quantities of lead compounds (or lead metal) as residue from practical science activities in a separate labelled container and retain for removal by a Registered Waste Carrier. See other guidance for specific practical procedures.

57B Risk Assessment Guidance

Lead salts: chromate(VI) and ethanoate

Lead(II) chromate(VI) $PbCrO_4$ (325.3)

Lead(II) ethanoate-3-water *lead acetate (hydrated)* $Pb(CH_3COO)_2.3H_2O$ (379.3)

DANGER

Lead chromate(VI): May cause cancer [H350].

Both: May damage the unborn child. Suspected of damaging fertility [H360Df]. May cause damage to organs through prolonged or repeated exposure [H373]. Very toxic to aquatic life with long lasting effects [H410].

In schools these substances are used infrequently and in small quantities. Exposure through ingestion or inhalation is, therefore, low and controlled, if the risk assessment advice is followed.

Lead and its compounds may be of concern to those who are pregnant (see *Pregnant, new and breastfeeding mothers and school science*).

Storage

Storage code: **Situ**, lead(II) chromate(VI) see **Other notes** (on reverse) [Yellow solid]

Storage code: **T**, lead(II) ethanoate [White solid]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills (solids):** Avoid raising dust. Scoop and/or wipe up as much solid as possible. Retain **all** solid waste and contaminated cloths/paper towels for disposal via a Registered Waste Carrier. Rinse the area with water and clear up. The diluted washings may be flushed away down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

57B Risk Assessment Guidance — Lead salts: chromate(VI) and ethanoate

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Lead(II) chromate(VI)	 DANGER (See reverse)	TT (Y9)	• Wear eye protection. • Avoid raising dust if using solids (powders). • Use correct transfer techniques (eg, when weighing the solids) to minimise risk of exposure through inhalation or ingestion. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. Wash hands thoroughly after use, even when low concentrations are used. • Clear up spills and wipe over surfaces after using lead salts. **Other notes; see also detailed activity-specific guidance:** • **Weighing the solid**: Weigh solid on a balance placed in a fume cupboard that is not switched on. Have sash partially down. • **Lead(II) salt solutions**: Lead(II) nitrate(V) solutions (< 0.015 M) are suitable in most cases where lead(II) ions are required. See *Recipe* 53 and *Hazcard* 57A. • **Precipitation reactions involving lead chromate(VI)**: Use alternatives to chromate(VI) salts when possible. Use small volumes. Do **not** dry and store. **Disposal**: W2, see below
Lead(II) ethanoate solid, and solutions ≥ 1 M			
Lead(II) ethanoate solutions < 1 M and ≥ 0.015 M	 DANGER Serious health hazard (CM**R**), ≥ 0.1 M Serious health hazard (RE), ≥ 0.2 M		
Lead(II) ethanoate solutions < 0.015 M	Currently not classified as hazardous. Experience of the use of lead salts in school science activities indicates that it is appropriate to apply the control measures given on this *Hazcard*.	Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W2**: Collect all unwanted lead compounds and small quantities of lead compounds (or lead metal) as residue from practical science activities in a separate labelled container and retain for removal by a Registered Waste Carrier. See other guidance for specific practical procedures.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

58A Risk Assessment Guidance **Lithium**

Lithium	Li (6.9)
 DANGER	In contact with water releases flammable gases which may ignite spontaneously [H260]. Reacts violently with water [EUH014]. Causes severe skin burns and eye damage [H314]. **Lithium is dangerous in contact with**: • NITRIC(V) ACID. The metal ignites on contact. • 1, 1, 1-TRICHLOROETHANE and similar compounds. The metal reacts explosively. • MERCURY. A violent reaction can occur.
Storage	Storage code: **FW** [Silvery-white (when freshly cut) semi-soft metal] • Store under paraffin liquid (‘medicinal paraffin’, see *Hazcard* 45B). Lithium will float, so some bottles have a lid device to keep the metal pieces submerged. Some lithium pieces may look black if their surfaces have oxidised/tarnished. A ‘whiff’ of ammonia may briefly be noticed when the lid is first removed (often if metal has not been kept submerged). • Store away from water/water-based reagents. Do **not** store in the flammables cupboard or with flammable liquids. Stand the bottle of lithium inside another clean, dry container (labelled) to keep it upright. See *Storage of chemicals*. • Purchase small quantities only (eg, 25 g will be adequate) so that stock is fresh.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE (skin, eyes), alkali**. • **If lithium catches fire**: It burns vigorously and is difficult to extinguish. Smother small fires with dry **salt** (sodium chloride) **not** sand. • **General spills/clearing up**: **FLAMMABLE WATER-REACTIVE**. Prevent spill from spreading. Use forceps to pick up metal pieces. Place pieces in a clean, **dry** container, cover with fresh liquid paraffin and store for disposal by a Registered Waste Carrier. Cover remaining spill with absorbent and scoop into a bucket of cold water. Once any reaction is complete (may take time), dilute further. Pour down a foul-water drain. Mop spill area but beware of possible reactions between the water and any remaining lithium fragments.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

58A Risk Assessment Guidance

Lithium

Take steps to prevent theft. After any use of lithium (eg, a demonstration), ensure that the bottle is securely locked away. In addition, to ensure that a technician will not be faced with an unexpected reaction when clearing up, place any tiles plus the equipment used to cut or handle pieces of lithium into a large bowl of cold water.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Lithium	 DANGER (See reverse)	TT (Y9)	• Wear splash-proof goggles. • Take particular care to avoid skin contact. Use tweezers or forceps to transfer pieces of lithium. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparing lithium for use (TT)**: All equipment must be **dry**. Use forceps to place a piece of lithium onto a tile. Use a sharp knife to cut off required piece. Immediately return the unwanted lithium to its bottle and close lid. Dab the cut piece of lithium with a paper tissue/filter paper to remove the oil (medicinal paraffin). Do **not** use organic solvents (eg, petroleum spirit or hexane) to remove the oil. • **Heating lithium metal (TT):** Wear splash-proof goggles. Protect the face. Use safety screens. Lithium has been known to explode when heated on porcelain, so heat on the ceramic centre of a gauze, or on a combustion spoon. **Disposal:** W5, see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W5**: Add only a few small pieces of lithium at a time to 1 M ethanoic acid and allow reaction to subside before adding further pieces. The reaction is not usually violent.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

58B Risk Assessment Guidance **Lithium compounds (see also 47B and 91B)**

Lithium carbonate	Li_2CO_3 (73.89)
 WARNING	Harmful if swallowed [H302]. Causes serious eye irritation [H319].
Storage	Storage code: **GIn** [White crystalline powder]

Lithium nitrate(V)	*anhydrous lithium nitrate(V)* $LiNO_3$ (68.95)
 DANGER	May intensify fire; oxidiser [H272]. Note: Hazard classification and labelling varies. Suppliers may also indicate one or more of: Harmful if swallowed [H302]. Causes serious eye irritation [H319].
Storage	Storage code: **Ox** [White crystalline solid] • Absorbs water from the atmosphere (hygroscopic).

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

58B Risk Assessment Guidance (also **47B** and **91B**) **Lithium compounds**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Lithium carbonate	 WARNING (See reverse)	Y7	• Wear eye protection. • Avoid raising dust. **Disposal**: W5
Lithium nitrate(V)	 DANGER (See reverse)		• Wear eye protection. **Other notes; see also detailed activity-specific guidance:** • **Heating the nitrate:** Wear splash-proof goggles. If heated in the open laboratory, ensure room is well ventilated and keep amounts below 1 g per student/pair of students. Otherwise, use a fume cupboard. Nitrogen dioxide gas (toxic) is evolved. Hot particles may shoot out of the test tube so place a loose plug of mineral wool in the mouth of the test-tube. **Disposal**: W7 → 5 % w/v

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

59A Risk Assessment Guidance — Magnesium

Magnesium turnings, powder and ribbon

Mg (24.30)

DANGER

Magnesium turnings/powder: Flammable solid [H228]. Self-heating in large quantities; may catch fire [H252]. In contact with water releases flammable gases [H261]. Note: ‘large quantities’ refers to kg amounts.

Magnesium ribbon: Classification/labelling vary. Some suppliers indicate no hazards but others give the same information as for magnesium powder.

Magnesium is dangerous in contact with:

- 1, 1, 1-TRICHLOROETHANE and similar compounds. The metal reacts violently.
- METHANOL. The metal reacts violently after a lengthy induction period.
- BROMINE and CHLORINE. The metal reacts violently.
- SULFUR. The metal reacts violently and explosively.
- SILVER NITRATE(V). When added to the metal, an explosion may occur in the presence of water.
- OXIDISING AGENTS. Explosive mixtures are formed with the metal.
- SULFATES(VI) and METAL OXIDES. Mixtures of solid with the metal (especially the powder) may be explosive.

Take steps to prevent theft. Reels of magnesium ribbon should not be left out in the laboratory. It is good practice to have a limited number of pre-cut lengths and to hand these out to students as needed.

Storage

Storage code: **FW** [Silver-grey metal]

- An oxide layer forms on the turnings and the powder is particularly prone to oxidation.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **If magnesium catches fire**: Magnesium can be difficult to ignite but burns vigorously and is difficult to extinguish. Smother small fires with **clean**, **dry** sand (keep a container of sand specifically for this purpose).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

59A Risk Assessment Guidance **Magnesium**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Magnesium turnings or powder	 DANGER (See reverse)	TT (Y9)	• Wear eye protection. • Avoid raising dust (magnesium powder). Keep powder away from naked flames. **Other notes; see also detailed activity-specific guidance**: • Powdered magnesium is particularly dangerous if blown into a Bunsen flame. • **Viewing burning magnesium**: An intense white light is emitted (mainly visible but some in UV-A region) that can cause unpleasant dazzle and after-images that may persist for some time. Wearing eye protection, view the burning metal through either (i) a passive welding filter lens, <u>shade 9</u> or (ii) through a hand held in front of eyes with fingers just apart (as small a gap as possible between fingers, ~ 1mm). Note: viewing through sunglasses, smoked glass blue glass or polaroid filters is **no longer recommended**. The welding filter lens is the preferred method. For data about the light emitted from burning magnesium and guidance on welding filter lenses, see *Ultraviolet (UV) light sources*. **NEVER look directly at magnesium when it is burning.** • **Reaction of magnesium powder with copper(II) oxide (TT)**: Use a **<u>maximum of 0.25 g</u>** of each reagent. Do **not** exceed these amounts unless the employer holds an explosives certificate issued by the police and the method has been discussed with CLEAPSS. See also *Fireworks and explosives*. **Disposal**: W5; see below
Magnesium ribbon		TT (Y7)	

Take steps to prevent theft.

Reels of magnesium ribbon should **not** be left out in the laboratory.

It is good practice to have a limited number of pre-cut lengths and to hand these out to students as needed.

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **W5**: Reaction of acid with turnings/powder generates a lot of heat. Add in small portions to 1 M ethanoic acid.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

59B Risk Assessment Guidance **Magnesium compounds**

Magnesium nitrate(V)-6-water	*hydrated magnesium nitrate*	$MgNO_3.6H_2O$ (256.41)
Magnesium chlorate(VII)	*magnesium perchlorate*	$Mg(ClO_4)_2$ (223.206)

DANGER

May intensify fire; oxidiser [H272]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

Note: Classification/labelling may vary from that given here.

Magnesium nitrate(V) is dangerous in contact with:

- COMBUSTIBLE SUBSTANCES, PHOSPHORUS, METAL POWDERS. Violent/dangerous reactions occur.

Storage	Storage code: **Ox (pending disposal only, W1, for the chlorate)** [White/colourless solids] • These solids absorb water from the atmosphere (hygroscopic). • The use of magnesium perchlorate (eg, for drying gases) is **not recommended** for schools.

Magnesium carbonate hydroxide	*magnesium carbonate basic (see Storage note below)*	*Formula varies*
Magnesium chloride-6-water	*hydrated magnesium chloride*	$MgCl_2.6H_2O$ (203.30)
Magnesium hydroxide		$Mg(OH)_2$ (58.32)
Magnesium oxide	*magnesia*	MgO (40.30)
Magnesium sulfate(VI)	*anhydrous magnesium sulfate*	$MgSO_4$ (120.37)
Magnesium sulfate(VI)-7-water	*hydrated magnesium sulfate; Epsom salts*	$MgSO_4.7H_2O$ (246.47)

Currently not classified as hazardous. Note: Classification/labelling may vary from that given here.

WEL (mg m^{-3}): 10 (LTEL), 30 (STEL); magnesium oxide as Mg (as inhalable dust).

Storage	Storage code: **GIn** [White powders/crystalline solids] • Hydrated magnesium chloride absorbs water from the atmosphere (hygroscopic). • Pure magnesium carbonate is not supplied.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

59B Risk Assessment Guidance **Magnesium compounds**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Hydrated magnesium nitrate(V) solid	 DANGER (See reverse)	Y7	- Wear eye protection. - Avoid raising dust (solids). **Other notes**; **see also detailed activity-specific guidance**: - **Heating the nitrate:** Wear splash-proof goggles. Ensure room is well ventilated. Hot particles may shoot out of the test tube so place a loose plug of mineral wool in the mouth of the test-tube. Nitrogen dioxide gas (toxic) is evolved. If heated in the open laboratory, keep amounts below 0.5 g per student/pair of students; otherwise use a fume cupboard. - **Heating the hydrated sulfate:** If heated in an evaporating basin, there can be considerable 'spitting'. Wear splash-proof goggles and use a low Bunsen flame. - Anhydrous magnesium sulfate(VI) is a good drying agent for organic liquids. **Disposal**: see notes below
Magnesium nitrate(V) solutions ≥ 0.5 M	 WARNING Irritant (skin, eyes)		
Solids/solutions - Magnesium chloride - Magnesium sulfate	Currently not classified as hazardous		
Solids - Magnesium carbonate - Magnesium oxide - Magnesium hydroxide			

Disposal	**Follow general guidance in *About Hazcards* (GL 120).** - **W7 (magnesium nitrate)**: Dilute to 0.2 M or below. - **W7 (magnesium sulfate, magnesium chloride)**. - **W8 (magnesium carbonate, magnesium oxide, magnesium hydroxide)**.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

60 Risk Assessment Guidance (see also *Hazcard* **81**) **Manganese & its compounds**

Manganese metal	Mn (54.94)
Manganese carbonate	$MnCO_3$ (114.95)
Currently not classified as hazardous. Note: Manganese metal powder would be highly flammable.	

Manganese(II) chloride-4-water		$MnCl_2.4H_2O$ (197.91)
Manganese(IV) oxide	*manganese dioxide, pyrolusite*	MnO_2 (86.94)

 WARNING	Harmful if swallowed [H302]. Manganese(IV) oxide is also: Harmful if inhaled [H332]. **Manganese(IV) oxide is dangerous in contact with**: • ALUMINIUM and OTHER METAL POWDERS. Explosive reactions can occur. • POWERFUL OXIDISING AGENTS such as POTASSIUM CHLORATE(V). Unstable mixtures form.

Manganese(II) sulfate-1-water	$MnSO_4.H_2O$ (169.02)
 WARNING	May cause damage to organs through prolonged or repeated exposure [H373]. Toxic to aquatic life with long lasting effects [H411].

Storage	Storage code: **GIn** • **Metal:** Dark grey. **Manganese(II) compounds:** Pale pink to 'rose' pink solids (crystalline). • **Manganese(IV) oxide**: A dark brown/black solid; usually sold as powder or granules. See note on reverse regarding use as a catalyst for the decomposition of hydrogen peroxide solutions. WEL (mg m^{-3}): 0.2 (LTEL), 0.6 (STEL), as inhalable dust; 0.05 (LTEL, 0.15 (STEL), as respirable dust; In both cases, for manganese and its inorganic compounds (as Mn).

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

60 Risk Assessment Guidance (see also *Hazcard* **81**) **Manganese & its compounds**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Manganese metal Manganese carbonate	Currently not classified as hazardous	Y7	• Wear eye protection. • Avoid raising dust when using powdered solids. **Other notes; see also detailed activity-specific guidance**: • **Preparation of manganese(II) solutions (TT)**: See *Recipe* 56. • **Preparation of oxygen gas (TT)**: See *Recipe* 64. • **Manganese(IV) oxide and hydrogen peroxide**: Some supplies of manganese(IV) oxide have failed to catalyse the decomposition of (*freshly-made*) hydrogen peroxide solutions into oxygen gas and water. If this happens, contact your supplier and ask for a replacement. Please also inform CLEAPSS. • **Reaction of manganese metal with dilute acids:** The metal reacts slowly with 0.4 M hydrochloric and sulfuric(VI) acids. • **Winkler's method for dissolved oxygen**: See *Recipe* 105. **Disposal:** see notes below
Manganese(IV) oxide	 WARNING Harmful (ingestion). Manganese(IV) oxide is also: Harmful (inhalation).		
Manganese(II) chloride-4-water solid, and solutions: ≥ 1.5 M			
Manganese(II) sulfate-1-water solid, and solutions: ≥ 0.7 M	 WARNING Serious health hazard (RE)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **Metal**: **W3** if it can be easily re-used; or **W8** (but be aware that the fine powder is highly flammable). • **Manganese(IV) oxide**: **W3**; or **W8** (residues on filter paper). • **Manganese(II) chloride/sulfate salts**: **W7**; dilute to below 0.25 M then pour down a foul-water drain.

Mercury Hg (200.59)

Cadmium Cd (112.411)

DANGER

Both: Fatal if inhaled [H330]. Causes damage to organs through prolonged or repeated exposure [H372]. Very toxic to aquatic life with long lasting effects [H400/H410].

Mercury: May damage the unborn child [H360D].

Cadmium: Suspected of causing genetic defects [H341]. May cause cancer [H350]. Suspected of damaging fertility. Suspected of damaging the unborn child [H361fd].

Mercury is dangerous in contact with:

- ALKALI METALS, BROMINE, CHLORINE. A violent reaction can occur.
- ALUMINIUM. Ignition may occur.
- AMMONIA. Explosive solids form after a period of contact.

WEL (mg m^{-3}): 0.02 (LTEL), 0.06 (STEL); mercury; 0.025 (LTEL), 0.075 (STEL), Carc; cadmium

Storage

Storage code: **T**

- **Mercury (silvery-grey liquid)**: Use plastic bottles and only fill to one-third of their volume. Do not attempt to clean mercury yourself, except to remove surface dirt/dust by shaking with sticky tape in a strong bottle or to remove surface water using filter paper.
- **Cadmium (silvery-white solid)**: an exhibition sample may be kept in a closed container.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE for mercury:

- **If swallowed**: Call 111 and follow the advice.
- **Spills on skin or clothes**: Remove contaminated clothing. Carefully wash any contaminated area(s). Check jewellery and consult a jeweller if silver-coloured staining (mercury amalgam) is found.
- **General spills**: For details see *Mercury spills* (CLEAPSS website). Contact CLEAPSS if you need further advice. Retain all residues, contaminated cloths and gloves for collection and disposal by a Registered Waste Carrier. See **Disposal** on reverse.

61 Risk Assessment Guidance **Mercury and cadmium**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

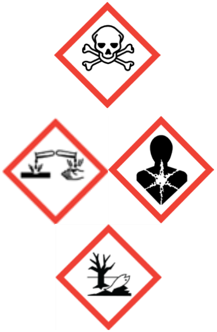
General use of:	Hazard information	User	Suggested general control measures and guidance
Mercury	 DANGER (See reverse)	TT (Y12)	• Have a mercury spills kit to hand whenever mercury-containing measuring devices or mercury itself are used. Clear spills promptly. • Wear eye protection as required by the activity. • Remove jewellery/watches and/or wear gloves. • Wash hands thoroughly after safely disposing of gloves. • Do **not** expose the metal to the open air for long periods (vapour risk). • **Never** heat mercury except in an efficiently-working **ducted** fume cupboard. • Do **not** use mercury thermometers in ovens or incubators. • Do **not** use mercury to fill gaps between a thermometer and any apparatus being heated (eg, the metal block in calorimetry/melting-point apparatus; Quickfit apparatus).

Serious poisoning is very rare in schools.
The risk is mainly to technicians or teachers exposed over long periods of time to low vapour concentrations from spilt mercury that was not cleared up.
If concerned, seek medical advice.
CLEAPSS offers a mercury monitoring service (fee charged) but note that monitoring is needed only if there is the possibility of concealed mercury (eg, after a major spill, in an old building etc).
			Other notes; see also detailed activity-specific guidance:
			• **Thermometers and other measuring devices**:
			  · For temperature measurements, use alternatives such as spirit thermometers or digital temperature probes/data loggers where possible.
			  · Although mercury-containing measuring devices are no longer available for purchase, those already held in schools may still be used if necessary (eg, thermometers for some melting point determinations).

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE**: • **W1**, **W2 only**: Retain **all** mercury-containing waste for specialist disposal by a Registered Waste Carrier. This includes small amounts in threads of broken thermometers, etc. Keep secure in sealed bags/plastic bottles.

Mercury(II) chloride *mercuric chloride, mercury dichloride* $HgCl_2$ (271.52)

Other inorganic mercury compounds (except those named on this *Hazcard*) and cadmium salts -



DANGER

Mercury(II) chloride: Fatal if swallowed or in contact with skin [H300, H310]. Causes severe skin burns and eye damage [H314]. Suspected of causing genetic defects & damaging fertility [H341, H361f]. Causes damage to organs through prolonged/repeated exposure [H372]. Very toxic to aquatic life with long lasting effects [H410].

Other mercury(II) compounds except the sulfide will include at least: Fatal if swallowed [H300]. Fatal in contact with skin [H310]. Causes damage to organs through prolonged or repeated exposure [H372]. Very toxic to aquatic life with long lasting effects [H410].

Cadmium salts (eg, chloride, sulfate): these are **not** suitable for school use.

Mercury(II) compounds are dangerous in contact with:

- HEAT: Decomposition occurs forming toxic gases & mercury vapour [chloride, sulfide, nitrate(V) salts].
- ETHANOL. Explosive mercury fulminate forms [mercury(II) nitrate(V)].

WEL (mg m^{-3}): 0.02 (LTEL), 0.06 (STEL) as mercury for mercury(II) compounds.

Storage

Storage code: **T** [White solids]

- Cadmium salts: storage is pending disposal, W1.

Mercury(I) chloride *mercurous chloride, calomel* Hg_2Cl_2 (472.09)

Mercury(II) sulfide *mercuric sulfide, cinnabar* HgS (232.66)

WARNING

Mercury(I) chloride: Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Very toxic to aquatic life with long lasting effects [H410].

Mercury(II) sulfide: May cause an allergic skin reaction [H317]. Contact with acids liberates toxic gas [EUH031].

WEL (mg m^{-3}): 0.02 (LTEL), 0.06 (STEL) as mercury for mercury(II) compounds.

Storage

Storage code: **GIn** [Chloride is a white solid. Sulfide is a red solid.]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes, skin). VERY TOXIC (ingestion, skin).** Mercury(II) compounds except the sulfide.
- **General spills/clearing up**: See **Disposal** on reverse.

62 Risk Assessment Guidance

Mercury and cadmium compounds

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Mercury(II) chloride solid & solutions ≥ 0. 1 M	 DANGER (See reverse)	TT	**The risks of harm to employees in education are low as the quantities used in practical activities are very small and exposure is infrequent. CLEAPSS would advise against the use of mercury compounds in routine science practical work.** • Wear splash proof goggles. • Wear gloves. Wash hands after safely disposing of gloves (W2). • **Do NOT heat mercury compounds except in an efficiently-operating <u>ducted</u> fume cupboard**. Heating causes decomposition to form toxic products including: mercury vapour (all), hydrogen chloride and chlorine (chloride salt); sulfur oxides and hydrogen sulfide (sulfide salt); nitrogen oxides (nitrate(V) salt). **Other notes; see also detailed activity-specific guidance**: • **Preparation and labelling of mercury(II) solutions**: See *Recipe* 57. • **General use of mercury(II) chloride solutions**: Check activity-specific guidance for details; use solutions < 0.01 M where possible. • **‘Pharaoh’s serpent’ demonstration**: Do **not** carry out this demonstration in school. For a safer alternative see *Soda snake.* **Disposal**: W1, W2 only, see below
Mercury(II) chloride solutions < 0.1 M and ≥ 0. 01 M	 DANGER, as below but HARMFUL → TOXIC		
Mercury(II) chloride solutions < 0.01 M and ≥ 0. 002M	 WARNING, HARMFUL		
Mercury(I) chloride Mercury(II) sulfide	 WARNING (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • **W1, W2 only**: Retain <u>all</u> mercury-containing waste for specialist disposal by a Registered Waste Carrier. Keep secure in sealed bags/plastic bottles.

Methanal *formaldehyde (the aqueous solution is often called formalin)* HCHO (30.03)

DANGER

Toxic if swallowed [H301]. Toxic in contact with skin [H311]. Causes severe skin burns and eye damage [H314]. May cause an allergic skin reaction [H317]. Toxic if inhaled [H331]. Suspected of causing genetic defects [H341]. May cause cancer [H350].

Solutions containing ≥ 10 % (w/w) methanol will also be: Causes damage to organs through prolonged or repeated exposure [H370]. See **Storage** below.

Note:

- Flash point will depend on the composition of the solution. Check supplier's information.
- WEL (mg m^{-3}): 2.5 (LTEL), 2.5 (STEL), as methanal

Storage

Storage code: **T** (Organic) [Colourless liquid, pungent odour]

- Methanal itself is a gas at room temperature but is supplied as an aqueous solution (~ 35-40 % w/w). The hazard information above refers to solutions ≥ 30 %.
- Solutions may also contain methanol as a stabiliser to minimise polymerisation. Methanol content varies by supplier, which may affect the hazard classification. Check supplier's information.
- Methanal is present as a dissolved gas and all solutions will have a noticeable vapour pressure at room temperature. Cautiously open containers in a fume cupboard.
- Securely store the solution in a reasonably large, well-ventilated area. Methanal is lachrymatory; in a small/poorly ventilated space, any escaping vapour is likely to irritate eyes and cause them to water.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills**: If more than 100 cm^3 of 40 % solution is spilt evacuate the laboratory. If safe to do so, open outside windows as you leave. After 3 hours it may be safe to re-enter to clear up the spill but do **not** put yourself at risk of exposure to this chemical. Contact CLEAPSS.

Methanal

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Methanal solutions ≥ 30 %	 DANGER (See reverse)	TT (Y12)	**Methanal is acutely toxic by inhalation**. It diffuses from solutions and, at concentrations ≥ 0.1 %, the WEL (STEL) will be approached in localised situations (eg, just above open containers/test tubes/preserved specimens). Inhalation of the vapour would act *at least* as a respiratory irritant. Take this into account in addition to the information below. It is advisable to include a warning to this effect on any labels used on prepared solutions. • Wear eye protection. Wear splash-proof goggles for corrosive solutions (i.e. ≥ 25 %). • Do **not** inhale vapour. Use a fume cupboard. Ensure laboratory is well-ventilated. • Wear gloves. Wash hands thoroughly after use. **Other notes; see detailed activity-specific guidance**: • **Biological specimens (TT):** Refer to detailed CLEAPSS guidance for any activity involving fixatives and preserving fluids. • **Resin preparation (Y12)**: Do **not** use methods involving hydrochloric acid. **Disposal**: W1/W2; W7 → 0.1 %, see note below
< 30 % & ≥ 25 %	 DANGER As below plus: Corrosive (skin, eyes)		
< 25 % & ≥ 0.2 %	 DANGER ≥ 15 %: Harmful (skin contact) ≥ 5 %: Harmful (ingestion) ≥ 5 %: Irritant (skin, eyes, respiratory). ≥ 1 %: Suspected of causing genetic defects. May cause an allergic skin reaction. May cause cancer		
< 0.2 % & ≥ 0.1 %	 DANGER May cause cancer		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W7**: Dilute to 0.1 % or lower (eg, 100 cm^3 of 4 % solution in a bucket, ~ 10 L, of water). Pour down a foul-water drain with more water. Use a fume cupboard sink.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Dibutyl phthalate	*dibutyl benzene-1,2-dicarboxylate*	$C_6H_4(COOC_4H_9)_2$ (278.34)
 DANGER	May damage the unborn child. Suspected of damaging fertility [H360Df]. Very toxic to aquatic life [H400]. WEL (mg m^{-3}): 5 (LTEL), 10 (STEL). **Avoid the use of dibutyl phthalate; see reverse of *Hazcard*.**	
Storage	Storage code: **T** (Organic)	[Colourless/pale-yellow oily liquid]

Methyl benzoate	*methyl benzenecarboxylate*	$C_6H_5COOCH_3$ (136.15)
Ethyl benzoate	*ethyl benzenecarboxylate*	$C_6H_5COOC_2H_5$ (150.17)
Phenyl benzoate	*phenyl benzenecarboxylate*	$C_6H_5COOC_6H_5$ (198.22)
 WARNING	**Methyl benzoate**: Harmful if swallowed [H302]. Some suppliers may also indicate: Causes skin irritation [H315] *and* Causes serious eye irritation [H319]. **Phenyl benzoate**: Harmful if swallowed [H302]. Causes skin irritation [H315]. Some suppliers may also indicate: May cause an allergic skin reaction [H317]. **Ethyl benzoate**: Classification/labelling vary. Some suppliers may indicate: Causes skin irritation [H315] and Causes serious eye irritation [H319]. Other suppliers may give no hazard classification.	
Ethyl cinnamate	*ethyl 3-phenylpropenoate*	$C_6H_5CH{=}CHCOOC_2H_5$ (176.21)
Methyl 3-nitrobenzoate		$NO_2C_6H_4COOCH_3$ (181.15)
Currently not classified as hazardous.		
Storage	Storage code: **GOrg** • Methyl benzoate, ethyl benzoate, ethyl cinnamate: colourless liquids with ‘fruity’ odours. • Phenyl benzoate, methyl 3-nitrobenzoate: white solids.	

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

Methyl benzoate & other esters

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Dibutyl phthalate	 DANGER (See reverse) **Avoid the use of dibutyl phthalate**	TT (Y12)	• Wear eye protection. • Take particular care to avoid skin. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Heating baths** (eg, melting point determination): Avoid the use of dibutyl phthalate. See *Hazcards* 37 and 45B for alternatives. **Disposal**: W1/W2
• Methyl benzoate • Ethyl benzoate • Phenyl benzoate	 WARNING (See reverse)	Y7	• Wear eye protection. • The odour from spills of the liquid esters can be very long-lasting. A lab coat is recommended. Also take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. • Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance**: • **Nitration reactions** (eg, of methyl or phenyl benzoate): see *Safer chemicals, safer reactions* (Guide L 195). **Disposal**: W2; see note below
• Ethyl cinnamate • Methyl 3-nitrobenzoate	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • Although the cinnamate, methyl 3-nitrobenzoate and other benzoates do not present significant hazards, they are insoluble in water. Keeping them for removal by a Registered Waste Carrier is sensible. Alternative disposal options may be possible, check activity-specific guidance.

65A Risk Assessment Guidance Nickel, nickel(II) carbonate, nickel(II) oxide

Nickel metal Ni (58.69)

DANGER

May cause an allergic skin reaction [H317]. Suspected of causing cancer [H350]. Causes damage to organs through prolonged or repeated exposure [H372]. Also (if particle size < 1 mm): Harmful to aquatic life with long lasting effects [H412].

Nickel-containing alloys (eg, coinage metals) are classified for skin sensitisation when the release rate of 0.5 µg of Ni/cm^2/week is exceeded (European Standard reference test method, EN1811).

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL), as nickel

Storage Storage code: **GIn** [Grey metal]

Nickel(II) carbonate (basic) $NiCO_3.2Ni(OH)_2.xH_2O$ (-)

Nickel(II) oxide NiO (74.69)

DANGER

carbonate

Nickel carbonate and oxide: May cause an allergic skin reaction [H317]. May cause cancer by inhalation [H350i]. Causes damage to organs through prolonged or repeated exposure (inhalation) [H372].

Nickel carbonate: Harmful if swallowed [H302]. Causes skin irritation [H315]. Harmful if inhaled [H332]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. Suspected of causing genetic defects [H340]. May damage the unborn child [H360D]. Very toxic to aquatic life with long lasting effects [H410].

Nickel oxide: May cause long lasting harmful effects to aquatic life [H413].

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL), Sk, Carc; as nickel (known human carcinogens)

Storage Storage code: **T** [Green solids]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills (solids)**: May be difficult to deal with to avoid raising dust. Contact CLEAPSS.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

65A Risk Assessment Guidance

Nickel, nickel(II) carbonate, nickel(II) oxide

Detailed guidance on specific activities and techniques involving these substances can be found: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Nickel metal	 DANGER (See reverse)	TT (Y12)	**Nickel metal (eg, foil, wire):** Risk of harm is low as the metal is used infrequently in school science and skin contact is short term. However, those with an allergic reaction to heavy metals (usually apparent from contact with jewellery or even money) should be alert to the risk and apply appropriate control measures. Check activity-specific guidance. **Nickel(II) compounds**: These are known human carcinogens and inhalation is a possibility if significant amounts of particulates become airborne. Although the risk of harm in school science activities is low (quantities used are small and potential exposure is infrequent), most procedures involving nickel(II) compounds can be carried out with *other* less hazardous materials. CLEAPSS would therefore advise against the use of nickel(II) compounds in routine science practical work. **If you think that there is no alternative to the use of nickel compounds, contact CLEAPSS to discuss the proposed activity.** **Disposal**: metal, W1 or W3 oxide/carbonate, W1
Nickel(II) carbonate	 DANGER (See reverse)		
Nickel(II) oxide	 DANGER (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

65B Risk Assessment Guidance — Nickel(II) salts

Nickel(II) chloride-6-water	$NiCl_2.6H_2O$ (237.69)
Nickel(II) nitrate(V)-6-water	$Ni(NO_3)_2.6H_2O$ (290.79)
Nickel(II) sulfate(VI)-6-water	$NiSO_4.6H_2O$ (262.85)
Nickel(II) sulfate(VI)-7-water	$NiSO_4.7H_2O$ (280.86)
Nickel(II) ammonium sulfate(VI)-6-water	$Ni(NH_4)_2(SO_4)_2.6H_2O$ (394.99)

chloride

nitrate

nitrate

nitrate, sulfates

DANGER

All: Causes skin irritation [H315], not nickel(II) ammonium sulfate. May cause an allergic skin reaction [H317]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. May cause genetic defects [H341]. May cause cancer by inhalation [H350i]. May damage the unborn child [H360D]. Causes damage to organs through prolonged or repeated exposure (inhalation) [H372]. Very toxic to aquatic life with long lasting effects [H410].

Nickel(II) chloride: Toxic if swallowed [H301]. Toxic if inhaled [H331].

Nickel(II) nitrate: May intensify fire; oxidiser [H272]. Causes serious eye damage [H318].

Nickel(II) nitrate/nickel(II) sulfate/ammonium nickel(II) sulfate: Harmful if swallowed [H302]. Harmful if inhaled [H332].

WEL (mg m^{-3}): 0.1 (LTEL), 0.3 (STEL), Sk, Carc; as nickel (known human carcinogens).

Storage	Storage code: **T**	[Green or blue-green solids]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **General spills (solids)**: May be difficult to deal with to avoid raising dust. Contact CLEAPSS.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

65B Risk Assessment Guidance

Nickel(II) salts

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Nickel(II) nitrate(V) -6-water	 DANGER (See reverse)	TT (Y12)	**Nickel(II) salts**: These are known human carcinogens and inhalation is a possibility if significant amounts of particulates become airborne. Although the risk of harm in school science activities is low (quantities used are small and potential exposure is infrequent), most procedures involving nickel(II) compounds can be carried out with *other* less hazardous materials. CLEAPSS would therefore advise against the use of nickel(II) compounds in routine science practical work. **Contact CLEAPSS for a Special Risk Assessment for any activity involving nickel(II) compounds.**
Nickel(II) salts except nitrate(V)	  sulfates  chloride DANGER (See reverse)		**Disposal**: W1 only

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Ninhydrin	*1,2,3-indanetrione hydrate, 2,2-dihydroxyindane-1,3-dione, indan-1,2,3-trione* $C_9H_6O_4$ (178.14)
 WARNING	Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: Contact with skin produces a violet stain that may persist for several days.
Storage	Storage code: **GOrg** [Off-white/pale yellow solid]

Ninhydrin sprays (commercially available)	
Note: Classification will depend on the formulation of the spray. Check information from supplier and also refer to the relevant *Hazcard*(s) for the solvents/other chemicals involved.	
Storage	If the spray is classified as flammable, store as FLAMMABLE LIQUID, **FL**.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

66 Risk Assessment Guidance

Ninhydrin

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Ninhydrin solid	 WARNING Harmful (ingestion) Irritant (skin, eyes)	TT	• Wear eye protection. Check supplier's information for purchased ninhydrin sprays and wear splash-proof goggles if the contents are corrosive to eyes. • Avoid skin contact. Ninhydrin produces a violet stain that may persist for several days. Wear disposable gloves. Use tweezers or tongs to handle chromatograms. **Other notes; see also detailed activity-specific guidance**: • **Preparing an aqueous solution of ninhydrin**: See *Recipe* 13. • **Using ninhydrin in chromatography activities**: See activity-specific guidance. Many activities involve the use of flammable and/or corrosive solvents for running (eluting) and developing and/or locating the chromatograms. Ovens/hot air dryers may be required. · Use a fume cupboard. · Ensure laboratory is well-ventilated (eg, open windows). · Ensure no ignition sources are present if using flammable solvents. **Disposal:** see below
Ninhydrin spray	See note on reverse	Y9	
Ninhydrin solution < 2 g per 100 cm^3 water	Currently not classified as hazardous	Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W7 (solid, aqueous solutions)**: Dissolve no more than 15 g of the solid in 1 litre of water. Rinse away down a foul-water drain with further dilution. • **Ninhydrin sprays, commercial**: **W1**, or **W8** if spray canister is empty. Note that some canisters are refillable; check supplier's information.

Nitric(V) acid HNO_3 (63.01)

DANGER

May intensify fire; oxidiser [H272]. Causes severe skin burns & eye damage [H314]. Corrosive to the respiratory tract [EUH071].

This substance (concentrated acid) is dangerous in contact with:

- COMBUSTIBLE MATERIALS including many ORGANIC substances (e.g. ETHANOIC ACID, ETHANOL, PROPANONE) and THIOCYANATES and THIOSULFATES. Violent reactions may occur. See **Other notes** on reverse**.**
- LITHIUM, SODIUM, POTASSIUM, MAGNESIUM. The metals can ignite on contact.

WEL (mg m^{-3}): 2.6 (STEL). See **Emergencies** information below (inhalation) and *Hazcard* 68B.

Storage

Storage code: **CLa** [Colourless liquid]

- The concentrated acid is usually supplied as a solution no greater than ~ 70% w/w (~ 15.8 M). Purchase the smallest quantity available and consider buying diluted acid if concentrated nitric acid is not required for practical activities.
- Do **not** store in direct sunlight; dark glass bottles/opaque containers are best. Light causes the acid to decompose (producing toxic nitrogen dioxide). If any yellow-brown colouration, decomposition has occurred; dispose of the acid.
- The acid and its fumes can degrade containers and labels. Regularly check their state and replace if affected. Stand plastic bottles in a glass container (eg, large beaker) to contain spills in case the plastic bottle splits.
- *Fuming* nitric(V) acid (> 95% w/w) should be made *in situ only* when required. Do **not** store. Contact CLEAPSS if bottles of *fuming* nitric acid are discovered. Do **not** attempt to dispose of the contents yourself.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE for the concentrated acid:

- **CORROSIVE (skin, eyes)**: **Continue irrigation and call 999**.
  Note (skin): Effective irrigation with cool water is essential. Skin turns yellow on contact with the acid and will peel off. If splashed area is correctly treated, peeling will be gradual over several days. If not, peeling may be severe and painful.
- **CORROSIVE, TOXIC (inhalation): Call 999.**
  Note (inhalation): Nitric acid readily forms a vapour (or mist) in air at room temperature and may also react or decompose to produce gaseous nitrogen oxides (very toxic, see *Hazcard* 68B).
- **General spills/clearing up**: Keep others away. In addition to gloves and splash-proof goggles, rubber boots may be needed if spill is large. Ventilate spill area if safe to do so. Evacuate if vapour is detected. Cover spill with absorbent and clear up into a bucket for treatment (use sodium carbonate) and careful disposal. Thoroughly wash spill area.

67 Risk Assessment Guidance

Nitric(V) acid, HNO_3

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Concentrated acid and solutions ≥ 10 M	 DANGER Corrosive (skin, eyes, respiratory). Oxidiser.	TT (Y9)	• Wear splash-proof goggles. Protect the face when transferring or dispensing large volumes. • Wear gloves for solutions at or above 3 M. Take particular care to avoid skin contact. See also activity-specific guidance and/or GL 120. • Avoid inhaling vapour. Use a fume cupboard for the concentrated acid and for lower concentrations if required (e.g. if NO_x fumes are produced). **Other notes; see also detailed activity-specific guidance:** • Etching solutions: Mixtures of ethanol and nitric acid (*nital*) are **not** safe. **Disposal**: W7 → 0.1 M; or W4. For concentrated acid, see Wspec below
Solutions: < 10 M and ≥ 0.8 M	 DANGER Corrosive (skin, eyes)		
< 0.8 M and ≥ 0.1 M	 WARNING Irritant (skin, eyes)	Y7	• Wear eye protection even when dilute solutions are used. **Other notes; see also detailed activity-specific guidance:** • 0.4 M (or lower) solutions will be adequate for most pre-16 activities. If choice of acid is not critical, hydrochloric acid is often a safer alternative. Be aware that nitric acid (even in dilute solution) does not behave in a similar manner to other strong acids and may produce NO_x fumes. **Disposal**: W7 → 0.1 M; or W4
< 0.1 M	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> of concentrated acid:** • **WSpec**: Wear splash-proof goggles and chemical-resistant gloves. Use a fume cupboard. Add no more than 50 cm^3 in small portions (~ 10 cm^3) to at least 800 cm^3 of 1 M sodium carbonate solution. Stir and allow cooling between additions. Check solution is *just* alkaline and then pour down a foul-water drain. • Do **NOT** dispose of concentrated nitric acid into other waste containers (e.g. organic waste containers). • Do **NOT** follow the above disposal method for large volumes of *fuming* nitric acid, contact CLEAPSS.

68A Risk Assessment Guidance

Nitrogen, N_2(g) and N_2(l)

Nitrogen (gas)

N_2 (28.01)

WARNING

If gas cylinder, will be: Contains gas under pressure; may explode if heated [H280] with the GHS 04 pictogram.

The gas itself is currently not classified as hazardous but note it is an asphyxiant (lowering the relative oxygen content of air). This should not pose a problem in a well-ventilated area.

Storage

Storage code: **Cyl**; or **Situ** (see **Other notes** on reverse) [Colourless, odourless gas]

- **Cyl**: Refillable cylinders can be hired. See *Gas cylinders* for detailed guidance on pressurised gas containers.
  - Ensure the location of all pressurised gas cylinders/canisters is recorded and known to the site manager.
  - **Cylinder (refillable)**: These can be hired. When fitted with a regulator (a single-stage one should be satisfactory for most purposes), the cylinder is considered as ‘being held ready for use’ (rather than ‘stored’). Keep cylinder upright (chained or clamped) and in a cool, well-ventilated area but **not** in the same place where flammables or radioactive materials are stored. Carry out a visual check of the apparatus whenever it is used. Check & follow up-to-date guidance on maintenance.
  - **Canister (non-refillable)**: Store canister on its side (with the mini flow valve/regulator removed) in a suitable container (to stop it rolling), on the shelf of a secure chemical store (**not** in the flammable liquids cupboard).

Nitrogen (liquid)

N_2 (28.01)

Liquid nitrogen is not currently classified as hazardous but it can cause serious frostbite. The use of liquid nitrogen requires specialist knowledge and care. It is essential that the detailed advice regarding the use, storage and transport of liquid nitrogen is read and strictly adhered to.

See *Cryogenics*. This guidance also covers action in the event of an emergency; a few selected points are given below but check details BEFORE obtaining/using liquid nitrogen. See also *Bulletin* 151 (Autumn 2014).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). See also *Cryogenics*; key points include:

- **Minor exposures (frost burn)**: Place affected area in, or flush affected area with, **tepid** water. **Call 999**.
- **Spills**: If a spill occurs in a confined or poorly-ventilated space, evacuate and allow liquid to disperse.

68A Risk Assessment Guidance — Nitrogen, $N_2(g)$ and $N_2(l)$

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Nitrogen (gas)	Currently not classified as hazardous. Nitrogen gas is an asphyxiant. If gas cylinder:  WARNING (See reverse)	TT (Y12)	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **Using nitrogen cylinders/canisters (TT):** See *Gas cylinders*. • **Preparation of N_2 gas (Y12):** See *Recipe* 42. **Disposal**: W6 (gas); see also note below
Nitrogen (liquid)	Currently not classified as hazardous. Nitrogen gas is an asphyxiant. Liquid nitrogen can cause serious frostbite.	TT	**The use of liquid nitrogen requires specialist knowledge and care. It is essential that the detailed advice regarding the use, storage and transport of liquid nitrogen is read and strictly adhered to.** **See *Cryogenics*. This guidance also covers action in the event of an emergency. Check details BEFORE obtaining/using liquid nitrogen.** **See also *Bulletin* 151 (Autumn 2014) for additional information.**

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE**: • Canisters (non-refillable): it may be possible to dispose of empty canisters into the normal waste or at some local waste recycling centres. The used canister needs to be punctured to make it safe for disposal; a tool to do this safely is available from suppliers. Check supplier's information.

68B Risk Assessment Guidance — Nitrogen oxides

Nitrogen monoxide and nitrogen dioxide are very toxic gases with serious effects on the respiratory system; adverse health effects may be apparent even at very low levels. Do NOT expose asthmatics to any of these gases.
Use an efficiently-working fume cupboard when preparing or using the gases.

Dinitrogen monoxide	*nitrous oxide, laughing gas*	N_2O (44.01)
Nitrogen monoxide	*nitric oxide*	NO (30.01)
Nitrogen dioxide	*nitrogen peroxide*	NO_2 (46.01)
Dinitrogen tetroxide		N_2O_4 (92.01)

DANGER

ALL: May cause or intensify fire; oxidiser [H270].

Nitrogen monoxide, nitrogen dioxide, dinitrogen tetroxide: Causes severe skin burns and eye damage [H314]. Fatal if inhaled [H330]. May cause respiratory irritation [H335]. Nitrogen monoxide: Corrosive to the respiratory tract [EUH071].

Nitrogen monoxide is dangerous in contact with:

- CARBON DISULFIDE. An explosive reaction can occur.

Nitrogen dioxide and dinitrogen tetroxide are dangerous in contact with:

- FINELY-DIVIDED METALS (eg, IRON, MAGNESIUM). These may ignite.
- HYDROGEN. This gas will ignite spontaneously when air is also present.

WEL (mg m^{-3}): 183 (LTEL), 549 (STEL), dinitrogen monoxide
2 (LTEL), 2.5 (STEL), nitrogen monoxide; 0.96 (LTEL), 1.91 (STEL), nitrogen dioxide

Storage

Storage code: **Situ**. Do **NOT** use cylinders, canisters or capsules.

- Dinitrogen monoxide (nitrous oxide), nitrogen monoxide (nitric oxide): colourless gases.
- Nitrogen dioxide (brown gas) exists in equilibrium with dinitrogen tetroxide (colourless liquid).

Emergencies

Follow standard procedures (see Emergency *Hazcards* and GL 120). NOTE:

- **GAS RELEASE (eg, fume cupboard fails, concentrated nitric acid spill):** Evacuate the immediate area.
- **TOXIC, CORROSIVE (inhalation). BEWARE DELAYED EFFECTS.**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

68B Risk Assessment Guidance — Nitrogen oxides

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Dinitrogen monoxide (*nitrous oxide*)	 DANGER (See reverse)	TT (Y12)	**BEWARE DELAYED EFFECTS** **Effects of exposure by inhalation may or may not be immediately apparent and can develop and/or increase over time.** **Inhalation by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions.** **If affected at any time, call the emergency services, informing them of the quantity of gas involved.** • Prepare and use in an efficiently-working fume cupboard. • Do **not** inhale these gases. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparation of nitrogen oxide gases (TT/Y12)**: Use a fume cupboard. See *Recipe 42* and also *Gas preparation*. • **Diffusion of gases demonstration (TT)**: See *Safer chemicals, safer reactions* for an alternative to the use of liquid bromine. **Disposal**: W6 in a fume cupboard
• Nitrogen monoxide (*nitric oxide*) • Nitrogen dioxide (*nitrogen peroxide*) • Dinitrogen tetroxide	 DANGER (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

69 Risk Assessment Guidance

Oxygen, $O_2(g)$

Oxygen O_2 (31.99)

DANGER

May cause or intensify fire; oxidiser [H270].

If gas cylinder, will also be: Contains gas under pressure; may explode if heated [H280].

Oxygen gas is dangerous in contact with:

- COMBUSTIBLE MATERIALS. These will burn more fiercely in an atmosphere of oxygen.
- CONCENTRATED AMMONIA SOLUTION. Explosions can occur.

- Combustible materials burn much more fiercely in even slightly oxygen-enriched air. This is unlikely to be a risk in schools, even if a cylinder leak occurs, but all science staff should be aware of the possibility.
- **Never** oil/grease gas cylinder valves/fittings. Under pressure, hydrocarbon/oxygen mixtures can cause explosions.
- Liquid oxygen is particularly dangerous to work with and is **NOT** recommended for use in schools.

Storage

Storage code: **Cyl;** or **Situ** (see **Other notes** on reverse) [Colourless, odourless gas]

- **Cyl**: Refillable cylinders can be hired. Non-refillable canisters containing oxygen (100 % oxygen) are currently not available to purchase. See *Gas cylinders* for detailed guidance on pressurised gas containers.
  - Ensure the location of all pressurised gas cylinders/canisters is recorded and known to the site manager.
  - **Cylinder (refillable)**: When fitted with a regulator (a single-stage one should be satisfactory for most purposes), the cylinder is considered as ‘being held ready for use’ (rather than ‘stored’). Keep cylinder upright (chained or clamped) and in a cool, well-ventilated area but **not** in the same place where flammables or radioactives are stored. Carry out a visual check of the apparatus whenever it is used. Check and follow up-to-date guidance on maintenance.
  - **Canister (non-refillable)**: One or more may be present in the department (if purchased some time ago). Store canister on its side (with the mini flow valve/regulator removed) in a suitable container (to stop it rolling), on the shelf of a secure chemical store (**not** in the flammable liquids cupboard).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **If oxygen gas is directed over a person (eg, so clothing becomes impregnated)**: Immediately extinguish all sources of ignition. Go outside for several minutes to allow the gas to diffuse from clothing.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

69 Risk Assessment Guidance

Oxygen, $O_2(g)$

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Oxygen gas	 DANGER Oxidising gas If gas cylinder:  WARNING (See reverse)	TT (Y7)	• Wear eye protection. • Splash-proof goggles and face protection will be needed for some activities involving oxygen gas. Check activity-specific guidance. • Work in a well-ventilated area. **Other notes; see also detailed activity-specific guidance**: • **Preparation of oxygen gas (large-scale; TT):** See *Recipe* 64 • **Making/testing of oxygen gas (small-scale; student)**: Wear eye protection. Various methods are possible using hydrogen peroxide solutions (≤ 20 'vol') with manganese(IV) oxide or potassium iodide as the catalyst. · Problems sometimes occur (i.e. little or no oxygen is evolved) if the dilute hydrogen peroxide solution has already decomposed (see *Recipe* 45). · Some supplies of manganese(IV) oxide have failed to catalyse the decomposition of hydrogen peroxide into oxygen gas and water. If this happens, contact your supplier and ask for a replacement. • Do **NOT** use so-called '*oxygen mixture*' (potassium chlorate(V) & manganese(IV) oxide) to prepare oxygen gas on any scale. • **Hydrogen/oxygen gas explosions (demonstrations; TT):** See *Hazcard* 48. **Disposal**: W6 (gas); see note below

Oxygen gas canisters (non-refillable)

There have been problems with the manufacture of canisters/canister valves due to the oxidising properties of oxygen.

Refillable cylinders (various sizes) are available on a rental basis.

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE**: • Canisters (non-refillable): it may be possible to dispose of empty canisters into the normal waste or at some local waste recycling centres. The used canister needs to be punctured to make it safe for disposal; a tool to do this safely is available from suppliers. Check supplier's information.

70A Risk Assessment Guidance (see also **70B**) **Phenols (1)**

Phenol	*hydroxybenzene, carbolic acid* C_6H_5OH (94.11)
   DANGER	Toxic if swallowed [H301]. Toxic in contact with skin [H311]. Toxic if inhaled [H331]. Causes severe skin burns and eye damage [H314]. Suspected of causing genetic defects [H341]. May cause damage to organs through prolonged or repeated exposure [H373]. **Phenol is dangerous in contact with**: • SODIUM NITRATE(III). An explosive mixture is formed. WEL (mg m^{-3}): 7.8 (LTEL), 16 (STEL), Sk

2-, 3-, or 4-methylphenol	*o-, m- or p-cresol* $CH_3C_6H_5OH$ (108.14)
  DANGER	Toxic if swallowed [H301]. Toxic in contact with skin [H311]. Causes severe skin burns and eye damage [H314].

2,4,6-trinitrophenol	*picric acid* $(NO_2)_3C_6H_5OH$ (229.11)
  DANGER	Explosive; mass explosion hazard [H201]. Toxic if swallowed [H301]. Toxic in contact with skin [H311]. Toxic if inhaled [H331]. WEL (mg m^{-3}): 0.1 (LTEL), 0.3 (STEL). **The use of this explosive chemical is NOT recommended in schools.** **It is sensitive to shock, friction and heat. Contact CLEAPSS if you find any in the store.**

Storage	Storage code: **T** (Organic) [Characteristic 'carbolic' or 'tar-like' odour] • Phenol is a white solid that absorbs moisture (i.e. is hygroscopic) and turns pinkish when exposed to air. The slightly coloured solid should still perform as expected for most activities. • *o*-cresol and *p*-cresol are colourless-yellowish solids. *m*-cresol is a colourless-yellowish liquid.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE, TOXIC (skin, eyes, ingestion, inhalation). Be aware that phenol burns are very serious.** Promptly brush solids off skin and/or remove contaminated clothing but do **not** delay irrigation. Use copious amounts of cool water (small amounts may increase absorption).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

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70A Risk Assessment Guidance (see also **70B**) **Phenols (1)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solids • Phenol • Cresols	 phenol DANGER (See reverse)	Y12	• Wear splash-proof goggles. • Wear gloves. • Wearing a laboratory coat (or similar) is recommended. • Ensure laboratory is well ventilated. **Other notes; see also detailed activity-specific guidance**: • **Using phenol**: Crystals absorb moisture from air and become ‘sticky’ (phenol is hygroscopic *and* deliquescent); they can be difficult to get out of the container. Contact with the solid is likely so gloves are essential. For student use, it is sensible to provide phenol ‘crystals’ in small containers with lids. Plastic tweezers or forceps can be used to manipulate crystals. • **Reactions of phenol and cresols**: Methyl 4-hydroxybenzoate may be used as an alternative for some reactions. See *Safer chemicals, safer reactions* and *Hazcard* 52. • **Solubility of phenol and cresols**: Phenol solutions are saturated at about 0.8 M. Cresols are not very soluble in water (~ 2 g per 100 cm^3 of water at room temperature). **Disposal**: W4, see note below
Phenol solutions < 0.5 M and ≥ 0.3 M	 DANGER Corrosive (skin, eyes). Serious health hazard (CMR) Harmful (ingestion), ≥ 0.5 M		
Phenol solutions < 0.3 M and ≥ 0.1 M	 WARNING Irritant (skin, eyes). Serious health hazard (CMR)		
Cresol solutions	Currently not classified as hazardous. See **Other notes**.		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W4**: Add no more than 1 g to 100 cm^3 of 1 M sodium carbonate solution. Flush down a foul-water drain.

70B Risk Assessment Guidance (see also **70A**) **Phenols (2)**

Naphthalen-1-ol *1-naphthol, α-naphthol* $C_{10}H_7OH$ (144.17)

DANGER

Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Causes skin irritation [H315]. Causes serious eye damage [H318]. May cause respiratory irritation [H335].

Naphthalen-2-ol *2-naphthol, β-naphthol* $C_{10}H_7OH$ (144.17)

WARNING

Harmful if swallowed [H302]. Harmful if inhaled [H332].
Very toxic to aquatic life [H400].

4-aminophenol *p-aminophenol* $H_2NC_6H_4OH$ (109.13)

WARNING

Harmful if swallowed [H302]. Harmful if inhaled [H332].

Suspected of causing genetic defects [H341].

Very toxic to aquatic life with long lasting effects [H400/H410].

Storage

Storage code: **GOrg**

- 4-aminophenol is a colourless solid.
- 1-naphthol and 2-naphthol are colourless / white solids. Samples obtained before 1990 should be disposed of as they may contain toxic impurities.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes):** Naphthalen-1-ol.

70B Risk Assessment Guidance (see also **70A**) **Phenols (2)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**

Naphthalen-1-ol	
	DANGER (See reverse)
		Y12	- Wear eye protection.
			- Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120.
			Other notes; see also detailed activity-specific guidance:
			- **These substances are dangerous in contact with:**
			  - OXIDISING AGENTS. Dangerous reactions may occur.
			  - HEAT. Decomposition occurs; toxic/irritant gases or vapours are produced. Explosive mixtures may form with air (naphthols).
			- **Diazotisation/preparation of azo dyes**: See *Safer chemicals, safer reactions* for a small-scale method.
			Disposal: naphthols, W1/W2 only
			4-aminophenol, W4 or W5

Naphthalen-2-ol	 WARNING (See reverse)		
4-aminophenol	 WARNING (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Phenylethene, phenylethyne and polymers

Phenylethene	*styrene*	$C_6H_5CHCH_2$ (104.15)
Phenylethyne	*phenylacetylene*	C_6H_5CCH (102.133)

DANGER

Phenylethene: Flammable liquid and vapour [H226]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. Harmful if inhaled [H332]. Suspected of damaging the unborn child [H361d]. Causes damage to organs (hearing) through prolonged or repeated exposure [H372].

Phenylethyne: Flammable liquid and vapour [H226]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. May be fatal if swallowed and enters the airways [H304].

Phenylethene (styrene) is dangerous in contact with:

- AIR. Vapour/air mixtures are explosive.

	WEL (mg m^{-3})	Flashpoint (^{o}C)
Phenylethene (styrene)	430 (LTEL), 1080 (STEL)	32
Phenylethyne	–	27

Storage

Storage code: **FL** (Organic) [Colourless, oily or viscous liquids, sweet to unpleasant odours]

- **Styrene**: Although supplied with a stabiliser, it polymerises during storage over the years. The liquid gradually becomes more viscous and then solidifies into a resin. Check regularly.

Poly(phenylethene) / polystyrene; other plastics; ion exchange resins

Currently not classified as hazardous.

Note: Some ion exchange resins are classified as eye irritants. Check supplier information.

Storage

Storage code: **GOrg**

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120).

71 Risk Assessment Guidance — Phenylethene, phenylethyne and polymers

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• Phenylethene • Phenylethyne	 DANGER (See reverse)	Y12	• Wear eye protection. • Use a fume cupboard for transferring or dispensing. • Ensure laboratory is well-ventilated. Avoid inhaling vapours. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Using phenylethene (styrene)**: It is usually necessary to first remove the inhibitor. See activity-specific guidance for this procedure and for the polymerisation of styrene using an initiator. **Disposal**: W2, but see note below
• Plastics/polymers • Ion exchange resins	See reverse.	Y7	• Eye protection and/or other control measures may be advised for some procedures. Check activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Ion exchange resins**: The tiny beads present a slip hazard if spilt. Do **not** put ion exchange resins down the sink. • **Using or testing plastics/polymers**: Activities involving heat may produce toxic gases. See also CLEAPSS Design & Technology, *Model Risk Assessments* for *Resistant Materials*. **Disposal**: W8

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • **Phenylethene (styrene):** If solidified, the resin can be disposed of as **W8**.

Phosphoric(V) acid and its salts

Phosphoric(V) acid	*orthophosphoric acid*	H_3PO_4 (97.99)
 DANGER	Causes severe skin burns and eye damage [H314]. **Phosphoric acid (concentrated) is dangerous in contact with**: • WATER. Always add acid *to* water with caution. • HYDROCHLORIC ACID (concentrated), CHLORIDES. Hydrogen chloride gas is given off. • CHLORATES, MANGANATE(VII) compounds. Spontaneously explosive products form. • SODIUM, POTASSIUM and many other metals. Dangerous reactions can occur. WEL (mg m^{-3}): 1.0 (LTEL), 2.0 (STEL)	
Storage	Storage code: **CLa** • Usually sold as an 85% (w/w) solution. Other concentrations are available.	[Colourless, syrupy liquid]

Potassium phosphate(V)	*tripotassium orthophosphate*	K_3PO_4 (212.27)
Sodium phosphate(V)-12-water	*sodium orthophosphate dodecahydrate*	$Na_3PO_4.12H_2O$ (380.12)
 WARNING	Causes skin irritation [H315]. Causes serious eye irritation [H319].	

Ammonium dihydrogenphosphate(V), $NH_4H_2PO_4$
Ammonium phosphate(V)-3-water, $(NH_4)_3PO_4.3H_2O$
Ammonium sodium hydrogenphosphate(V), *microcosmic salt*, NH_4NaHPO_4
Diammonium hydrogenphosphate(V), $(NH_4)_2HPO_4$
Calcium phosphate(V), *calcium orthophosphate*, $Ca_3(PO_4)_2$
Calcium dihydrogenphosphate(V)-2-water, $Ca(H_2PO_4)_2.2H_2O$
Potassium dihydrogenphosphate(V), KH_2PO_4
Dipotassium hydrogenphosphate(V), K_2HPO_4
Dipotassium hydrogenphosphate(V)-3-water, $K_2HPO_4.3H_2O$
Sodium dihydrogenphosphate(V)-2-water, $NaH_2PO_4.2H_2O$
Disodium hydrogenphosphate(V), *disodium hydrogen orthophosphate*, Na_2HPO_4
Disodium hydrogenphosphate(V)-7-water, $Na_2HPO_4.7H_2O$
Disodium hydrogenphosphate(V)-12-water, $Na_2HPO_4.12H_2O$
Adenosinetriphosphate (ATP)-disodium (or dipotassium) salt

Currently not classified as hazardous.

Storage	Storage code: **GIn**	[White/colourless crystalline solids/powders]
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**	

Phosphoric(V) acid and its salts

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Concentrated acid and solutions ≥ 2.6 M	 DANGER Corrosive (skin, eyes)	TT (Y9)	• Wear splash-proof goggles. Protect the face when transferring or dispensing large volumes. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL120. **Other notes; see also detailed activity-specific guidance**: • **Preparation of solutions**: See *Recipe* 65. **Disposal**: W7 → 0.1 M; or W4
Solutions: < 2.6 M and ≥ 1.0 M	 WARNING Irritant (skin, eyes)	Y7	• Wear eye protection even when dilute solutions are used. **Other notes; see also detailed activity-specific guidance**: • **Preparation of buffer solutions**: See *Recipe* 18. Buffer solutions between pH 2-10 make use of various phosphate salts. **Disposal**: W7 → 0.1 M; or W4. See note below.
Solutions < 1.0 M	Currently not classified as hazardous.		
Phosphate salt solutions			

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE (for phosphate salts)**: • **W7** except calcium phosphate(V) which is **W8**.

73A Risk Assessment Guidance — Phosphorus, P (white, yellow)

The Explosives Regulations prohibit the making of mixtures of sulfur and/or phosphorus with potassium chlorate(V), or other chlorates, without the prior approval of the Health and Safety Executive (HSE).

White phosphorus *yellow phosphorus* P (30.97)

DANGER

Catches fire spontaneously if exposed to air [H250]. Fatal if swallowed [H300]. Causes severe skin burns and eye damage [H314]. Fatal if inhaled [H330]. Very toxic to aquatic life [H400].

White phosphorus is dangerous in contact with:

- OXIDISING AGENTS, particularly CHLORATES and METAL OXIDES. Explosive mixtures form.
- AIR, HEAT. Ignites in air at 34 °C. Emits toxic fumes.

WEL (mg m^{-3}): 0.1 (LTEL), 0.3 (STEL)

Storage

Storage code: **Spec**. See notes below and on reverse. [White/yellow ‘waxy’ solid, garlic-like odour]

- White phosphorus is not currently available from suppliers but some may already be in the store.
- Store with TOXIC chemicals. Keep away from sodium, potassium and oxidising agents.
- Keep solid **under water** in a transparent, glass, screw-top bottle. Check water level once a term to ensure it completely covers the phosphorus pieces. Refresh the water every year but keep the solid immersed in water (see notes on reverse for a safe procedure for doing this).
- Do **not** store white phosphorus in an outside store; freezing/expansion of the water may cause bottle to break. Add 2 spatula measures of salt (sodium chloride) to the water to minimise this risk.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **VERY TOXIC, CORROSIVE (ingestion, inhalation, skin, eyes). Call 999**.
  (If possible/safe to do so: use tongs to transfer visible pieces into a container of water but **DO NOT** delay or reduce irrigation.)
- **If solid catches fire**: Cover with sand and then add water. Collect large pieces (use tongs/tweezers) into a water-filled container. Destroy small pieces by (a) burning in an efficiently-operating fume cupboard or (b) by treating with copper(II) sulfate(VI) solution (~ 0.2 M - 0.5 M).
- **General spills (eg, bench, floor)**: Cover spill area in copper(II) sulfate(VI) solution (~ 0.2 M - 0.5 M). Leave for 15 minutes. The area turns black where there is phosphorus contamination.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

73A Risk Assessment Guidance

Phosphorus, P (white, yellow)

The Explosives Regulations prohibit the making of mixtures of sulfur and/or phosphorus with potassium chlorate(V), or other chlorates, without the prior approval of the Health and Safety Executive (HSE).

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Phosphorus (white/yellow)	 DANGER (See reverse)	TT	• Wear splash-proof goggles. • Wear gloves. Manipulate the solid using tongs or forceps. • Protect the face and wear a lab coat when cutting the solid. • White phosphorus ignites spontaneously in air so keep all pieces under water until ready to carry out the required activity. **Other notes; see also detailed activity-specific guidance**: • **Refreshing the storage water in containers of white phosphorus**: Do **not** empty out the existing water and then refill. Instead, gently flush through with tap water (cold). Ensure that the water level remains above the solid so that the phosphorus pieces do **not** become exposed to the air. • **Cutting white phosphorus**: Do **not** do this on your own, work with an experienced colleague. Seek detailed guidance/training **before** attempting this procedure for the first time (contact CLEAPSS if necessary). White phosphorus is a hard solid and is very difficult to cut. The cutting process is always carried out with the solid immersed in water (to prevent ignition) in a deep **plastic** bowl (**never** use a glass bowl). **Disposal:** W1, but see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • Contact CLEAPSS before disposing of any stock of white phosphorus.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

73B Risk Assessment Guidance — Phosphorus, P (red)

The Explosives Regulations prohibit the making of mixtures of sulfur and/or phosphorus with potassium chlorate(V), or other chlorates, without the prior approval of the Health and Safety Executive (HSE).

Red phosphorus	P (30.97)
 DANGER	Flammable solid [H228]. Harmful to aquatic life with long lasting effects [H412]. **Red phosphorus is dangerous in contact with**: • OXIDISING AGENTS, particularly CHLORATES and METAL OXIDES. Both produce explosive mixtures.
Storage	Storage code: **FS** [Dark-red, powdery solid] • Do **not** store with flammable liquids (FL). Red phosphorus can be kept on shelves in a secure store with GIn, or in a secure cupboard but do **not** keep it next to oxidisers (Ox). Keep containers tightly closed. • Wear gloves and splash-proof goggles and carefully open containers in an efficiently-working fume cupboard; the odour from the bottle can sometimes be quite unpleasant. There may be some liquid on the surface of the solid in old bottles; this is phosphoric acid (formed by the reaction of phosphorus with moist air). In this state, it is advisable to dispose of the entire red phosphorus sample via a registered waste contractor, W1.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

73B Risk Assessment Guidance **Phosphorus, P (red)**

The Explosives Regulations prohibit the making of mixtures of sulfur and/or phosphorus with potassium chlorate(V), or other chlorates, without the prior approval of the Health and Safety Executive (HSE).

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Phosphorus (red)	 DANGER (See reverse)	TT (Y12)	• Wear eye protection. • Carefully open containers in a fume cupboard. • Avoid raising dust. **Other notes; see also detailed activity-specific guidance:** • **Finding % oxygen in air (TT demo)**: See *Burning phosphorus in air*. **Disposal:** W1, W6; see notes below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE**: • **W1 (decomposed/unwanted stock)**: If there is evidence that the solid has reacted with water vapour (see front of *Hazcard*), dispose of the container and contents via a registered waste contractor. • **W6 (small, ~ 1 g or less, quantities)**: Use a fume cupboard. Place the sample of red phosphorus in a small metal crucible firmly supported on a tripod (see also *Make-it guide - bottle top crucibles*). Direct a small Bunsen (or kitchen blowtorch) flame onto the top of the solid sample to ignite the phosphorus. The solid should continue to burn with no further heating. Once cool, place crucible and contents into a $250\ \text{cm}^3$ beaker of water and leave overnight. Flush the resulting dilute phosphoric acid solution (~ 0.1 M) down a foul-water drain with further dilution.

73C Risk Assessment Guidance — Arsenic and antimony (& compounds)

Arsenic	As (74.92)
 DANGER	Toxic if swallowed or if inhaled [H301, H331]. Very toxic to aquatic life with long lasting effects [H410]. WEL (mg m^{-3}): 0.1 (LTEL), 0.3 (STEL), Carc **Arsenic and its compounds are NOT suitable for school use. An exhibition sample of the element may be kept in a sealed container.**
Storage	Storage code: **T** [Grey-metallic solid]

Antimony(III) chloride *antimony trichloride*	$SbCl_3$ (228.12)
 DANGER	Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335]. Toxic to aquatic life with long lasting effects [H411]. **See notes on reverse on this card**. WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); as antimony (Sb)
Storage	Storage code: **CW** [Colourless solid, absorbs moisture (i.e. hygroscopic)]

Antimony	Sb (121.76)
 WARNING	Information about antimony varies. Suppliers may indicate one or more of: Harmful if swallowed and if inhaled [H302, H332]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Suspected of causing cancer [H351] and Harmful to aquatic life with long lasting effects [H412]. See **Other notes** (on reverse). WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); as antimony (Sb)
Storage	Storage code: **GIn** [Grey-metallic solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (skin, eyes):** antimony(III) chloride.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

73C Risk Assessment Guidance — Arsenic and antimony (& compounds)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Arsenic	 DANGER (See reverse)	TT	**Arsenic and its compounds are NOT suitable for school use. An exhibition sample of the element may be kept in a closed container.** **If it is essential to transfer or manipulate an existing sample, contact CLEAPSS.** **Disposal**: W1
Antimony chloride	 DANGER (See reverse)	TT	• Wear eye protection. Wear splash-proof goggles with antimony(III) chloride. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Antimony and antimony(III) chloride:** The use of antimony and its compounds is **not** recommended for school use. The chloride decomposes on heating to form hydrogen chloride gas (toxic, corrosive). The chloride also reacts with water (hydrolyses) to form a strongly acidic solution. **Disposal**: W1 or see activity-specific guidance
Antimony	 WARNING (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

73D Risk Assessment Guidance

Bismuth and its compounds

Bismuth		Bi (208.98)
Currently not classified as hazardous.		
Storage	Storage code: **GIn**	[Soft, grey-white, metallic solid]

Bismuth(III) chloride	*bismuth trichloride*	$BiCl_3$ (315.34)
Bismuth(III) chloride oxide	*bismuth oxychloride*	BiOCl (260.43)
WARNING	Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: Some suppliers may indicate that bismuth(III) chloride is corrosive rather than irritant. The solid is hygroscopic (absorbs moisture) and reacts with water to form strongly acidic solutions.	
Storage	Storage code: **GIn**	[White or off-white solids]

Bismuth(III) nitrate(V)		$Bi(NO_3)_3$ (394.99)
Bismuth(III) nitrate(V)-5-water	*bismuth(III) nitrate(V) pentahydrate*	$Bi(NO_3)_3.5H_2O$ (485.07)
DANGER	May intensify fire; oxidiser [H272]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: Classification and labelling vary. Some suppliers indicate that the nitrate(V) salts are corrosive rather than irritant. Some may also indicate Toxic to aquatic life with long lasting effects [H411].	
Storage	Storage code: **Ox**	[Colourless-white solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (eyes):** Chloride or nitrate(V) salts.

73D Risk Assessment Guidance — **Bismuth and its compounds**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Bismuth	Currently not classified as hazardous	Y7	• Eye protection and/or other control measures may be advised for some procedures. Check activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Investigating alloys**: *Field's metal* is a safer alternative to *Wood's* metal, as it contains no lead or cadmium. *Field's metal* is a mixture of bismuth, indium and tin and melts at 61 °C. *Wood's metal* is an alloy of bismuth, tin, lead and cadmium (melting point ~ 65 °C). **Disposal**: see below
Bismuth(III) chloride and oxychloride	 WARNING (See reverse)	Y9	• Wear eye protection. Wear splash-proof goggles with corrosive solutions. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Bismuth nitrate(V) solutions**: See *Recipe* 14. Solutions are prepared with dilute nitric acid to prevent the formation of insoluble basic salts. **Disposal**: see below
Bismuth(III) nitrate(V) solid	 DANGER (See reverse)	TT (Y9)	
Bismuth(III) nitrate(V) solution: 0.1 M in nitric acid	 DANGER Corrosive (skin, eyes)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • Unwanted stock/solids: **W1/W2** • For residues from practical work, check activity-specific guidance.

Phosphorus chlorides

Phosphorus(III) chloride	*phosphorus trichloride*	PCl_3 (137.33)
Phosphorus(V) chloride	*phosphorus pentachloride*	PCl_5 (208.24)

DANGER

Both: Reacts violently with water [EUH014]. Contact with water liberates toxic gas [EUH029]. Causes severe skin burns and eye damage [H314]. Fatal if inhaled [H330]. May cause damage to organs through prolonged or repeated exposure [H373].

Phosphorus(III) chloride: Fatal if swallowed [H300]. **Phosphorus(V) chloride**: Harmful if swallowed [H302].

Phosphorus chlorides are dangerous in contact with many reagents including:

- WATER. Violent reactions occur, emitting hydrogen chloride.
- SODIUM, POTASSIUM. Violent or explosive reactions occur.

WEL (mg m^{-3}): 1.1 (LTEL), 2.9 (STEL), phosphorus(III) chloride; 0.87 (LTEL), 2.0 (STEL), phosphorus(V) chloride.

Storage

Storage code: **CW**

- **Phosphorus(III) chloride**: colourless liquid, pungent odour, fumes in air.
- **Phosphorus(V) chloride**: white-yellow solid.
- Both chemicals are moisture-sensitive and pressure may build up in the bottle due to the reaction with water vapour in the atmosphere (hydrogen chloride is formed). Keep bottle inside another container that also contains soda lime. Open bottle with caution in an efficiently-working fume cupboard.
- Hydrogen chloride fumes can leak into the store and accelerate the corrosion of metals. The fumes may also cause white deposits (usually ammonium chloride) on other bottles in the store.
- Purchase small quantities only as needed. Regularly check condition of bottle tops; replace if required.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **VERY TOXIC, CORROSIVE (skin, eyes, inhalation, ingestion)**: **Call 999.**

Phosphorus chlorides

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
- Phosphorus(III) chloride - Phosphorus(V) chloride	 DANGER (See reverse)	Y12	- Wear splash-proof goggles. Protect the face when opening bottles (pressure may have built up). - Do **not** inhale fumes. Use a fume cupboard for dispensing or transferring these chemicals. Ensure laboratory is well-ventilated. - Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. - Take steps to prevent water or excessive amounts of water vapour entering the bottle. **Never** return unused reagent to its bottle. **Other notes; see also detailed activity-specific guidance**: - **Reactions of phosphorus chlorides**: A fume cupboard will be required for activities, even on a small-scale. **Disposal:** W4, see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** - **W4**: Work in a fume cupboard. To 1 litre of 1 M sodium carbonate solution add no more than: · 10 g of phosphorus(V) chloride in 1 g portions, · 10 cm^3 of phosphorus(III) chloride in 1 cm^3 portions. The reaction produces gases and generates heat (is exothermic). Allow the reaction to subside after the addition of each portion. Pour the cooled solution down a foul-water drain with further dilution.

75 Risk Assessment Guidance

Phosphorus(V) oxide, P_2O_5

Phosphorus(V) oxide	*phosphorus pentoxide, diphosphorus pentoxide* P_2O_5 (141.94)
 DANGER	Causes severe skin burns and eye damage [H314]. **Phosphorus(V) oxide is dangerous in contact with**: • WATER. A violent reaction occurs. Any combustible material in the vicinity may even ignite. • METHANOIC ACID. Carbon monoxide is given off. • SODIUM, POTASSIUM. These metals may ignite on contact. • IODIDES. A violent reaction occurs. WEL (mg m^{-3}): 1.0 (LTEL), 2.0 (STEL)
Storage	Storage code: **CS** [White powder] • Phosphorus(V) oxide strongly absorbs water (it is *hygroscopic*) to form a syrupy liquid / ‘glassy’ crust. Keep dry by placing the jar/bottle in a desiccator, or other outer container, which also contains anhydrous calcium chloride. • Purchase small quantities and only when required, so that stock is fresh. Check state of containers and their contents on a regular basis (eg, once per term). If any signs of deterioration, dispose of as W1. • Phosphorus(V) oxide actually has the molecular formula P_4O_{10} (formula mass 283.9) but most suppliers label it as at the top of this *Hazcard*.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE, POWDER (eyes, skin, inhalation)**. Be aware that the dehydrating nature of phosphorus(V) oxide means that it can quickly cause severe localised burns. • **General spills**: **CORROSIVE POWDER**. Reacts with water. Can be difficult to deal with. If unsure how to proceed, contact CLEAPSS.

75 Risk Assessment Guidance

Phosphorus(V) oxide, P_2O_5

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Phosphorus(V) oxide	 DANGER Corrosive (skin, eyes)	TT (Y9)	• Wear splash-proof goggles. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. • Avoid raising dust (eg, use in a fume cupboard which is **not** switched on; have the sash partially pulled down). **Other notes; see also detailed activity-specific guidance**: • **Use as a drying agent (TT)**: Take care when disposing of the used solid. A glassy crust often forms, concealing the dry oxide that will react violently with water. Do **not** re-use the solid. Safer alternatives for drying agents can be used (eg, silica gels). Check activity-specific information for details. **Disposal:** W4, see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W4:** Use a fume cupboard. Wear gloves and splash-proof goggles. Protect the face. Add up to 10 g of the solid in 1 g portions to 1 litre of 1 M sodium carbonate solution with stirring. The reaction produces gases and heat so allow this to subside between each addition of the solid. Pour resulting mixture down a foul-water drain with further dilution.

Potassium	K (39.10)
DANGER	In contact with water releases flammable gases which may ignite spontaneously [H260]. Reacts violently with water [EUH014]. Causes severe skin burns and eye damage [H314]. **Potassium is dangerous in contact with**: • WATER. Hydrogen gas is given off which ignites. Corrosive liquid spits out. • MANY OTHER SUBSTANCES. Check the appropriate *Hazcard* for the substances used.
Storage	Storage code: **FW** [Silver-grey, soft metal] • Store under paraffin liquid (‘medicinal paraffin’, see *Hazcard* 45B). Check regularly. Replace liquid if dirty or solidifying. • Store away from water/water-based reagents. Do **not** store in the flammables cupboard or with flammable liquids. Stand the bottle of potassium inside another clean, dry container (labelled) so that it cannot tip over. A clean, dry metal tin (eg, biscuit tin) could be used. See *Storage of chemicals*. • Purchase small quantities only (10-25 g will be adequate) so that stock is fresh. • If old stock potassium has a distinct yellow crust, do **not** cut into it; it may catch fire and/or explode even with light pressure from a knife blade. Store for removal by a Registered Waste Carrier, W1. If in doubt, contact CLEAPSS.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE (skin, eyes), alkali.** • **If potassium catches fire**: Potassium burns vigorously and is very difficult to extinguish. Smother with **clean**, **dry** sand (keep a container of sand specifically for this purpose). • **General spills/clearing up**: **FLAMMABLE WATER-REACTIVE**. Prevent spill from spreading. Use forceps to pick up visible metal pieces. Place in a clean, **dry** container and cover with fresh oil. Store for disposal by Registered Waste Carrier. • Cover remaining spill with absorbent and scoop into a **dry** bucket. (*) Add small portions of contaminated absorbent to an excess of propan-2-ol. Once reaction is complete (may take time), dilute by adding portions to a bucket of cold water. Pour down a foul-water drain. *Spill area may then be mopped but beware of possible sparks from remaining potassium fragments.

76 Risk Assessment Guidance

Potassium

Take steps to prevent theft. After any use of potassium (eg, a demonstration), ensure that the bottle is securely locked away. In addition, to ensure that a technician will not be faced with a sudden fire when clearing up, place any tiles plus the equipment used to cut or handle pieces of potassium into a large bowl of cold water.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Potassium	 DANGER (See reverse)	TT	• Wear splash-proof goggles. • Take particular care to avoid skin contact. Use tweezers or forceps to transfer pieces of potassium. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparing potassium for use (TT)**: Ensure all equipment is **dry**. Use forceps to place a piece of potassium onto a tile. Use a sharp knife to cut off the required piece. Immediately return the unwanted potassium to its bottle and close the lid. Dab the cut piece of potassium with a paper tissue or filter paper to remove the oil (medicinal paraffin/paraffin liquid light). Do **not** use organic solvents (eg, petroleum spirit, hexane) to remove the oil; this has caused fires. **Disposal**: WSpec, see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **WSpec**: Use a fume cupboard in a secure room (& where you will not be interrupted). Work with an experienced colleague. **Do NOT cut into any potassium that has a distinct yellow crust; contact CLEAPSS**. Add up to 2 g cut into small pieces (~ 3 mm sides), one at a time, to 100 cm^3 of 2-methylpropan-2-ol (*tert-butanol*) in a 400 cm^3 glass beaker. There may be sparks/flames. Place a heat-proof mat over the beaker to prevent alcohol vapour catching fire or to extinguish any flames. Allow reaction (suitably labelled) to finish before adding more pieces of potassium (up to 10 g max). Once reaction is complete, carefully add mixture to a bucket of cold water and pour away down a foul-water drain.

77 Risk Assessment Guidance **Potassium chlorates (V) & (VII), sodium chlorate(V)**

The Explosives Regulations prohibit the making of mixtures of sulfur and/or phosphorus with potassium chlorate(V), or other chlorates, without the prior approval of the Health and Safety Executive (HSE).

The preparation and use of other mixtures involving these chlorates is also affected by the Explosives Regulations.

See *Fireworks and explosives*. Contact CLEAPSS for further advice.

Potassium chlorate(V) $KClO_3$ (122.55)

Potassium chlorate(VII) *potassium perchlorate* $KClO_4$ (138.55)

Sodium chlorate(V) $NaClO_3$ (106.44)

chlorate (v)

DANGER

ALL: May cause fire or explosion; strong oxidiser [H271]. Harmful if swallowed [H302].

Potassium chlorate(V): Harmful if inhaled [H332].

Potassium chlorate(V), sodium chlorate(V): Toxic to aquatic life with long lasting effects [H411].

These compounds are dangerous in contact with:

- AMMONIA and AMMONIUM SALTS. Unstable, explosive mixtures form, even when mixed dry.
- METAL POWDERS, MANGANESE(IV) OXIDE, SULFIDES, THIOSULFATES, CARBON, SUGARS, HYDROCARBONS. Unstable and dangerous mixtures form.
- CONCENTRATED SULFURIC(VI)/PHOSPHORIC(V) ACIDS. Explosive chlorine oxides/chloric acids form.
- COMBUSTIBLE MATERIALS (eg, paper, sugar, wood, clothes etc). These materials, if impregnated with the salts (eg, as solutions) will ignite easily and burn very vigorously once dry. The reactions may be demonstrated under controlled conditions (see activity-specific guidance).

Storage Storage code: **Ox** [White or colourless solids]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **STRONGLY OXIDISING (eyes, inhalation, ingestion).**
- **VERY TOXIC (ingestion). BEWARE DELAYED EFFECTS**.
- **General spills/clearing up**: Treat as **OXIDISING**. Do **not** use fabric gloves to handle the substances.

77 Risk Assessment Guidance Potassium chlorates (V) & (VII), sodium chlorate(V)

The Explosives Regulations prohibit the making of mixtures of sulfur and/or phosphorus with potassium chlorate(V), or other chlorates, without the prior approval of the Health and Safety Executive (HSE).

The preparation and use of other mixtures involving these chlorates is also affected by the Explosives Regulations.

See *Fireworks and explosives*. Contact CLEAPSS for further advice.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solids (all)	 DANGER (See reverse)	TT (Y9)	• Wear eye protection. Check detailed guidance: activities may require the use of face protection and/or safety screens (explosion risk). • Take steps to minimise the impact of any spills (eg, use trays to prevent solutions soaking into wooden surfaces/clothing). • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120.
Potassium chlorate(V) solutions ≥ 2.0 M	 WARNING Harmful (ingestion)		

Do **not** have these compounds in the laboratory at the same time as concentrated sulfuric/phosphoric acid.

Potassium chlorate(V) can be used in most cases; there is little need to keep/use sodium chlorate(V).

Do **not** confuse sodium chlorate**(V)** [$NaClO_3$], usually found as a solid (eg, commercial weedkiller), with sodium chlorate**(I)**. Sodium chlorate(I), [NaClO], is a solution (often used as a disinfectant) and may be used to prepare chlorine gas.

Other notes; see also activity-specific guidance:

- **Solubility investigations**: The solubility of potassium chlorate(V) varies greatly with temperature and is often suggested for this type of investigation. There are safer alternatives, but if potassium chlorate(V) is used, collect all solutions at the end for safe disposal.
- **Oxygen gas preparation (TT)**: Do **not** use chlorates. See *Hazcard* 69.

Disposal: W1 or WSpec, see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **WSpec**: Use a fume cupboard. Dilute to, or prepare a 0.1 M solution. Add ~ 10 g of sodium (or potassium) metabisulfite to no more than 100 cm^3 of this solution. Leave for 1 hour then flush away down a foul-water drain.

78A Risk Assessment Guidance (see also **78B, 78C**) **Potassium chromate(VI), K_2CrO_4**

Potassium chromate(VI)	K_2CrO_4 (194.19)
 DANGER	Causes skin irritation [H315]. May cause an allergic skin reaction [H317]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. May cause genetic defects [H340]. May cause cancer by inhalation [H350i]. Very toxic to aquatic life with long lasting effects [H410]. **Potassium chromate(VI) is dangerous in contact with**: • ALUMINIUM, MAGNESIUM, CARBON, SULFUR, PHOSPHORUS, COMBUSTIBLE MATERIALS, including ORGANIC SUBSTANCES. Explosive or vigorous-burning mixtures are formed. WEL (mg m^{-3}): 0.05 (LTEL); 0.15 (STEL), Carc, Sen; as chromium (Cr)
Storage	Storage code: **T** [Yellow solid/crystals]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **TOXIC (ingestion, inhalation, skin)**. • **General spills/clearing up (solid)**: **TOXIC (inhalation)**. Large-scale spills may be difficult to deal with to avoid raising dust. Contact CLEAPSS if unsure how to proceed. If safe to deal with: Carefully scoop or sweep solid into a clean container; avoid raising dust. Treat small quantities as described under **Disposal** (**WSpec**, see reverse of *Hazcard*).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

78A Risk Assessment Guidance (see also **78B, 78C**) **Potassium chromate(VI), K_2CrO_4**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid, and solutions ≥ 0.9 M	 DANGER (See reverse)	TT (Y12)	Inhalation of chromate(VI) salts is a remote possibility if significant amounts of dust become airborne. Use correct transfer techniques. Do **not** allow small volumes of solution to dry out on glassware/lab surfaces; wipe up immediately with a damp cloth/paper towel. Avoid raising dust. • Wear eye protection. Wear splash-proof goggles when transferring or dispensing large quantities. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Weighing the solid**: Weigh on a balance placed in a fume cupboard that is **not** switched on. Have sash partially down. Wipe down the work area with a damp paper towel. • **Preparing potassium chromate(VI) solutions**: See *Recipe* 69.
Solutions: < 0.9 M and ≥ 0.04 M	 DANGER Irritant (respiratory), ≥ 0.4 M. Sensitiser (skin). Serious Health Hazard (CMR, inhal^n).	Y12 (Y9)	
Solutions: < 0.04 M and ≥ 0.01 M	 DANGER Serious Health Hazard (CMR, inhal^n)		
Solutions < 0.01 M	Currently not classified as hazardous.	Y7	**Disposal**: WSpec/W7, see notes below; or W1

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **WSpec: Use a fume cupboard (sulfur dioxide may be evolved).** Dissolve no more than 10 g of solid chromate(VI) in 250 cm^3 of 1 M sulfuric acid (gives ~ 0.1 M dichromate(VI) solution). Add ~ 12g of solid sodium metabisulfite in small portions with stirring. Solution turns green due to formation of Cr^{3+} ions (see *Hazcard* 24). Mix thoroughly and pour the resulting solution down a foul-water drain with further dilution. • **W7**: Very small quantities (eg, washings from used glassware) may be rinsed down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

78B Risk Assessment Guidance (see also **78A, 78C**)

Sodium chromate(VI), Na_2CrO_4

Sodium chromate(VI)	Na_2CrO_4 (161.97)
Sodium chromate(VI)-4-water	$Na_2CrO_4.4H_2O$ (234.04)
 DANGER	Toxic if swallowed [H301]. Harmful in contact with skin [H312]. Causes severe skin burns and eye damage [H314]. May cause an allergic skin reaction [H317]. Fatal if inhaled [H330]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. May cause genetic defects [H340]. May cause cancer [H350]. May damage fertility. May damage the unborn child [H360FD]. Causes damage to organs through prolonged or repeated exposure [H372]. Very toxic to aquatic life with long lasting effects [H400/410]. **Sodium chromate(VI) is dangerous in contact with**: • ALUMINIUM, MAGNESIUM, CARBON, SULFUR, PHOSPHORUS, COMBUSTIBLE MATERIALS, including ORGANIC SUBSTANCES. Explosive or vigorously-burning mixtures are formed. WEL (mg m^{-3}): 0.05 (LTEL); 0.15 (STEL), Carc, Sen; as chromium (Cr).
Storage	Storage code: **T** [Yellow solid/crystals]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **TOXIC (ingestion, inhalation, skin)**. • **General spills/clearing up (solid)**: **TOXIC (inhalation)**. Large-scale spills may be difficult to deal with to avoid raising dust. Contact CLEAPSS if unsure how to proceed. If safe to deal with: Carefully scoop or sweep solid into a clean container; avoid raising dust. Treat small quantities as described under **Disposal** (**WSpec**, see reverse of *Hazcard*).

78B Risk Assessment Guidance (see also **78A, 78C**) **Sodium chromate(VI), Na_2CrO_4**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid, and solutions ≥ 0.8 M	DANGER (See reverse, as for solid)	TT (Y12)	Inhalation of chromate(VI) salts is a remote possibility if significant amounts of dust become airborne. Use correct transfer techniques. Do **not** allow small volumes of solution to dry out on glassware/lab surfaces; wipe up immediately with a damp cloth/paper towel. Avoid raising dust. • Wear eye protection. Wear splash-proof goggles when transferring or dispensing large quantities. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Weighing the solid**: Weigh on a balance placed in a fume cupboard that is **not** switched on. Have sash partially down. Wipe down the work area with a damp paper towel. • **Preparing sodium chromate(VI) solutions**: See *Recipe* 69. **Disposal**: WSpec/W7, see notes below; or W1
Solutions < 0.8 M and ≥ 0.2 M	 DANGER Corrosive (skin, eyes). Harmful (ingestion). Irritant (respiratory). Sensitiser (skin, respiratory). Serious Health Hazard (RE). Serious Health Hazard (CM**R**).	Y12 (Y9)	
Solutions < 0.2 M and ≥ 0.01 M	 DANGER Irritant (skin, eyes) & Serious Health Hazard (RE), ≥ 0.1 M. Sensitiser (skin, respiratory). Serious Health Hazard (CM**R**)		
Solutions < 0.01 M	Currently not classified as hazardous.	Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **WSpec: Use a fume cupboard (sulfur dioxide may be evolved).** Dissolve no more than 10 g of solid chromate(VI) in 250 cm^3 of 1 M sulfuric acid (gives ~ 0.1 M dichromate(VI) solution). Add ~ 12g of solid sodium metabisulfite in small portions with stirring. Solution turns green due to formation of Cr^{3+} ions (see *Hazcard* 24). Mix thoroughly and pour the resulting solution down a foul-water drain with further dilution. • **W7**: Very small quantities (eg, washings from used glassware) may be rinsed down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

78C Risk Assessment Guidance (also **78A, 78B**) **Potassium & sodium dichromates(VI)**

Potassium dichromate(VI)	$K_2Cr_2O_7$ (294.19)
Sodium dichromate(VI)	$Na_2Cr_2O_7$ (261.97)
Sodium dichromate(VI)-2-water	$Na_2Cr_2O_7.2H_2O$ (297.99)
 DANGER	May intensify fire; oxidiser [H272]. Toxic if swallowed [H301]. Harmful in contact with skin [H312]. Causes severe skin burns and eye damage [H314]. May cause an allergic skin reaction [H317]. Fatal if inhaled [H330]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. May cause genetic defects [H340]. May cause cancer [H350]. May damage fertility. May damage the unborn child [H360FD]. Causes damage to organs through prolonged or repeated exposure [H372]. Very toxic to aquatic life with long lasting effects [H410]. **Potassium dichromate(VI) and sodium dichromate(VI) are dangerous in contact with**: • ALUMINIUM, MAGNESIUM, CARBON, SULFUR, PHOSPHORUS, COMBUSTIBLE MATERIALS, including ORGANIC SUBSTANCES. Explosive or vigorous-burning mixtures are formed. WEL (mg m^{-3}): 0.05 (LTEL); 0.15 (STEL), Carc, Sen; as chromium (Cr)
Storage	Storage code: **T** [Orange-red crystals] • Do **not** store with organic chemicals (GOrg) as these are combustible.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **TOXIC (ingestion, inhalation, skin)**. • **General spills/clearing up (solid)**: **TOXIC (inhalation)**, **OXIDISING**. Large-scale spills may be difficult to deal with to avoid raising dust. Contact CLEAPSS if unsure how to proceed. If safe to deal with: Carefully scoop or sweep solid into a clean container; avoid raising dust. Treat small quantities as described under **Disposal** (**WSpec**, see reverse of *Hazcard*).

78C Risk Assessment Guidance (also **78A, 78B**) **Potassium & sodium dichromates(VI)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid, and solutions ≥ 0.4 M	DANGER (See reverse, as for solid)	TT (Y12)	Inhalation of dichromate(VI) salts is a remote possibility if significant amounts of dust become airborne. Use correct transfer techniques. Do **not** allow small volumes of solution to dry out on glassware/lab surfaces; wipe up immediately with a damp cloth/paper towel. Avoid raising dust. • Wear eye protection. Wear splash-proof goggles when transferring or dispensing large quantities. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Weighing the solid**: Weigh on a balance placed in a fume cupboard that is **not** switched on. Have sash partially down. Wipe down the work area with a damp paper towel. • **Preparing dichromate(VI) solutions**: See *Recipe* 70. • **Potassium dichromate(VI) test papers**: See *Recipe* 99. **Disposal**: WSpec/W7, see notes below; or W1
Solutions < 0.4 M and ≥ 0.1 M	 DANGER Corrosive (skin, eyes). Harmful (ingestion). Irritant (respiratory). Sensitiser (skin, respiratory). Serious Health Hazard (RE). Serious Health Hazard (CMR).	Y12 (Y9)	
Solutions < 0.1 M and ≥ 0.004 M	 DANGER Irritant (skin, eyes). Serious Health Hazard (RE), ≥ 0.04 M. Sensitiser (skin, respiratory). Serious Health Hazard (CMR)		
Solutions < 0.004 M	Currently not classified as hazardous	Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **WSpec: Use a fume cupboard (sulfur dioxide may be evolved).** Dissolve no more than 10 g of dichromate(VI) in 250 cm^3 of 1 M sulfuric acid (~ 0.1 M acidified dichromate solution). Add ~ 12g of solid sodium metabisulfite in small portions with stirring. Solution turns green due to formation of Cr^{3+} ions (see *Hazcard* 24). Mix thoroughly. Pour resulting solution down a foul-water drain with further dilution. • **W7**: Very small quantities (eg, washings from used glassware) may be rinsed down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

79 Risk Assessment Guidance

Potassium hexacyanoferrate(II) and (III)

Potassium hexacyanoferrate(II)-3-water	*potassium ferrocyanide* $K_4Fe(CN)_6.3H_2O$ (422.39)
Not usually classified as hazardous	Contact with acids liberates very toxic gas [EUH032]. Note: Classification and labelling vary by supplier and may differ from the information given here **Potassium hexacyanoferrate(II) is dangerous in contact with**: • ACIDS. Do **not** heat with dilute or concentrated acids because toxic gases will be evolved. • HEAT. A toxic gas is evolved. • NITRITES [NITRATE(III) compounds]. These may explode on heating.
Storage	Storage code: **GIn** [Pale yellow, crystalline solid]

Potassium hexacyanoferrate(III)	*potassium ferricyanide* $K_3Fe(CN)_6$ (329.24)
Not usually classified as hazardous	Contact with acids liberates very toxic gas [EUH032]. Note: Classification and labelling vary by supplier and may differ from the information given here. **Potassium hexacyanoferrate(III) is dangerous in contact with**: • ACIDS. Do **not** heat with dilute or concentrated acids because toxic gases will be evolved. • AMMONIA. An explosive mixture is formed. • HEAT. A toxic gas is evolved. • NITRITES [NITRATE(III)], COPPER(II) SULFATE(VI), CHROMIUM(VI) OXIDE. These may explode on heating.
Storage	Storage code: **GIn** [Orange-red crystalline solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120)**.

79 Risk Assessment Guidance

Potassium hexacyanoferrate(II) and (III)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Potassium hexacyanoferrate(**II**): solid and solutions	Not usually classified as hazardous	Y7	• Wear eye protection (treat solids and solutions as irritants). • Do **not** have Bunsen burners on. Do **not** heat the solids. • Do **not** add concentrated acids to these substances (solids or solutions); toxic gases are produced. **Other notes (see also detailed activity-specific guidance)**: • **Use of solutions**: 0.1 M solutions can be used to detect Fe^{2+} or Fe^{3+} ions. See *Recipe* 101. • **Rust indicator (ferroxyl indicator)**: See *Recipe* 101. The indicator solution can be made with or without agar (note: heating is not needed if agar is omitted). Using ferroxyl indicator: a blue colouration indicates the presence of Fe^{2+} ions (anodic area); a pink colouration indicates the presence of OH^{-} ions (cathodic area). • **Blueprints**: See *Recipe* 52. **Disposal**: W7
Potassium hexacyanoferrate(**III**): solid and solutions	Not usually classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Potassium bromate(V) and iodate(V)

Potassium bromate(V) $KBrO_3$ (167.0)

DANGER

May cause fire or explosion; strong oxidiser [H271]. Toxic if swallowed [H301]. May cause cancer [H350].

Potassium bromate(V) is dangerous in contact with:

- ALUMINIUM, MAGNESIUM, CARBON, SULFUR, PHOSPHORUS, COMBUSTIBLE MATERIALS, including ORGANIC SUBSTANCES. Mixtures may be explosive or burn vigorously.

Note: Potassium bromate(V) is not volatile. Exposure through inhalation is, therefore, low and controlled if the risk assessment advice is followed.

Potassium iodate(V) KIO_3 (214.0)

Potassium periodate *potassium iodate(VII)* KIO_4 (230.0)

DANGER

Note: Classification/labelling vary. Most suppliers include one or more of the following:
May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

Potassium iodate(V) is dangerous in contact with:

- ALUMINIUM, MAGNESIUM, CARBON, SULFUR, PHOSPHORUS, COMBUSTIBLE MATERIALS, including ORGANIC SUBSTANCES. Mixtures may be explosive or burn vigorously.

Storage	Storage code: **Ox**	[White crystalline solids]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **TOXIC (ingestion)**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Potassium bromate(V) and iodate(V)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Potassium bromate(V) solid	DANGER Oxidiser. Toxic (ingestion). Serious health hazard (CMR)	TT	• Wear eye protection. • Avoid raising dust. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Action of heat on iodates and bromates (TT):** Wear splash-proof goggles. Use a fume cupboard. Iodine and bromine are produced. • **Potassium bromate and iodate solutions:** Bromate(V) and iodate(V) solutions are saturated at ~ 0.5 M (room temperature). Potassium **per**iodate is not particularly soluble (~ 0.02 M at room temperature; data varies). • Potassium iodate(V) solutions: • **Preparation of bromine water (TT)**: See Methods 2 and 3 in *Recipe* 17. • **For clock reaction mixtures**: See *Recipe* 29. • **For oscillating reaction mixtures**: See *Recipe* 63. **Disposal:** bromate, W7 → 0.004 M iodate, W7 → 0.2 M
Potassium bromate(V) solutions: < 0.5 M and ≥ 0.005 M See also **Other notes**.	DANGER Serious health hazard (CMR) Harmful (ingestion), ≥ 0.3 M	TT (Y9)	
Potassium bromate solutions: < 0.005 M	Currently not classified as hazardous.	Y7	
Potassium iodate(V) solid	DANGER (See reverse)	TT (Y9)	
Potassium iodate(V) solutions	Currently not classified as hazardous	Y7	

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Potassium manganate(VII) *potassium permanganate* $KMnO_4$ (158.03)

DANGER

May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Very toxic to aquatic life with long lasting effects [H410]. Note: some suppliers may also indicate: Causes severe skin burns and eye damage [H314] with the GHS05 pictogram (corrosive).

Potassium manganate(VII) is dangerous in contact with:

- AMMONIA and AMMONIUM COMPOUNDS. Unstable explosive salts may form, even when mixed dry.
- METAL POWDERS (eg, magnesium). Explosive or vigorously-burning mixtures are formed.
- ORGANIC and COMBUSTIBLE MATERIALS. Explosive or vigorously-burning mixtures are formed. Note: the mixture with PROPANE-1,2,3-TRIOL (glycerol) self-ignites after a delay (which can be unpredictable). Under controlled conditions, this can be safely demonstrated.
- CONCENTRATED SULFURIC(VI) ACID and CONCENTRATED PHOSPHORIC ACID. Explosive manganese(VII) oxide (manganese heptoxide) is formed. **Take steps to avoid unintended mixing of solid potassium manganate(VII) with either of these acids (eg, avoid putting out together).**

WEL (mg m^{-3}): 0.5 (LTEL), 1.5 (STEL); as manganese (Mn)

Storage

Storage code: **Ox** [Dark-violet crystals]

- Particle size varies widely. Check with supplier if a ‘granular’ form is required.
- Store solutions in dark bottles and shield from light to slow the rate of decomposition and staining of glassware. Solutions do not keep well unless the container is scrupulously clean.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **TOXIC (ingestion), CORROSIVE (skin, eyes)**: If not immediately treated, can cause severe harm/damage.
- **If spilt on skin/clothes**: Quickly brush off as much **dry** solid as possible. Irrigate with plenty of water.
- **General spills/clearing up: OXIDISING**

81 Risk Assessment Guidance — Potassium manganate(VII), $KMnO_4$

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solid	 DANGER Oxidiser. Harmful (ingestion).	Y12 (Y7)	- Wear eye protection even when dilute solutions are used. - Avoid raising dust when using the solid. - Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: - The solid and solutions will stain skin brown (as well as other organic material, eg, paper, clothes). Skin stains will gradually fade over time. - **Solution preparation (TT)**: *Recipe* 73 (also has information about stain removal and cleaning glassware). - **General use of solutions**: Solutions ≤ 0.1 M will be suitable for many pre-16 activities. See *Safer chemicals, safer reactions*. **Disposal:** Solid, WSpec; see below Solutions, W7 → 0.1 M
Solutions* ≥ 0.1 M	 WARNING Irritant (skin, eyes)	Y7	
Solutions* < 0.1 M	Currently not classified as hazardous		

*Solutions made up in dilute sulfuric acid, see *Recipe* 73.

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts of the solid**: - **Wspec:** Dissolve no more than 5 g of the solid in 1 litre of 0.5 M sulfuric acid. Then select **one** of the following reducing agents to add, in portions with stirring, until the solution becomes colourless: (i) sodium metabisulfite (~ 10 g will be needed), use a **fume cupboard** as sulfur dioxide gas may be produced, (ii) iron(II) sulfate-7-water (~ 40 g will be needed). Pour the resulting mixture down a foul-water drain with further dilution.

Potassium nitrate(V)	KNO_3 (101.10)
 WARNING	May intensify fire; oxidiser [H272]. Note: Classification and labelling vary. Some suppliers may also indicate one or more of the following (with the GHS 07 pictogram also included): Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

Sodium nitrate(V)	$NaNO_3$ (84.99)
 WARNING	May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Note: Some suppliers may also indicate one or more of the following: Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

Storage	Storage code: **Ox** [Colourless crystalline solids]

The preparation and use of some mixtures involving potassium/sodium nitrate(V) with various substances (including those listed below) is affected by the Explosives Regulations. See *Fireworks and explosives*. Contact CLEAPSS for further advice.

Potassium nitrate(V) and sodium nitrate(V) are dangerous in contact with:

- MANY SUBSTANCES including: ALUMINIUM, MAGNESIUM, SODIUM, POTASSIUM and other METALS. CARBON, SULFUR, PHOSPHORUS and other NON-METALS. COMBUSTIBLE MATERIALS including ORGANIC SUBSTANCES, AMMONIUM SALTS, SULFIDES, SULFIDES, THIOSULFATES, ETHANOATES. Unstable, explosive mixtures are formed.
- HEAT. Solids decompose to produce oxygen gas and nitrate(III) compounds (nitrites).

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

82 Risk Assessment Guidance

Potassium nitrate(V) and sodium nitrate(V)

The preparation and use of some mixtures involving potassium/sodium nitrate(V) with various substances is affected by the Explosives Regulations. See *Fireworks and explosives*. Contact CLEAPSS for further advice.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solids • Potassium nitrate(V) • Sodium nitrate(V)	 WARNING (See reverse)	TT (Y7)	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **Solubility variation (vs temperature), solution enthalpy changes**: Unless the use of potassium nitrate(V) is essential, use potassium chloride. • **Reaction of solid nitrate(V) salts with sugar or wood (TT)**: Refer to latest CLEAPSS guidance that takes into account the requirements of the Explosives Regulations. See *Fireworks and explosives* and contact CLEAPSS. **Disposal**: W7 → 0.05 M
Sodium nitrate(V) solutions ≥ 3.0 M	 WARNING Harmful (ingestion) Irritant (skin, eyes) Irritant (respiratory)	Y7	
Sodium/potassium nitrate(V) solutions < 3.0 M and ≥ 1.0 M	 WARNING Irritant (skin, eyes) Irritant (respiratory), ≥ 2.0 M		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

83 Risk Assessment Guidance

Propanal and other aldehydes

Propanal	*propionaldehyde*	CH_3CH_2CHO (58.08)
 DANGER	Highly flammable liquid and vapour [H225]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. **Propanal is dangerous in contact with**: • AMMONIACAL SILVER NITRATE(V) SOLUTION. Explosive products form. Note: Flash point: – 30 °C (Boiling point: 48 °C)	
Storage	Storage code: **FL** (Organic)	[Colourless liquid]

Butanal	*butyraldehyde*	$CH_3CH_2CH_2CHO$ (72.11)
 DANGER	Highly flammable liquid and vapour [H225]. See also **Other notes**. Note: Flash point: – 22 °C (Boiling point: 75 °C)	
Storage	Storage code: **FL** (Organic)	[Colourless liquid, characteristic ‘ketone’ odour]

Benzenecarbaldehyde	*benzaldehyde*	C_6H_5CHO (106.12)
 WARNING	Harmful if swallowed [H302]. Note: Flash point: 63 °C (Boiling point: 179 °C)	
Storage	Storage code: **GOrg**	[Colourless liquid, almond-like odour]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **General spills: HIGHLY FLAMMABLE, VOLATILE (propanal, butanal)**.

83 Risk Assessment Guidance **Propanal and other aldehydes**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Propanal	 DANGER (See reverse)	Y9	• Wear eye protection. • Transferring/dispensing large volumes (TT): Use a fume cupboard. Ensure no naked flames or other sources of ignition. • Ensure laboratory is well ventilated. Avoid inhaling vapour. **Other notes; see also detailed activity-specific guidance**: • The odours of these aldehydes are quite noticeable and can be irritating. Over time (eg, long-term storage), oxidation from the air can cause the smell to become more pungent and unpleasant. If this is the case, retain for disposal by a Registered Waster Carrier (W1). • **Heating**: Do **not** use a naked flame to heat highly flammable liquids. Use hot water from a kettle or use electrically-heated baths. • **Test-tube reactions of aldehydes**: Propanal and butanal are suitable for small-scale procedures (eg, a few drops). Use a mineral wool plug in the open end of a test tube to minimise fumes. Do **not** inhale the fumes. Note: oxidation products (organic acids) have obnoxious odours and are corrosive. **Disposal**: W7 → 5 % (v/v); see note below
Butanal	 DANGER (See reverse)		
Benzaldehyde	 WARNING (See reverse)	Y7	• Wear eye protection. **Disposal**: W2

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE:** • **W7 (propanal, butanal):** Use a fume cupboard. Avoid inhaling fumes.

84A Risk Assessment Guidance — Propan-1-ol and propan-2-ol

Propan-1-ol	*n-propanol, propyl alcohol*	$CH_3CH_2CH_2OH$ (60.1)
Propan-2-ol	*iso-propanol, isopropyl alcohol*	$CH_3CHOHCH_3$ (60.1)

DANGER

propan-1-ol

Both: Highly flammable liquid and vapour [H225]. May cause drowsiness or dizziness [H336].

Propan-1-ol: Causes serious eye damage [H318]. **Propan-2-ol**: Causes serious eye irritation [H319].

These alcohols are dangerous in contact with:

- OXIDISING AGENTS. Alcohols will react vigorously.
- KETONES (other than propanone). Peroxides form in days, giving an explosion risk.
- POTASSIUM. The alcohol will catch fire.

	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})
Propan-1-ol	22	97.2	500 (LTEL), 625 (STEL), Sk
Propan-2-ol	12	82.3	999 (LTEL), 1250 (STEL)

Storage

Storage code: **FL** (Organic) [Colourless liquids]

- Store propan-2-ol in a dark bottle, or in an opaque bottle out of the light. This is to limit the formation of peroxides (explosion risk).
- Propan-2-ol can be kept for several years if it is to be used as a solvent or a fuel. If it is ever to be boiled to *almost* dryness, ensure the alcohol sample is **not** more than 2 years old.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (eyes)**: Propan-1-ol.

84A Risk Assessment Guidance

Propan-1-ol and propan-2-ol

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Propan-1-ol	 DANGER (See reverse)	Y7	• Wear eye protection. • Transferring/dispensing large volumes (TT): Use a fume cupboard. Wear splash-proof goggles with propan-1-ol. • Ensure no naked flames or other sources of ignition. • Avoid inhaling fumes. Ensure laboratory is well ventilated. **Other notes; see also detailed activity-specific guidance:** • **Heating**: Do **not** use a naked flame to heat these highly flammable liquids. Use hot water from a kettle or use electrically-heated baths. • **Distillation**: Do **not** distil propanols to dryness. Use recently-purchased stock (< 2 years old). • **Burning/use as a fuel**: Do **not** allow students to fill or refill crucibles or spirit burners, TT only. The use of a spirit burner should be dedicated to a specific alcohol. Ensure the wick fits tightly in its holder and the holder fits tightly in the container. See *Safer chemicals, safer reactions* and *spirit burners*. • **Degreasing/cleaning agents**: Use propan-2-ol. **Disposal**: W7 → 5% v/v
Propan-2-ol	 DANGER (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

84B Risk Assessment Guidance Butanols

Butan-1-ol	*n-butanol, butyl alcohol*	$CH_3CH_2CH_2CH_2OH$ (74.12)
2-methylpropan-1-ol	*iso-butanol, isobutyl alcohol*	$(CH_3)_2CHCH_2OH$ (74.12)

DANGER

Flammable liquid and vapour [H226]. Causes skin irritation [H315]. Causes serious eye damage [H318]. May cause respiratory irritation [H335]. May cause drowsiness or dizziness [H336]. *Butan-1-ol is also*: Harmful if swallowed [H302].

Flash point: 37 °C WEL (mg m^{-3}): 154 (STEL), Sk; butan-1-ol

Flash point: 28 °C WEL (mg m^{-3}): 154 (LTEL), 231 (STEL); 2-methylpropan-1-ol

2-methylpropan-2-ol	*tert-butyl alcohol*	$(CH_3)_3COH$ (74.12)

DANGER

Highly flammable liquid and vapour [H225]. Causes serious eye irritation [H319]. Harmful if inhaled [H332]. May cause respiratory irritation [H335].

Flash point: 11 °C WEL (mg m^{-3}): 308 (LTEL), 462 (STEL)

Butan-2-ol	*sec-butyl alcohol*	$CH_3CH_2CH(OH)CH_3$ (74.12)

WARNING

Flammable liquid and vapour [H226]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. May cause drowsiness or dizziness [H336].

Flash point: 24 °C WEL (mg m^{-3}): 308 (LTEL), 462 (STEL)

All of these alcohols are dangerous in contact with:

- OXIDISING AGENTS. Alcohols react vigorously.
- KETONES (except propanone). Peroxides form in days. Explosion risk.

Storage	Storage code: **FL** (Organic) [Colourless liquids] • 2-methylpropan-2-ol solidifies on cool days (melting point: 26 °C). See **Other notes** (on reverse).
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE (eyes)**: Butan-1-ol, 2-methylpropan-1-ol.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

84B Risk Assessment Guidance — Butanols

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
• Butan-1-ol • 2-methylpropan-1-ol	 DANGER Flammable. Corrosive (eyes). Irritant (skin, respiratory). May cause drowsiness or dizziness. Harmful (ingestion), butan-1-ol.	Y7	• Wear eye protection. • Transferring/dispensing large volumes (TT): Use a fume cupboard. Ensure no naked flames or other sources of ignition. Wear splash-proof goggles with butan-1-ol and 2-methylpropan-1-ol. • Avoid inhaling fumes. Ensure laboratory is well ventilated. **Other notes; see also detailed activity-specific guidance**: • **Melting 2-methylpropan-2-ol**: To melt the solid, place bottle in a plastic bag (to protect label), loosen the lid slightly and stand in warm water. • **Heating**: Do **not** use naked flames to heat highly flammable liquids. Use hot water from a kettle or use electrically-heated baths. Boiling points (^{o}C): butan-1-ol, 117.7; butan-2-ol, 99.5; 2-methylpropan-1-ol , 107.9; 2-methylpropan-2-ol, 82.4. • **Burning/use as a fuel**: Do **not** allow students to fill or refill crucibles or spirit burners, TT only. The use of a spirit burner should be dedicated to a specific alcohol. Ensure the wick fits tightly in its holder and the holder fits tightly in the container. *See Safer chemicals, safer reactions* and *spirit burners*. **Disposal**: W7 → 5% v/v
2-methylpropan-2-ol	 DANGER Highly flammable. Irritant (eyes, respiratory). Harmful (inhalation).		
Butan-2-ol	 WARNING Flammable. Irritant (eyes, respiratory). May cause drowsiness or dizziness.		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

84C Risk Assessment Guidance **Other alcohols**

Cyclohexanol		$C_6H_{11}OH$ (100.158)
Pentan-1-ol*	*n-amyl alcohol, pentanol*	$CH_3(CH_2)_3CH_2OH$ (88.15)
3-methylbutan-1-ol*	*iso-amyl alcohol*	$(CH_3)_2CHCH_2OH$ (88.15)
Hexan-1-ol	*n-hexyl alcohol, 'hexanol', caproyl alcohol*	$CH_3(CH_2)_4CH_2OH$ (102.17)
Heptan-1-ol	*n-heptyl alcohol, 'heptanol'*	$CH_3(CH_2)_5CH_2OH$ (116.20)
Octan-1-ol	*n-octyl alcohol, 'octanol', capryl alcohol*	$CH_3(CH_2)_6CH_2OH$ (130.23)
Octan-2-ol	*iso-octyl alcohol, sec-octyl alcohol, sec-caprylic alcohol*	$CH_3(CH_2)_5CH(OH)CH_3$ (130.23)


(*)


(All)

WARNING

*Pentan-1-ol, 3-methylbutan-1-ol: Flammable liquid and vapour [H226]. Note: Suppliers may indicate this for hexan-1-ol but it is on the boundary. If supplier includes the GHS02 pictogram (flame), consider storage as **FL**.

Classification & labelling vary. Suppliers may indicate one or more of: Harmful if swallowed [H302]. Harmful in contact with skin [H312]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. Harmful if inhaled [H332]. May cause respiratory irritation [H335]. For octan-2-ol, some suppliers may indicate: Causes serious eye damage [H318]; the GHS 05 (CORROSIVE) pictogram and DANGER would then be present.

	3-methylbutan-1-ol	cyclohexanol
WEL (mg m^{-3})	366 (LTEL), 458 (STEL)	208 (LTEL), 624 (STEL)

Hexadecanol	*cetyl alcohol, palmityl alcohol*	$CH_3(CH_2)_{14}CH_2OH$ (242.44)

Currently not classified as hazardous.

Storage	Storage code: **FL** (pentan-1-ol, 3-methylbutan-1-ol); **GOrg** (others) • Colourless liquids (except hexadecanol which is a waxy solid). Odours are 'aromatic' or 'pungent'. • Cyclohexanol is a viscous liquid (or 'sticky' solid on cool days). It has a 'camphor-like' odour (mothballs). If it needs to be melted, stand container (in a bag to protect labels) in warm water and loosen lid slightly.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

84C Risk Assessment Guidance — Other alcohols

<table>
<tr><td colspan="4">Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk</td></tr>
<tr><th>General use of:</th><th>Hazard information</th><th>User</th><th>Suggested general control measures and guidance</th></tr>
<tr><td>• Pentan-1-ol
• 3-methyl-butan-1-ol</td><td>
WARNING
(See reverse)</td><td rowspan="3">Y7</td><td rowspan="3">• Wear eye protection.
• Ensure no ignition sources when dispensing/transferring flammable liquids.
• Ensure laboratory is well ventilated. Avoid inhaling fumes. Consider using a fume cupboard to dispense or transfer these liquids.

Other notes; see also detailed activity-specific guidance:
• Cooling curves: See <i>Safer chemicals, safer reactions.</i>
• Use as fuels: Filling/refilling crucibles or spirit burners, TT only. Dedicate each spirit burner to a specific alcohol. Ensure wick fits tightly in its holder and that this fits tightly in burner. See <i>Safer chemicals, safer reactions</i> and <i>spirit burners</i>.

<table>
<tr><th>Alcohol</th><th>Melting point (°C)</th><th>Boiling point (°C)</th><th>Flash point (°C)</th></tr>
<tr><td>Cyclohexanol</td><td>26</td><td>161</td><td>> 60</td></tr>
<tr><td>Hexadecanol</td><td>49</td><td>325</td><td>–</td></tr>
<tr><td>Pentan-1-ol</td><td>– 78</td><td>137</td><td>33</td></tr>
<tr><td>3-methylbutan-1-ol</td><td>– 117</td><td>130</td><td>43</td></tr>
<tr><td>Hexanol / Heptanol</td><td>– 46 / – 33</td><td>157 / 178</td><td>~ 60 / 73</td></tr>
<tr><td>Octan-1-ol / 2-ol</td><td>– 15 / – 32</td><td>195 / 180</td><td>81 / 71</td></tr>
</table>

Disposal: W2, W6, W7, W8; see notes below</td></tr>
<tr><td>• Cyclohexanol
• Hexan-1-ol
• Heptan-1-ol
• Octan-1-ol
• Octan-2-ol</td><td>
WARNING
(See reverse)</td></tr>
<tr><td>• Hexadecanol</td><td>Currently not classified as hazardous</td></tr>
</table>

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only**: • **W6 (all except hexadecanol which is W8)**: Burn small volumes using a spirit burner in a fume cupboard. • **W7 (pentanol, 3-methylbutan-1-ol, cyclohexanol):** Dissolve no more than 30 cm^3 in 1 litre of water. • **W8 (hexadecanol)**.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

85A Risk Assessment Guidance

Propanone and other ketones (1)

Propanone	*acetone* CH_3COCH_3 (58.08)
Butan-2-one	*butanone; ethyl methyl ketone; methyl ethyl ketone (MEK)* $CH_3CH_2COCH_3$ (72.11)
 DANGER	Highly flammable liquid and vapour [H225]. Causes serious eye irritation [H319]. May cause drowsiness or dizziness [H336]. Repeated exposure may cause skin dryness and cracking [EUH066]. **These substances are dangerous in contact with**: • ORGANOHALOGENS (eg, 1,1,1-TRICHLOROETHANE). May react violently after long induction period. • NITRIC(V) ACID and OTHER OXIDISING AGENTS. A violent reaction occurs. WEL (mg m^{-3}): 1210 (LTEL), 3620 (STEL) Flash point: – 20 °C (propanone) 600 (LTEL), 899 (STEL), Sk – 9 °C (butan-2-one)
Storage	Storage code: **FL** (Organic) [Colourless liquids, characteristic 'sharp & sweet' odour]

4-methylpentan-2-one	*isobutyl methyl ketone* $C_6H_{12}O$ (100.16)
 DANGER	Highly flammable liquid and vapour [H225]. Causes serious eye irritation [H319]. Harmful if inhaled [H332]. May cause respiratory irritation [H335]. Repeated exposure may cause skin dryness and cracking [EUH066]. WEL (mg m^{-3}): 208 (LTEL), 416 (STEL), Sk Flash point: 18 °C
Storage	Storage code: **FL** (Organic) [Colourless liquid, characteristic 'ketone' odour]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).** • **General spills**: **HIGHLY FLAMMABLE** (all), **VOLATILE** (propanone, butan-2-one). Vapours are irritating.

85A Risk Assessment Guidance

Propanone and other ketones (1)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
• Propanone • Butan-2-one	 DANGER (See reverse)	Y7	• Wear eye protection. • Ensure no naked flames or other sources of ignition. • Transfer or dispense in a fume cupboard. • Ensure laboratory is well-ventilated. Avoid inhaling vapour. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance:** • **Heating**: Do **not** use a naked flame. Use hot water from a kettle or use electrically-heated baths. Boiling points (°C): propanone, 56.1; butanone, 79.6. • **Using propanone to dry glassware**: Do **not** use routinely. Reserve for special cases when speed is essential. Work in a fume cupboard. Ensure no naked flames. Rinse glassware in a small volume of propanone; leave to dry in the fume cupboard. **Disposal**: W7 → 1 M (~ 5 % v/v)
Aqueous solutions of propanone	See *Recipe* 2		
4-methylpentan-2-one	 DANGER (See reverse)	TT	This ketone is used as a solvent for protactinium generators. Follow the procedure in *Making, storing, monitoring & using a protactinium generator*. • Wear eye protection. • Wear disposable nitrile gloves and a laboratory coat. **Disposal**: see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for 4-methylpentan-2-one**: • **Solvent for protactinium generator:** See *Making, monitoring & using a protactinium generator* and *Managing Ionising Radiations and Radioactive Substances in Schools and Colleges* (L93).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

85B Risk Assessment Guidance — Other ketones (2)

Cyclohexanone	$C_6H_{10}O$ (98.14)
 WARNING	Flammable liquid and vapour [H226]. Harmful if inhaled [H332]. **Cyclohexanone is dangerous in contact with**: • ORGANOHALOGENS (including 1,1,1-TRICHLOROETHANE). May react violently after a long delay. • NITRIC(V) ACID and OTHER OXIDISING AGENTS. A violent reaction occurs. WEL (mg m^{-3}): 41 (LTEL), 82 (STEL), Sk Flash point: 44 °C
Storage	Storage code: **FL** (Organic) [Colourless liquid; ‘peardrops’ odour]

Phenylethanone	*acetophenone*	$C_6H_5COCH_3$ (120.15)
1,2-diphenylethanedione	*benzil*	$C_6H_5(CO)_2C_6H_5$ (210.23)
 WARNING	Note: Hazard classification and labelling may differ from that given here. **Acetophenone**: Harmful if swallowed [H302]. Causes serious eye irritation [H319]. **Benzil**: Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].	
Diphenylmethanone	*benzophenone*	$C_6H_5COC_6H_5$ (182.22)
 WARNING	Note: Hazard classification and labelling varies. Suppliers may indicate one or more of: Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. May cause damage to organs through prolonged or repeated exposure [H373]. Toxic to aquatic life with long lasting effects [H411].	
Storage	Storage code: **GOrg** • **Acetophenone**: Colourless viscous liquid; solidifies at ~ 20 °C • **Benzil**: Yellow solid. **Benzophenone**: White solid; floral odour.	

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

85B Risk Assessment Guidance **Other ketones (2)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Cyclohexanone	 WARNING (See reverse)	TT (Y9)	• Wear eye protection. • Use a fume cupboard and avoid naked flames or other sources of ignition when transferring or dispensing cyclohexanone. • Ensure laboratory is well-ventilated if using on the open bench (or use a fume cupboard). Avoid inhaling vapours. • Take particular care to avoid skin contact (cyclohexanone). See activity-specific guidance and/or GL 120 **Other notes; see also detailed activity-specific guidance**: • **Reactions of a carbonyl group**: These ketones can be used for small-scale (drops, test-tube) reactions. **Disposal**: On this scale, residues may be flushed down a foul-water drain with plenty of water. **Disposal**: W2
• Phenylethanone (*acetophenone*) • Diphenylethanedione (*benzil*)	 WARNING (See reverse)		
Diphenylmethanone (*benzophenone*)	 WARNING (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

86A Risk Assessment Guidance — Silicon & silicon(IV) oxide

Silicon	Si (28.09)
Silicon(IV) oxide *silica, sand*	SiO_2 (60.09)

Currently not classified as hazardous but note:

Silicon**:** WEL (mg m^{-3}): 10 (LTEL), respirable dust
4 (LTEL), inhalable dust

Silica: WEL (mg m^{-3}): 6 (LTEL), respirable dust (amorphous)
2.4 (LTEL), inhalable dust (amorphous)
0.1 (LTEL), respirable dust (crystalline)

Avoid inhaling dust. Silica exists in different forms and some are classified with health hazards. As a fine dust (especially if crystalline), silica can, if inhaled and over long periods of time, cause health problems. However, in school science activities exposure via inhalation is very low and controlled if risk assessment advice is followed.

See notes on reverse of this *Hazcard*.

Storage	Storage code: **GIn** [Silicon, silver-grey. Silicon(IV) oxide, various]

Mineral wool *ceramic fibre wool (various trade names)*	-
Silica gel and self-indicating silica gels with no hazard classification	-

Currently not classified as hazardous but see notes above regarding silica dust. Note also:

- **Self-indicating silica gels**: It is possible to obtain colour-changing gels that are not classified as hazardous. Some can be regenerated by gentle heating and so may be used more than once. The gels are impregnated with various indicators and may be suitable replacements for cobalt(II)-based moisture indicating gels.
- **Mineral (ceramic fibre) wool and heat-resistant paper**: Purchase and use those that are not classified as hazardous.

Self-indicating silica gel containing cobalt(II) chloride

DANGER

Silica gels containing cobalt(II) chloride may be labelled as indicated here, depending on the quantity of cobalt(II) salt they contain. Check supplier's information and see also notes on reverse of this *Hazcard*.

Storage	Storage code: **GIn**
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

86A Risk Assessment Guidance — Silicon & silicon(IV) oxide

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• Silicon • Silicon(IV) oxide • Mineral wool • Silica gel & self-indicating silica gel (non-cobalt)	Currently not classified as hazardous. Beware of dust inhalation.	Y7	• Wear eye protection. • Avoid raising/inhaling dust. Wash hands thoroughly after use. • Wipe up spills immediately with a damp disposable cloth/paper towel. • Take particular care to avoid skin contact. Wear gloves when transferring large quantities of desiccant. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Transferring/weighing solids**: To avoid raising dust, transfer solids in a fume cupboard that is **not** switched on. Have sash partially down. • **Self-indicating silica gel containing cobalt(II) chloride**: Use gels containing alternative indicators where possible. However, exposure to cobalt(II) via inhalation is low and controlled if risk assessment advice is followed. See also *Hazcard* 25. • **Design & Technology activities involving silica**: See CLEAPSS' Design & Technology section, *Model Risk Assessments*. **Disposal**: W3, W8, WSpec; see below
Self-indicating silica gel with cobalt(II) chloride (See *Hazcard* 25)	 DANGER	TT (Y7)	

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **Silicon & sand/silica**: Wrap contaminated cloths/paper towels before placing in the normal refuse, **W8**. • **Silica gels (no hazard classification):** Regenerate or recycle if possible, **W3**. Otherwise, **W8**. • **Silica gels (self-indicating with hazard classification)**: Use a fume cupboard. Regenerate/recycle where possible, **W3**. Otherwise, **WSpec**: add the solid to plenty of water and leave for 24 hours. Decant liquid down a foul-water drain with further dilution. Wrap and place remaining solid in the normal refuse. • **Contaminated mineral wool**: Check activity-specific guidance.

86B Risk Assessment Guidance — Silicon tetrachloride

Silicon tetrachloride *silicon(IV) chloride* $SiCl_4$ (169.89)

WARNING

and/or

DANGER

Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Reacts violently with water [EUH014].

Note that silicon tetrachloride reacts with water to produce fumes of hydrogen chloride/hydrochloric acid (CORROSIVE and TOXIC if inhaled). This may be reflected in the labelling by some suppliers.

Silicon tetrachloride is dangerous in contact with:

- WATER. There is a vigorous exothermic reaction producing fumes of hydrochloric acid.
- REACTIVE METALS (eg, SODIUM, POTASSIUM, MAGNESIUM). Vigorous reactions occur.

Avoid purchasing/storing this chemical. Make in situ when required. See notes below/on reverse.

Storage

Storage code: **Spec** or **Situ**, see below and on reverse [Colourless, fuming liquid]

- **For existing stock (bottles)**: **Storage is pending immediate disposal. Keep cool and dry**. **Do not attempt to open a bottle**. The volatile liquid reacts with water (hydrolysis) to form hydrogen chloride gas and solid silicon dioxide. Once opened, any silicon dioxide formed around the mouth of the bottle may seal it. In warm conditions, the bottles have been known to explode. To minimise this risk, store bottle inside another (tough plastic) container that also contains silica gel desiccant.
- **For existing stock (ampoules)**: Keep ampoules in their protective packaging with other corrosives. Ampoules (unopened) keep indefinitely. Do **not** retain any unused silicon tetrachloride from an ampoule after opening. See **Disposal**.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes).**
- **CORROSIVE, TOXIC (inhalation)**. Procedures or reactions may produce hydrogen chloride gas.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

86B Risk Assessment Guidance **Silicon tetrachloride**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Silicon tetrachloride	 WARNING and/or  DANGER (See reverse)	TT (Y12)	A number of incidents reported to CLEAPSS have involved silicon tetrachloride, often when a bottle cap has become 'stuck' or a bottle has exploded inside its outer container. **Do NOT attempt to open a bottle**. **Contact CLEAPSS**. **CLEAPSS' advice is to make the chemical *in situ* rather than buying & storing it.** • Wear splash-proof goggles. • Use a fume cupboard. • Avoid inadvertent contact with water. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Opening ampoules (TT)**: Seek additional detailed guidance/training before attempting this procedure for the first time. • **Preparing silicon tetrachloride/investigating its reactions**: See *Preparing and Using Silicon(IV) Chloride* for details. Do **not** keep the product. **Disposal**: W4, see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W4**: Use a fume cupboard. Add in small portions to 1 M sodium carbonate solution. Use no more than 5 cm^3 of silicon tetrachloride per 200 cm^3 of sodium carbonate. Allow reaction to subside after each addition and before adding more. Flush the mixture down a foul-water drain with further dilution.

Silver and its compounds

Silver nitrate(V) — $AgNO_3$ (169.87)

DANGER

May intensify fire; oxidiser [H272]. Causes severe skin burns and eye damage [H314]. Very toxic to aquatic life with long lasting effects [H400, H410]. Note: Some suppliers may also indicate harmful if swallowed [H302].

Silver nitrate(V) is dangerous in contact with:

- AMMONIA and ETHANOL. Explosive compounds (fulminates with ethanol) form under certain conditions.
- MAGNESIUM. Mixture of solids is explosively unstable. A trace of moisture can trigger the explosion.

WEL (mg m^{-3}): 0.01 (LTEL), 0.03 (STEL); as soluble silver

Storage

Storage code: **CS** [White-grey crystalline solid]

- Store solid and solutions in dark bottles. Use only distilled or deionised water to make up solutions.
- Do **NOT** add silver residues to organic waste containers; keep separate (in a silver-residues bottle) but do **NOT** dispose of Tollen's reagent in this way (see **Other notes** and **Disposal**, on reverse).

Silver metal	Ag (107.90)
Silver chloride	AgCl (143.30)
Silver bromide	AgBr (187.80)
Silver iodide	AgI (234.80)

Currently not classified as hazardous. See detailed guidance for information about activities involving nanosilver.

WEL (mg m^{-3}): 0.1 (LTEL), 0.3 (STEL); as metallic silver

Storage

Storage code: **GIn** [Silver-grey metal]

- **Silver halides**: Store in dark bottles. The solids are light sensitive.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes). TOXIC (ingestion).**

  Silver nitrate (solid and even dilute solutions) is very dangerous to eyes. It stains clothes, skin and other organic material black. The stain is difficult to remove but will fade over time. Work surfaces also stain.

87 Risk Assessment Guidance — Silver and its compounds

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Silver nitrate solid	DANGER Oxidiser. Corrosive (skin, eyes).	Y12	• Wear eye protection even when dilute solutions are used. • Splash-proof goggles are advised when transferring or dispensing large quantities of corrosive solutions. • Take particular care to avoid skin contact (staining occurs even with dilute solutions). See activity-specific advice and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparation of silver nitrate(V) solutions (TT)**: see *Recipe* 77. • **Use of silver nitrate(V) solutions**: It is rarely necessary to use solutions ≥ 0.18 M; solutions below 0.1 M (or even 0.05 M) will be adequate for many activities. • **Tollen's reagent**: This should be prepared ***in situ* only** and disposed of immediately after use (no more than 30 minutes after preparation). Rinse away down a foul-water drain, W7. See also *Testing for carbonyl compounds with Tollen's reagent*. **Disposal**: see notes below
Solutions: ≥ 0.3 M	DANGER Corrosive (skin, eyes)		
< 0.3 and ≥ 0.18 M	DANGER Corrosive (eyes) Irritant (skin)		
< 0.18 and ≥ 0.06 M	WARNING Irritant (skin, eyes)	Y7	
< 0.06 M	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **NEVER** add silver residues to organic waste containers; keep separate. • **Silver solutions**: **W7** → 0.05 M. • **Silver halide precipitates**: Retain for collection by a Registered Waste Carrier, **W2**. Alternatively, **WSpec**: Add 1 M sodium thiosulfate to dissolve the solid. Dilute to give a silver concentration below 0.05 M then rinse away down a foul-water drain. • **Tollen's reagent**: Prepare *in situ* **only** then dispose of within 30 minutes by rinsing away down a foul-water drain, **Wspec**.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Sodium Na (22.99)

DANGER

Reacts violently with water [EUH014]. In contact with water releases flammable gases which may ignite spontaneously [H260]. Causes severe skin burns and eye damage [H314].

Sodium is dangerous in contact with:

- WATER. Hydrogen gas is given off which ignites. Corrosive liquid spits out.
- ACIDS, MERCURY, SULFUR, BROMINE, IODINE & OXIDISING AGENTS. Violent or explosive reactions occur.

Storage

Storage code: **FW** [Silvery, soft metal]

- Store under paraffin liquid ('medicinal paraffin', see *Hazcard* 45B). Ensure the liquid covers the sodium. Check regularly and replace the liquid if it is dirty or beginning to solidify.
- Store away from water/water-based reagents. Do **not** store in the flammables cupboard or with flammable liquids. Stand the bottle of sodium inside another clean, dry container (labelled) to keep it upright. A clean, dry metal tin (eg, a biscuit tin) could be used. See *Storage of chemicals*.
- Purchase small quantities only (eg, 25 g will be adequate) so that stock is fresh. Corrosion occurs on the surface of the metal and needs to be cut off (see **Disposal, WSpec**; on reverse).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes), alkali**.
- **If sodium catches fire**: Sodium burns vigorously and is difficult to extinguish. Smother small fires with **clean**, **dry** sand (keep a container of sand specifically for this purpose).
- General **spills/clearing up**: **FLAMMABLE WATER-REACTIVE**. Prevent spill from spreading. Use forceps to pick up metal pieces. Place pieces in a clean, dry container, cover with fresh oil and store for disposal by a Registered Waste Carrier. Cover remaining spill with absorbent and scoop into a dry bucket.*

  Add small portions of contaminated absorbent to an excess of Industrial Denatured Alcohol (IDA). Once reaction is complete (this may take time), dilute by adding portions to a bucket of cold water and then flush away down a foul-water drain.

  *Spill area may then be mopped but beware of possible sparks from any remaining sodium fragments.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

88 Risk Assessment Guidance

Sodium

Take steps to prevent theft. After any use of sodium (eg, a demonstration), ensure that the bottle is securely locked away.
In addition, to ensure that a technician will not be faced with a sudden fire when clearing up, place any tiles plus the equipment used to cut or handle pieces of sodium into a large bowl of cold water.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Sodium	 DANGER (See reverse)	TT (Y12)	• Wear splash-proof goggles. • Take particular care to avoid skin contact. Use tweezers or forceps to transfer pieces of sodium. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparing sodium for use**: All equipment must be **dry**. Use forceps to place a piece of sodium onto a tile. Use a sharp knife to cut off the required piece. Immediately return the unwanted sodium to its bottle and close lid. Dab the cut piece of sodium with a paper tissue or filter paper to remove the oil (medicinal paraffin). Do **not** use organic solvents, such as petroleum spirit or hexane to remove the oil; this has caused fires when clearing up. **Disposal**: WSpec, see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **WSpec**: Add the metal (no more than 5 g) in small pieces (~ 4 mm sides) a few at a time, to 100 cm^3 of propan-2-ol (*iso*-propanol) in a glass beaker. Place a heat-proof mat over the beaker to extinguish any flames caused by the propan-2-ol vapour catching fire. Allow the reaction to subside before adding more pieces of sodium. Once reaction is complete, carefully add solution to a bucket of cold water and pour down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Sodium chlorate(I) & dichlorisocyanurate

Sodium chlorate(I)	*sodium hypochlorite, bleach* NaClO (74.44)
 DANGER	Causes severe burns and eye damage [H314]. Contact with acids liberates toxic gas [EUH031]. Very toxic to aquatic life [H400]. **Sodium chlorate(I) is dangerous in contact with**: • ACIDS. Chlorine gas (TOXIC) is liberated. • CONCENTRATED SULFURIC(VI) ACID. A dangerous reaction occurs. • AMMONIUM SALTS, AMINES, METHANOL. Explosive products form.
Storage	Storage code: **CLb** [Colourless liquid; strong chlorine odour] • Available as a 10 - 14% (w/v) 'available chlorine' solution. Will gradually loses chlorine to the atmosphere. Pressure may build up, especially in warm conditions; open bottles carefully in a fume cupboard. Ensure storage area is well-ventilated (the chlorine will also accelerate rusting). The solution has a limited shelf-life; see *Recipe* 81.

Sodium dichloroisocyanurate	*sodium troclosene, disinfectant/water purification (various trade names)* $NaC_3N_3O_3Cl_2$ (219.95)
 DANGER	May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Contact with acids liberates toxic gas [EUH031]. Very toxic to aquatic life with long lasting effects [H410].
Storage	Storage code: **GIn** [Colourless/white solid] • The solid produces a slight 'chlorine' odour but it can be stored for several years.

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (skin, eyes):** sodium chlorate(I) solution. • **General spills: OXIDISING** (sodium dichloroisocyanurate).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

89 Risk Assessment Guidance

Sodium chlorate(I) & dichlorisocyanurate

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solutions ≥ 5%* (5% is ~ 0.7 M $NaClO$)	 DANGER Corrosive (skin, eyes)	Y12	• Wear eye protection. Wear splash-proof goggles for solutions of sodium chlorate(I) ≥ 5% (w/v available chlorine). • Ensure laboratory is well-ventilated. Many activities will require the use of an efficiently-working fume cupboard. • Take particular care to avoid skin contact with solutions ≥ 5%. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • Do **not** confuse sodium chlorate(I) with the sodium chlorate(V). Sodium chlorate(V) is a solid (used, for example, as commercial weedkiller). • **Preparation of sodium chlorate(I) solutions**: *Recipe* 81. • **Preparation of chlorine gas (TT)**: *Recipe* 24. • **Preparation of chlorine water (TT)**: see *Recipe* 25.
< 5% and ≥ 3% (3% is ~ 0.4 M $NaClO$)	 DANGER Corrosive (eyes) Irritant (skin)	Y9	
< 3% and ≥ 1% (1% is ~ 0.15 M $NaClO$)	 WARNING Irritant (skin, eyes)	Y7	
Solid sodium dichloroisocyanurate and solutions ≥ 0.5 M	 (s) DANGER  (s)/(aq) WARNING (aq) (See reverse) Note: the solid reacts with water to form chlorine gas. See *Hazcard* 22A	TT (Y7)	**Disposal**: chlorate(I), W7 → 0.5 % dichloroisocyanurate, W7 → 0.05 M

*as w/v available chlorine

Disposal	Follow general guidance in *About Hazcards* (GL 120).

90 Risk Assessment Guidance Sodium dithionite, $Na_2S_2O_4$

Sodium dithionite *sodium hydrosulfite* $Na_2S_2O_4$ (174.11)


DANGER

Self-heating: may catch fire [H251]. Harmful if swallowed [H302]. Contact with acids liberates toxic gas [EUH031].

Sodium dithionite is dangerous in contact with:

- WATER. Addition of small volumes of water to the solid can cause spontaneous ignition.
- HEAT. The solid decomposes at ~ 90 °C. Sulfur dioxide gas (toxic, corrosive) is produced. See *Hazcard* 97.
- ACIDS. Sulfur dioxide gas (TOXIC, CORROSIVE) is generated. See *Hazcard* 97.
- OXIDISING AGENTS. Explosive mixtures may form.

Storage

Storage code: **FS** [Grey-white powder; ‘sulfurous’ odour]

- **FIRE RISK**. If sodium dithionite is slightly damp it can spontaneously ignite in air. Keep container securely closed and store in a dry, cool and well-ventilated space. Keep away from water, acids and oxidisers.
- With moisture, sulfur dioxide gas (toxic, corrosive) will be evolved.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **Inhalation of sulfur dioxide gas: TOXIC, CORROSIVE. BEWARE DELAYED EFFECTS.** Sulfur dioxide gas is formed when sodium dithionite decomposes or reacts. See *Hazcard* 97.
- **General spills: TOXIC, CORROSIVE.** Large spills of the solid or concentrated solutions may be difficult to deal with because appreciable volumes of sulfur dioxide gas can be produced. Evacuate the area. Do not put yourself or others in danger of inhaling this toxic and corrosive gas.

  If safe to deal with: Scoop up as much solid as possible. Rinse the area with copious amounts of water, add absorbent and clear up. Treat the collected solid as described in **Disposal** (on reverse).

90 Risk Assessment Guidance — Sodium dithionite, $Na_2S_2O_4$

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid	 DANGER (See reverse)	Y12 (Y9)	• Wear eye protection. • Use a fume cupboard when using the solid and/or preparing solutions. • Ensure laboratory is well-ventilated. • Avoid inadvertent contact with acids or small amounts of water. **Other notes; see also detailed activity-specific guidance**: • **General use of the solid**: Design activities to minimise the need for students to directly use or transfer the solid. • **Preparing solutions (Y12)**: Solutions do **not** keep so must be made immediately before use. Use a fume cupboard. Weigh the required mass of sodium dithionite in a small, **dry** beaker. Add the solid (in small portions) with stirring to at least 80% of the final volume of water. **Disposal**: solid, WSpec; see below solutions, W7 → 0.1 M
Saturated solutions ~ 1.4 M	 WARNING Harmful (ingestion)		
Solutions < 1.4 M	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **Disposal of solid [Wspec]:** Use a fume cupboard. Add no more than 20 g of solid in 5 g portions to 1 dm^3 (1 litre) of water with stirring. Allow reaction to subside after each addition and before adding the next portion. Pour the resulting liquid down a foul-water drain with further dilution.

91A Risk Assessment Guidance — Sodium hydroxide and soda lime

<table>
<tr><td colspan="2">Sodium hydroxide <i>caustic soda</i> NaOH (40.00)</td></tr>
<tr><td colspan="2">Soda lime and <i>Carbosorb</i></td></tr>
<tr><td>
DANGER</td><td>Causes severe skin burns and eye damage [H314].
This substance (sodium hydroxide) is dangerous in contact with:
• WATER. A vigorous exothermic reaction occurs. So much heat is evolved that boiling could occur. A choking mist is often formed as the solid dissolves.
• ZINC, ALUMINIUM. Hydrogen is evolved.
WEL (mg m^{-3}): 2.0 (STEL); sodium hydroxide</td></tr>
<tr><td>Storage</td><td>Storage code: CS [White solids: beads/pellets/powder, sodium hydroxide; granules, soda lime]
• Sodium hydroxide: Absorbs both water and carbon dioxide from the atmosphere. If the solid forms a cake, it may be necessary to dispose of it, W1 (caked solid will still be corrosive). Solutions absorb carbon dioxide from the atmosphere (a white solid will collect around the lid/stopper). Dilute solutions are particularly affected and are best stored in plastic screw-top bottles; avoid the use of ‘polystop’ bottles.
• Soda lime: This is used to absorb carbon dioxide. Approximate composition by mass: 5% NaOH, 1% KOH, 0.2% silica, 14-19% water and $Ca(OH)_2$ to make a total of 100%. Self-indicating soda lime (eg, <i>Carbosorb</i>) changes colour when its carbon dioxide-absorbing capacity is exhausted. Soda lime can also be used to absorb corrosive acidic fumes (eg, from bromine and acid chlorides during storage).</td></tr>
</table>

<table>
<tr><td>Emergencies</td><td>Follow standard procedures (see <i>Emergency Hazcards</i> and GL 120). NOTE:
• CORROSIVE (skin, eyes, inhalation), alkali: Solid and solutions.
Beware: even dilute solutions can cause eye damage.</td></tr>
</table>

91A Risk Assessment Guidance — Sodium hydroxide and soda lime

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Soda lime and solid sodium hydroxide	DANGER Corrosive (skin, eyes)	TT (Y9)	• Wear splash-proof goggles. • Protect the face when transferring/dispensing large quantities. • Take particular care to avoid skin contact. Use a spatula or forceps for transferring the solid. See activity-specific guidance and/or GL 120. • Avoid raising/inhaling dust (solids). **Other notes; see also detailed activity-specific guidance**: • **Preparation of sodium hydroxide solutions (TT)**: See *Recipe* 85. Seek additional guidance/training before attempting this procedure for the first time. Solutions < 2 M are adequate for many pre-16 activities.
Sodium hydroxide solutions ≥ 0.5 M			**Disposal**: W7 → 0.1 M; or W5. Solids: see below
Solutions < 0.5 M and ≥ 0.125 M	WARNING Irritant (skin, eyes)	Y7	• Wear eye protection even when dilute solutions are used. **Other notes; see also detailed activity-specific guidance**: • Experience of the use of this alkali in school science activities indicates that it is appropriate to apply the control measures given here. It is advisable to include a warning to this effect on the label.
Solutions < 0.125 M	Currently not classified as hazardous		**Disposal**: W7 → 0.1 M; or W5

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts of the solids:** • **Sodium hydroxide**: Dissolve solid to make a 1 M solution then follow **W5** using 1 M ethanoic acid to neutralise. • **Soda lime**: Add no more than 50 g of the solid to 1 litre of 1 M or 2 M hydrochloric (or nitric) acid with stirring. Once dissolved, pour solution down a foul-water drain with more water.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

91B Risk Assessment Guidance Potassium hydroxide and lithium hydroxide

Potassium hydroxide	*caustic potash*	KOH (56.11)
Lithium hydroxide	*anhydrous lithium hydroxide*	LiOH (23.95)
Lithium hydroxide hydrate	*lithium hydroxide monohydrate*	$LiOH.H_2O$ (41.96)

DANGER

Causes severe skin burns and eye damage [H314]. Harmful if swallowed [H302].

These substances are dangerous in contact with:

- WATER. A vigorous exothermic reaction occurs. So much heat is evolved that boiling could occur. A choking mist is often formed as the solid dissolves.
- ZINC, ALUMINIUM. Hydrogen is evolved.

WEL (mg m^{-3}): 2.0 (STEL) potassium hydroxide; 1.0 (STEL) lithium hydroxide

Storage

Storage code: **CS** [White solids; often as pellets for potassium hydroxide]

- **Potassium hydroxide**: Absorbs both water and carbon dioxide from the atmosphere. If the solid forms a cake, it may be necessary to dispose of it, W1 (caked solid will still be corrosive). Solutions absorb carbon dioxide from the atmosphere (a white solid will collect around the lid/stopper). Dilute solutions are particularly affected and are best stored in plastic screw-top bottles; avoid the use of ‘polystop’ bottles.
- **Lithium hydroxide**: Absorbs both water and carbon dioxide from the atmosphere. Solutions behave similarly to those of potassium hydroxide.

Emergencies

Follow standard procedures (see *Emergency Hazcard*s and GL 120). NOTE:

- **CORROSIVE (skin, eyes, inhalation), alkali**: Solid & solutions.

  Beware: even dilute solutions can cause eye damage.

91B Risk Assessment Guidance Potassium hydroxide and lithium hydroxide

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Lithium/potassium hydroxide solids. Potassium hydroxide solutions* ≥ 3 M	 DANGER Corrosive (skin, eyes) Harmful (ingestion)	TT (Y9)	• Wear splash-proof goggles. • Protect the face when transferring/dispensing large quantities. • Take particular care to avoid skin contact. Use a spatula or forceps to transfer the solid. See activity-specific guidance and/or GL 120. • Avoid raising/inhaling dust (solids). **Other notes; see also detailed activity-specific guidance**: • **Preparation of solutions (TT)**: See *Recipe* 71 for both potassium hydroxide and lithium hydroxide. Seek additional guidance or training before attempting this procedure for the first time. **Disposal**: solutions, W7 → 0.1 M; or W5 solids, see below
Potassium hydroxide solutions* < 3 M and ≥ 0.4 M	 DANGER Corrosive (skin, eyes)		
Potassium hydroxide solutions* < 0.4 M and ≥ 0.1 M	 WARNING Irritant (skin, eyes)	Y7	• Wear eye protection even when dilute solutions are used. **Other notes; see also detailed activity-specific guidance**: • Experience of the use of this alkali in school science activities indicates that it is appropriate to apply the control measures given here. It is advisable to include a warning to this effect on the label. **Disposal**: W7 → 0.1 M; or W5
Potassium hydroxide solutions* < 0.1 M	Currently not classified as hazardous		

*See *Recipe* 71 for lithium hydroxide.

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> of the solids:** • Dissolve solid to make a 1 M solution then follow **W5** using ethanoic acid (1 M) to neutralise.

Sodium and potassium metabisulfite

Sodium metabisulfite	*sodium disulfite, disodium disulfate(IV)*	$Na_2S_2O_5$ (190.11)
Sodium bisulfite	*sodium hydrogensulfite, sodium hydrogensulfate(IV)*	$NaHSO_3$ (104.06)
Sodium sulfite	*sodium sulfate(IV)*	Na_2SO_3 (126.04)
Potassium metabisulfite	*potassium disulfite, dipotassium disulfate(IV)*	$K_2S_2O_5$ (222.32)
Potassium bisulfite	*potassium hydrogensulfite, potassium hydrogensulfate(IV)*	$KHSO_3$ (120.17)
Potassium sulfite	*potassium sulfate(IV)*	K_2SO_3 (158.26)

DANGER

Harmful if swallowed [H302]. Causes serious eye damage [H318]. Contact with acids liberates toxic gas [EUH031]. Note: Classification and labelling vary by supplier (especially for the potassium compounds). CLEAPSS currently advises this classification be assumed for all the above.

These compounds are dangerous in contact with:

- ACIDS or HEAT. Sulfur dioxide gas (TOXIC) is produced.
- SODIUM NITRATE(III) [SODIUM NITRITE]. A vigorous, exothermic reaction occurs.

WEL (mg m^{-3}): 5 (LTEL), 15 (STEL); sodium metabisulfite, sodium bisulfite

Storage

Storage code: **GIn** [White crystalline solids]

- All these substances react with moisture in the air to release sulfur dioxide (toxic). They are also subject to oxidation when exposed to oxygen/air. The metabisulfites last longer during storage.
- Metabisulfite is sold as a source of bisulfite. 2 moles of **bi**sulfite form per mole of **metabi**sulfite dissolved.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **TOXIC (inhalation): BEWARE DELAYED EFFECTS. Sulfur dioxide gas (toxic) diffuses from sulfite solutions. The effects of exposure by inhalation of this gas may or may not be immediately apparent and can develop and/or increase over time. Inhalation of sulfur dioxide by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions.**

  See also *Hazcard* 97.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

92 Risk Assessment Guidance — Sodium and potassium metabisulfite

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

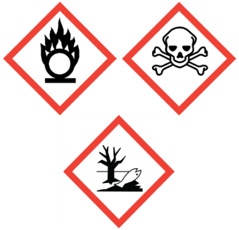
General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solids: • metabisulfite • bisulfite • sulfite	DANGER (See reverse)	TT (Y9)	**BEWARE DELAYED EFFECTS. Sulfur dioxide gas (toxic) diffuses from sulfite solutions. The effects of exposure by inhalation of this gas may or may not be immediately apparent and can develop and/or increase over time. Inhalation of sulfur dioxide by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions. See *Hazcard* 97.** • Wear eye protection. Wear splash-proof goggles for corrosive solutions. • Do not inhale (eg, over solutions). Ensure laboratory is well-ventilated. A fume cupboard will be required for some activities. • Gloves may be advised for some practical procedures or for users with wounds or skin conditions. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparing solutions (TT)**: Use a fume cupboard. See *Recipe* 97. • **Using solutions**: A solution may be used to substitute for sulfur dioxide solution or to provide an atmosphere of sulfur dioxide. Use less than 1 cm^3 per test tube if used in the open lab. See activity-specific guidance. • **'Acid rain'**: Use 0.0001 M sulfuric acid; not metabisulfite solution. **Disposal**: W1 or Wspec, see below
Solutions* ≥ 0.15 M	DANGER Corrosive (eyes) Harmful (ingestion)	Y9	
Solutions* < 0.15 M & ≥ 0.05 M	WARNING Irritant (eyes) Harmful (ingestion)	Y7	
*Solutions release sulfur dioxide gas (toxic).			

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **WSpec (solid, solution)**: In a fume cupboard, add solid to water in small portions. To this (or existing) solution, add litmus indicator then 1 M sodium carbonate solution until mixture is alkaline. Pour down a foul-water drain with further dilution.

Sodium and potassium nitrate(III)

Do NOT confuse these compounds with sodium nitrate(V) and potassium nitrate(V).

Sodium nitrate(III)	*sodium nitrite*	$NaNO_2$ (68.99)
Potassium nitrate(III)	*potassium nitrite*	KNO_2 (85.10)



DANGER

May intensify fire; oxidiser [H272]. Toxic if swallowed [H301]. Very toxic to aquatic life [H400].

These compounds are dangerous in contact with:

- ACIDS. Nitrogen oxides (toxic) are given off.
- COMBUSTIBLE MATERIALS. Paper, wood, clothes etc., will burn easily if they have been soaked or impregnated with nitrate(III) solutions and allowed to dry out.
- AMMONIUM SALTS, CYANIDES, PHENOL, THIOSULFATES. Explosive, unstable mixtures form. These may explode on contact.

Do NOT carry out reactions between nitrites and secondary or tertiary amines (even as small-scale tests). The products are carcinogenic.

Storage

Storage code: **T** [White crystalline solids]

- Nitrites are oxidisers. Do **not** store alongside flammable liquids (FL) or other combustible materials such as organic chemicals (GOrg).

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **TOXIC (ingestion).**
- **General spills**: **OXIDISING, TOXIC**.

  Note: If spilt on skin or clothes. Remove contaminated clothing. Wash off skin with plenty of water. Soak and thoroughly rinse contaminated clothing.

Sodium and potassium nitrate(III)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Solids	 DANGER (See reverse)	TT (Y12)	**Do NOT confuse these compounds with sodium nitrate(V) and potassium nitrate(V).** • Wear eye protection. • Take particular care to avoid skin contact (solid, solutions ≥ 4.0 M). See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Use of solutions (students)**: Use 0.1 M solutions prepared by the teacher or technician. • **Ammonium nitrite preparation**: **NEVER** attempt to prepare the solid salt. Even solutions can explode if sufficiently concentrated. • **Preparation of nitric(III) acid (nitrous acid)**: Prepare just before use. Wear eye protection. Use a fume cupboard for the preparation of volumes greater than 10 cm^3. Keep solution cold (below 5 ^{o}C); if warmed, nitrogen oxides (toxic) are produced. **Disposal**: W1, W2 (solids), see also note below
Solutions: ≥ 4.0 M	 DANGER Toxic (ingestion)		
Solutions: < 4 M and ≥ 0.5 M	 WARNING Harmful (ingestion)	Y9	
Solutions: < 0.5 M	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • Check activity-specific guidance for disposal of prepared nitrate(III) solutions.

Sodium peroxide and potassium superoxide

Sodium peroxide Na_2O_2 (77.98)

Potassium superoxide *potassium dioxide* KO_2 (71.10)

DANGER

May cause fire or explosion; strong oxidiser [H271]. Causes severe skin burns and eye damage [H314].

Note: Both substances react very vigorously with water and some suppliers may also include the hazard statement: Reacts violently with water [EUH014].

These substances are dangerous in contact with:

- WATER. Vigorous reaction (may be violent) occurs producing a corrosive solution.
- COMBUSTIBLE MATERIAL including ORGANIC SUBSTANCES. Violent or explosive reactions can occur. May ignite spontaneously, particularly if damp.
- ETHANOIC ACID, ETHANOIC ANHYDRIDE. Explosion may occur.
- HYDROGEN SULFIDE. The gas may ignite.
- TIN(II) CHLORIDE. May form an explosive mixture.

Storage

Storage code: **Ox** [Yellow-white solids, hygroscopic (absorb water)]

- These yellowish powders turn white on storage because carbon dioxide and water are absorbed.
- The solids are sometimes found in tins that corrode and burst. Check containers regularly.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes, inhalation), alkali.**

  Note: If on skin/clothes, brush off as much solid as possible but do **not** delay irrigation with plenty of cool water to counter the heat generated by the reaction of these peroxides with water.
- **General spills/clearing up**: **OXIDISING, POWDER.** Collect up dry.

  Note: Solids react vigorously with water. Heat and corrosive, alkaline solutions are produced.

Sodium peroxide and potassium superoxide

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• Sodium peroxide • Potassium superoxide	 DANGER Oxidiser. Corrosive (skin, eyes). React violently with water.	TT (Y12)	**Do NOT weigh out these substances on paper.** • Wear splash-proof goggles. • Avoid raising/inhaling dust. • Take particular care to avoid skin contact. Gloves are advised when dispensing the solid. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparation of oxygen (TT)**: Do **not** use these solids. See *Recipe* 64. • **Reaction with water (small-scale, Y12)**: Solutions formed are corrosive. **Disposal:** W5, see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts only:** • **W5**: Use a fume cupboard. Add no more than 10 g of solid in ~1 g portions to 1 litre of water. Allow reaction to subside after adding each portion. Add an indicator (eg, litmus) then add 1 M ethanoic acid, with stirring, until the solution is just acidic. Rinse down a foul-water drain with further dilution.

95A Risk Assessment Guidance — Sodium and potassium salts (1)

Sodium carbonate	*anhydrous sodium carbonate*	Na_2CO_3 (105.99)
Sodium carbonate-10-water	*washing soda*	$Na_2CO_3.10H_2O$ (286.14)
Potassium carbonate		K_2CO_3 (138.21)

 WARNING	Causes serious eye irritation [H319].

Sodium bismuthate(V)	$NaBiO_3$ (279.97)
Sodium thiocyanate-2-water	$NaSCN.2H_2O$ (117.07)
Potassium thiocyanate	KSCN (97.18)

 WARNING	**All**: Harmful if swallowed [H302]. **Sodium/potassium thiocyanate**: Harmful in contact with skin [H312]. Harmful if inhaled [H332]. Contact with acid liberates very toxic gas [EUH032]. Harmful to aquatic life with long lasting effects [H412].

Sodium alginate

Sodium sesquicarbonate, $Na_2CO_3.NaHCO_3.2H_2O$

Sodium hydrogencarbonate, *sodium bicarbonate*, $NaHCO_3$

Potassium hydrogencarbonate, *potassium bicarbonate*, $KHCO_3$

Sodium octadecanoate, *sodium stearate, soap*, $C_{17}H_{35}COONa$

Sodium octa-9-decenoate, *sodium oleate*, $C_{17}H_{33}COONa$

Sodium tauroglycocholate, *bile salts*

Sodium thiosulfate-5-water, *hypo*, $Na_2S_2O_3.5H_2O$

Currently not classified as hazardous.

Storage	Storage code: **GIn** [White/colourless solids] • **Carbonates**: the anhydrous salts absorb water; hydrated salts lose water and become powdery.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120).**

95A Risk Assessment Guidance — Sodium and potassium salts (1)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Sodium bismuthate(V)	 WARNING Harmful (ingestion)	Y7	• Wear eye protection. • Avoid raising dust (especially from the powdered reagents). **Other notes; see also detailed activity-specific guidance**: • **Alginate gels**: Can block sinks. Separate solid gel from water (add a soluble calcium salt to complete gel process). Place in normal refuse. • **Thiocyanates**: · Do **not** heat solids or solutions; toxic gases form. · Under some conditions, contact with acids produces very toxic gases. At dilute concentrations (room temperature), no toxic gases form. • **Preparing sodium carbonate solutions:** *Recipes* 80 and 94. • **Preparing sodium hydrogencarbonate solutions:** *Recipe* 84. • **Preparing sodium thiosulfate solutions:** *Recipe* 87. • **Sodium thiosulfate/acid rate of reaction activities**: Toxic sulfur dioxide gas is produced (*Hazcard* 97). Avoid high temperatures (~ 10 °C to 55 °C is a suitable range). Pour used reaction mixtures into a ‘stop bath’ of sodium carbonate solution (~ 0.5 M) containing an acid-base indicator. **Disposal**: bismuthate, W1, W2 carbonates, W5 thiocyanates, W7 → 2 M other salts, W8, W7
Thiocyanates: solids, and solutions ≥ 2.5 M			
Carbonates: solids, and solutions ≥ 0.8 M	 WARNING Irritant (eyes)		
Other salts listed (solids/solutions)	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Sodium and potassium salts (2)

Disodium peroxodisulfate(VI)	*sodium persulfate*	$Na_2S_2O_8$ (238.11)
Dipotassium peroxodisulfate(VI)	*potassium persulfate*	$K_2S_2O_8$ (270.32)
Sodium hexanitritocobaltate(III)	*sodium cobaltinitrite*	$Na_3Co(NO_2)_6$ (403.94)

DANGER

All: May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Causes skin irritation [H315]. May cause an allergic skin reaction [H317]. Causes serious eye irritation [H319]. May cause allergy or asthma symptoms or breathing difficulties if inhaled [H334]. May cause respiratory irritation [H335].

Sodium hexanitritocobaltate(III): Suspected of causing cancer [H351].

WEL (mg m^{-3}): 0.1 (LTEL), 0.3 (STEL), Carc, Sen; as cobalt (Co)

Storage

Storage code: **Ox** [Persulfates, white solids; cobaltinitrite, yellow-brown solid]

- **Persulfates**: the oxidising 'power' may deteriorate on storage. In the presence of water, oxygen is slowly evolved. Above 50-60 °C, deterioration is rapid in solution.

Sodium silicate solution	*water glass, liquid glass*	
Sodium dodecyl sulfate	*sodium lauryl sulfate*	$C_{12}H_{25}OSO_3Na$ (288.38)

DANGER

(*)

Sodium silicate: Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335]. Note: classification and labelling vary by supplier since much depends on the formulation of the solution.

Sodium dodecyl sulfate: *Flammable solid [H228]. Harmful if swallowed or if inhaled [H302, H332]. Causes skin irritation [H315]. Causes serious eye damage [H318]. May cause respiratory irritation [H335]. Harmful to aquatic life with long lasting effects [H412].

Storage

Storage code: **GIn** (both, as solids), **CLb** (sodium silicate solution) [White or colourless solids; see note below]

- **Sodium silicate**: Do not buy the solid; it is very slow to dissolve in water. It is more convenient to buy a solution (specific gravity ~ 1.5). The colourless solutions are alkaline.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin, eyes)**: sodium silicate. **CORROSIVE (eyes)**: sodium dodecyl sulfate.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

95B Risk Assessment Guidance **Sodium and potassium salts (2)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solids listed	DANGER (See reverse)	TT (Y9)	- Wear eye protection. Wear splash-proof goggles when transferring or dispensing large quantities of these chemicals. - Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: - **Preparing persulfate solutions (TT)**: Do **not** heat the solutions; persulfates begin to decompose above 50 °C. The sodium salt is more soluble than the potassium one (approximately 545 g vs 50 g per litre at ~ 20 °C). Sodium persulfate solutions ≥ 0.4 M will also be: Harmful (ingestion); Sensitiser (skin). - **Persulfate/iodide 'clock reaction' mixtures**: *Recipe* 29. - **Preparing (TT) and using cobaltinitrite solutions for detecting ammonium or potassium ions**: See *Recipe* 101. - **Preparing sodium silicate (water glass) solutions (TT) and making crystal/chemical gardens:** See *Recipe* 86.
Solutions - persulfates < 0.4 M & ≥ 0.04 M (See **Other notes**) - cobaltinitrite* < 0.2 M & ≥ 0.02 M	 DANGER Irritant (respiratory) Sensitiser (respiratory) *Serious health hazard (CMR)	Y9	
Sodium silicate solutions	 DANGER (See reverse and *Recipe* 86)	TT (Y7)	
Sodium dodecyl sulfate solutions ≥ 0.1 M	 DANGER Corrosive (eyes)	Y9	
< 0.1 M and ≥ 0.03 M	 WARNING Irritant (eyes)	Y7	**Disposal**: cobaltinitrite, W1/W2 See notes below for others.

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: - **WSpec (persulfate solids)**: Use a fume cupboard. Dissolve 5 g of solid in 100 cm^3 of water. Add 5 g of sodium metabisulfite with stirring. Rinse down a foul-water drain. **W7 → 0.04M (persulfate solutions)**. - **W1/W2 (sodium silicate solid**). **W7 (silicate solutions)**: Dilute by 5 x the original volume. Rinse away. - **W7 → 0.05 M;** or **W2 (dodecyl sulfate)**.

95C Risk Assessment Guidance — Sodium and potassium salts (3)

Sodium fluoride	NaF (41.99)
Potassium fluoride	KF (58.10)

DANGER

Sodium fluoride: Toxic if swallowed [H301]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. Contact with acid liberates very toxic gas [EUH032].

Potassium fluoride: Toxic if swallowed [H301]. Toxic in contact with skin [H311]. Toxic if inhaled [H331].

These substances are dangerous in contact with:

- ACIDS. Very toxic gas is given off.

WEL (mg m^{-3}): 2.5 (LTEL), 7.5 (STEL); as fluoride

See *Hazcard* 47B for other Group 1 halide salts.

Sodium azide	NaN_3 (65.01)
Sodium cyanide	NaCN (49.01)
Potassium cyanide	KCN (65.12)

DANGER

All: Fatal if swallowed [H300]. Contact with acid liberates very toxic gas [EUH032]. Very toxic to aquatic life with long-lasting effects [H400/H410].

Cyanides: Fatal in contact with skin [H310]. Fatal if inhaled [H330].

WEL (mg m^{-3}): 0.1 (LTEL), 0.3 (STEL), Sk; sodium azide

WEL (mg m^{-3}): 1 (LTEL), 5 (STEL), Sk; potassium and sodium cyanides (as cyanide)

The use of these salts is NOT recommended. Contact CLEAPSS.

Storage

Storage code: **T** [White or colourless solids]

- **Sodium azide, sodium/potassium cyanide**: storage is only pending disposal, **W1**.

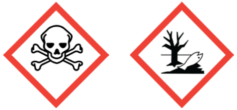
Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

95C Risk Assessment Guidance — Sodium and potassium salts (3)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solid fluorides	 DANGER (See reverse)	TT	• Solid fluorides: Wear splash-proof goggles and gloves. • Fluoride solutions: Wear eye protection. • Ensure that concentrated sulfuric(VI) acid is not in the vicinity when these fluoride salts are being used. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparation of fluoride solutions (TT):** Wear gloves and splash-proof goggles. • **Testing for fluoride ions with silver nitrate**: Use 0.1 M sodium fluoride solution to show that no precipitate forms. See *Recipe* 100 for halide/silver nitrate(V) tests. • **Winkler's method for dissolved oxygen**: some published methods suggest the use of sodium azide. The procedure can, however, be carried out without this, see *Recipe* 105. **Disposal**: W1, see note below
Solutions (fluorides) < 5.0 M & ≥ 0.8 M Sodium fluoride solutions are saturated at ~ 1 M.	 WARNING Harmful (ingestion, skin)	Y9	
• Sodium azide • Sodium cyanide • Potassium cyanide	 DANGER (See reverse) **Use of these salts is NOT recommended. Contact CLEAPSS.**		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W1 (sodium/potassium fluorides)**: Washings from test-tube/drop-scale qualitative silver nitrate tests for fluoride ions may be flushed down a foul-water drain with further dilution, W7.

96A Risk Assessment Guidance — Sulfur, S

The Explosives Regulations prohibit the making of mixtures of sulfur with potassium chlorate(V), or other chlorates, without the prior approval of the Health and Safety Executive (HSE).

Sulfur — S (32.06)


WARNING

Causes skin irritation [H315].

Note*:* Some suppliers also label sulfur as: Flammable solid [H228] and include the GHS02 pictogram.

Sulfur is dangerous in contact with:

- HEAT. It burns to form sulfur dioxide, a toxic gas, see **Emergencies** (below) and *Hazcard* 97.
- ALKALI METALS, MAGNESIUM, CALCIUM, ALUMINIUM. Very reactive mixtures are formed which can be very dangerous. Do **not** perform these activities in schools.
- ZINC. The reaction is very exothermic.
- OXIDISING AGENTS, METAL OXIDES. Explosive mixtures are formed. (Amongst others, mixtures with potassium and sodium chlorates and silver nitrate(V) are particularly unstable).

Storage

Storage code: **FS** or **GIn** — [Yellow powder/solid]

- Although categorised as FS, sulfur may be stored with general inorganic (GIn) chemicals.
- Sulfur can be purchased in different forms: as ‘roll’ sulfur and as ‘flowers of sulfur’. Roll sulfur is a crystalline form and is often sold in large lumps or ready-powdered. Although it consists of S_8 molecules, many suppliers label it as at the top of this card. Flowers of sulfur (a fine powder) are amorphous, ie, there is no specific formula or crystal structure.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **Inhalation of sulfur dioxide gas**: **TOXIC, CORROSIVE. BEWARE DELAYED EFFECTS**.

  Sulfur dioxide gas is formed when sulfur burns. Effects of exposure by inhalation may or may not be immediately apparent and can develop and/or increase over time. Inhalation by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions. See also *Hazcard* 97.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

96A Risk Assessment Guidance Sulfur, S

The Explosives Regulations prohibit the making of mixtures of sulfur with potassium chlorate(V), or other chlorates, without the prior approval of the Health and Safety Executive (HSE).

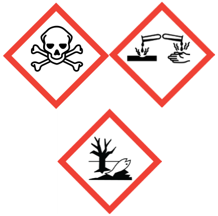
Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Sulfur	 WARNING Irritant (skin)	Y7	• Wear eye protection. • Avoid raising dust. Fine sulfur dust may also be irritating to eyes. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL120. **Other notes; see also detailed activity-specific guidance:** • **Melting sulfur**: Ensure laboratory is well-ventilated. Use a mineral wool plug in the mouth of the test tube to minimise sulfur vapour escaping into the atmosphere and catching fire. Heat slowly and gently because sulfur is a poor conductor of heat (sulfur melts at ~ 100 °C). • **Burning sulfur (TT)**: Use a fume cupboard.
If sulfur dioxide gas (formed when sulfur burns) is inhaled: **TOXIC, CORROSIVE; BEWARE DELAYED EFFECTS**. See reverse and also *Hazcard* 97.			**Disposal**: W2; W8 - see note below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE, for <u>small amounts</u> only**: • **W8**: Once cooled, test tubes contaminated with sulfur (eg, from melting sulfur or from the iron/sulfur reaction) may be placed in the glass bin. Place test tube contents in the normal waste.

96B Risk Assessment Guidance — Sulfur chlorides

Disulfur dichloride *sulfur monochloride* S_2Cl_2 (135.04)



DANGER

Toxic if swallowed [H301]. Harmful if inhaled [H332]. Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335]. Reacts violently with water [EUH014]. Contact with water liberates toxic gas [EUH029]. Very toxic to aquatic organisms [H400].

Disulfur dichloride is dangerous in contact with:

- WATER. A violent reaction occurs producing hydrogen chloride and sulfur dioxide gases.
- SODIUM, POTASSIUM, ALUMINIUM POWDER. A violent reaction occurs.
- UNSATURATED HYDROCARBONS. Ignition may occur.

WEL (mg m^{-3}): 5.6 (STEL)

Storage

Storage code: **Situ** [Yellow-red ‘oily’ liquid, pungent odour, ‘fumes in air]

Thionyl chloride *sulfur dichloride oxide* $SOCl_2$ (118.97)

DANGER

Harmful if swallowed [H302]. Causes severe skin burns and eye damage [H314]. Harmful if inhaled [H332]. May cause respiratory irritation [H335]. Reacts violently with water [EUH014]. Contact with water liberates toxic gas [EUH029].

Thionyl chloride is dangerous in contact with: as for disulfur dichloride.

WEL (mg m^{-3}): 4.9 (STEL)

Storage

Storage code: **CW** [Colourless-yellow volatile liquid, pungent odour]

- Keep small quantities ($\leq$ 100 cm^3) in a labelled desiccator with soda lime so stock is always fresh.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills/clearing up**: Depending on the volume involved, evacuation may be required (toxic gases evolved) and it may be necessary to call the Fire & Rescue Service (FRS) via 999.

  If safe to deal with: Ventilate area of spill as much as possible. Spread **dry** absorbent over spill and scoop up as much as possible. Treat collected spill as for **Disposal** (see reverse).

96B Risk Assessment Guidance **Sulfur chlorides**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Disulfur dichloride	 DANGER (See reverse)	TT (Y12)	- Wear splash-proof goggles. - Use an efficiently-working fume cupboard. - Wear gloves and a laboratory coat (the compounds are foul-smelling). - Ensure laboratory is well-ventilated. **Other notes; see also detailed activity-specific guidance**: - Use an efficiently-working fume cupboard for all activities. Both of the sulfur chlorides (i) have very pungent and ‘acrid’ odours and (ii) react violently with water to form toxic and corrosive gases (sulfur dioxide and/or hydrogen chloride). - **Preparation of disulfur dichloride**: This substance should **not** be stored. Prepare and dispose of it in the same lesson. **Disposal:** W4, see below
Thionyl chloride	 DANGER (See reverse)		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** - **W4:** Use a fume cupboard. Add the liquid sulfur chloride (no more than 25 cm^3) in small portions (just a few cm^3 at a time), to 1 litre of 1 M sodium carbonate solution. Allow reaction to subside completely after adding each portion and before adding more sulfur chloride. Flush the resulting solution down a foul-water drain with more water.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

97 Risk Assessment Guidance

Sulfur dioxide, $SO_2(g)$

Sulfur dioxide SO_2 (64.06)

DANGER

Causes severe skin burns and eye damage [H314]. Toxic if inhaled [H331].

Sulfur dioxide gas is dangerous in contact with:

- AMMONIA, ALKALI METALS, CHLORINE, ALCOHOLS, CHLORATES, AMINES. Violent reactions occur.
- COPPER, ALKALI METALS. Under some conditions, explosions may take place.

WEL (mg m^{-3}): 1.3 (LTEL), 2.7 (STEL)

Sulfur dioxide is a pungent, choking gas with serious effects on the respiratory system and eyes. Adverse health effects may be apparent even at very low levels (~ 0.3 mg m^{-3} or 0.1 ppm), especially in those suffering from asthma.

Do NOT expose asthmatics to this gas.

Use an efficiently-working fume cupboard when preparing or using sulfur dioxide.

Storage

Storage code: **Situ** [Colourless gas; irritating & pungent odour]

- Cylinders of sulfur dioxide gas are **not** recommended. Prepare gas *in situ* when required; see *Recipe* 96.
- Canisters containing sulfur dioxide gas are no longer obtainable. If you already have one, store in a sealed plastic container containing some self-indicating silica gel and keep it in a well-ventilated store. Arrange for collection by a Registered Waste Carrier at the earliest opportunity.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **GAS RELEASE**: Evacuate laboratory/prep room and adjacent areas if more than ~ 30 cm^3 of sulfur dioxide gas is released or if the release is in a confined/poorly-ventilated space.
- **TOXIC, CORROSIVE (inhalation). BEWARE DELAYED EFFECTS.**

97 Risk Assessment Guidance — Sulfur dioxide, $SO_2(g)$

<table>
<tr><td colspan="4">Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk</td></tr>
<tr><th>General use of:</th><th>Hazard information</th><th>User</th><th>Suggested general control measures and guidance</th></tr>
<tr><td>Sulfur dioxide gas</td><td>
DANGER
Corrosive (skin, eyes)
Toxic (inhalation)</td><td rowspan="2">TT (Y9)</td><td rowspan="2">• Prepare and use in an efficiently-working fume cupboard.
• Do not inhale the gas.
• Wear splash-proof goggles when preparing or using the gas on a large scale (eg, demonstration activities).
• Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120.
Other notes; see also more detailed activity-specific guidance:
• Preparing sulfur dioxide gas (large-scale, TT): See <i>Recipe</i> 96.
• Preparing a solution of sulfur dioxide (TT): See <i>Recipe</i> 97.
  • Note: Once prepared, the solution can be used as a source of sulfur dioxide to avoid the need for students to make the gas <i>in situ</i>. Dispense the solution from a small bottle in a fume cupboard.
  Allow no more than 1 cm³ of solution per test-tube and ensure the laboratory is well-ventilated. Sulfur dioxide gas readily diffuses from the solution, especially in warm conditions. Warn students not to inhale the sulfur dioxide gas that may be given off.
Disposal: W1 or W6; see note below</td></tr>
<tr><td colspan="2">BEWARE DELAYED EFFECTS
Effects of exposure by inhalation may or may not be immediately apparent and can develop and/or increase over time.
Inhalation by those with known breathing difficulties (eg, asthma) may exacerbate such pre-existing conditions.
If affected at any time, call the emergency services, informing them of the quantity of sulfur dioxide involved.</td></tr>
</table>

<table>
<tr><td>Disposal</td><td>Follow general guidance in <i>About Hazcards</i> (GL 120). NOTE:
• W1: Sulfur dioxide canisters.
• W6: Small quantities only. Use an efficiently-working (preferably ducted) fume cupboard.</td></tr>
</table>

98A Risk Assessment Guidance Sulfuric(VI) acid

Sulfuric(VI) acid H_2SO_4 (98.07)

DANGER

Causes severe skin burns and eye damage [H314].

Sulfuric acid (concentrated) is dangerous in contact with:

- WATER. A vigorous, exothermic reaction occurs.
- HYDROCHLORIC ACID (concentrated), CHLORIDES. Hydrogen chloride gas is given off.
- CHLORATE(V), MANGANATE(VII) compounds. Spontaneously explosive products form.
- SODIUM, POTASSIUM and many other metals. Dangerous reactions can occur.
- PHOSPHORUS (WHITE). Ignition can occur.

WEL (mg m^{-3}): 0.05 (LTEL), 0.15 (STEL), as a mist

- **When diluting and/or preparing solutions: Always add the concentrated acid slowly to cold water (or preferably ice), never the reverse; stir frequently to ensure thorough mixing**. See **Other notes.**
- Fuming sulfuric(VI) acid (oleum) is **not** recommended for school use.

Storage

Storage code: **CLa** [Colourless 'oily' liquid]

- Plastic bottles and their contents may become discoloured (brownish). The acid may still be used. However, if newly-purchased acid is discoloured, check with supplier.
- Tightly close bottles after use; concentrated acid absorbs water from the air.
- Concentrated sulfuric acid has almost twice the density of water so large bottles are heavy. Use a bottle carrier to move bottles from one area to another.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **CORROSIVE (skin*, eyes)**. Use copious volumes of cool water to counter the exothermic reaction of the concentrated acid with water.

*If possible/safe to do so: Remove contaminated clothing. Quickly wipe off excess liquid with a dry cloth but **DO NOT** delay irrigation.

98A Risk Assessment Guidance — Sulfuric(VI) acid

Detailed guidance on specific activities and techniques involving this substance can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Concentrated acid	 DANGER Corrosive (skin, eyes)	TT (Y9)	• **Concentrated acid and solutions ≥ 1.5 M** · Wear splash-proof goggles. Protect the face when transferring or dispensing large volumes. · Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. · Do **not** allow students to carry large bottles. • **Solutions < 1.5 M** · Wear eye protection even when dilute solutions are used. · For many pre-16 activities, 0.4 M solutions are adequate. **Other notes; see also detailed activity-specific guidance:** • **Diluting the concentrated acid/preparing solutions (TT)**: Seek extra guidance/training before attempting this procedure for the first time. Follow the method in *Recipe* 98, which uses ice (made from distilled water). **Always** add the concentrated acid to water (**not** the reverse). **Disposal**: Wspec, see below W7 → 0.1 M; or W4
Solutions ≥ 1.5 M			
Solutions < 1.5 M and ≥ 0.5 M	 WARNING Irritant (skin, eyes)	Y7	
Solutions < 0.5 M	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for small amounts of concentrated acid**: • **WSpec**: Protect the face as well as wearing gloves and splash-proof goggles. Add small volumes (~ 5-10 cm^3) of the acid to 1 litre of 1 M sodium carbonate solution (containing an indicator). Stir constantly and allow cooling between additions (or add ice). Avoid creating spray. Check solution is alkaline. Pour down a foul-water drain. Treat no more than 50 cm^3 of the concentrated acid. Soak contaminated glassware in cold water (or 1 M sodium carbonate). Rinse down a foul-water drain.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

98B Risk Assessment Guidance **Sulfamic acid and sulfates(VI)**

Sulfamic acid	*amidosulfonic acid, sulfamidic acid*	H_2NSO_3H (97.09)
 WARNING	Causes skin irritation [H315]. Causes serious eye irritation [H319]. Harmful to aquatic life with long lasting effects [H412].	
Storage	Storage code: **GIn**	[Colourless solid]

Sodium hydrogensulfate(VI)	*sodium bisulfate (anhydrous)*	$NaHSO_4$ (120.06)
Sodium hydrogensulfate(VI)-1-water	*sodium bisulfate monohydrate*	$NaHSO_4.H_2O$ (138.08)
 DANGER	Causes serious eye damage [H318].	
Storage	Storage code: **CS**	[Colourless solids]

Potassium sulfate(VI)	*potassium sulfate*	K_2SO_4 (174.26)
Sodium sulfate(VI)	*anhydrous sodium sulfate*	Na_2SO_4 (142.04)
Sodium sulfate(VI)-10-water	*hydrated sodium sulfate, Glauber's salt*	$Na_2SO_4.10H_2O$ (322.20)
Currently not classified as hazardous.		
Storage	Storage code: **GIn**	[Colourless solids]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE (eyes)**: sodium hydrogensulfate(VI) solid or solution.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

98B Risk Assessment Guidance **Sulfamic acid and sulfates(VI)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Sodium bisulfate solids & solutions ≥ 0.25 M	DANGER Corrosive (eyes)	Y9	- Wear eye protection. Wear splash-proof goggles when transferring/dispensing large quantities of sulfamic acid and sodium bisulfate (note: solutions have very low pH). **Other notes: see also detailed activity-specific guidance**: - **General use of salts/salt solutions**: Heat is evolved when anhydrous salts are added to water. - **Sodium sulfate(VI):** · Anhydrous salt is a useful drying agent for organic solvents. · Solutions may be used as safer substitutes for dilute sulfuric acid for electrolysis activities. See *Safer chemicals, safer reactions* and *electrolysis.* - **Sulfamic acid**: · May be used as a descaler (eg, for water stills). - **Sodium hydrogen sulfate(VI) [sodium bisulfate]**: · Solutions have very low pH values (similar to dilute sulfuric acid solutions). Has been used as ‘solid’ sulfuric acid and in some toilet cleaners. **Disposal:** sulfate(VI) salts, W7 sulfamic acid/bisulfates, W4
Sodium bisulfate solutions < 0.25 M & ≥ 0.1M	WARNING Irritant (eyes)	Y7	
Sodium bisulfate solutions < 0.1 M	Currently not classified as hazardous. Solutions have very low pH.		
Sulfamic acid solid & solutions ≥ 1.0 M	WARNING Irritant (skin, eyes)	Y9 (Y7)	
Sulfamic acid solutions < 1.0 M	Currently not classified as hazardous. Solutions have very low pH.	Y7	
Other sulfate(VI) salts (solids/solutions) listed on this *Hazcard*.	Currently not classified as hazardous		

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

99 Risk Assessment Guidance Tetrachloroethene and trichloroethene

Tetrachloroethene *tetrachloroethylene, perchloroethylene* C_2Cl_4 (165.83)

WARNING

Suspected of causing cancer [H351]. Toxic to aquatic life with long lasting effects [H411]. Note: Classification and labelling vary. Some suppliers may indicate (with the GHS 07 pictogram) one or more of: Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause an allergic skin reaction [H317]. May cause drowsiness or dizziness [H336].

WEL (mg m^{-3}): 138 (LTEL), 275 (STEL), Sk

Storage Storage code: **GOrg** [Colourless liquid, ‘sweet’ odour]

Trichloroethene *trichloroethylene (this is **not** the same as 1,1,1-trichloroethane, see Hazcard 103A)* $CHClCCl_2$ (131.39)

DANGER

Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause drowsiness or dizziness [H336]. Suspected of causing genetic defects [H341]. May cause cancer [H350]. Harmful to aquatic life with long lasting effects [H412].

WEL (mg m^{-3}): 550 (LTEL), 820 (STEL), Carc, Sk

Storage Storage code: **T** (Organic). [Colourless liquid, ‘ether-like’ odour]

- **Storage is pending disposal, W1 only. See notes on reverse.**

These substances are dangerous in contact with:

- REACTIVE METALS (eg, ALKALI METALS, MAGNESIUM, ALUMINIUM), ALKALIS. Violent or explosive reactions occur.
- HEAT. If heated to decomposition, toxic gases are produced.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **General spills (tetrachloroethene)**: If spilt outside a fume cupboard, ventilate spill area as much as possible (eg, by opening outside windows) before absorbing and then collecting up the spill.

99 Risk Assessment Guidance **Tetrachloroethene and trichloroethene**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Tetrachloroethene	 WARNING (See reverse)	TT	• Wear eye protection. • Avoid inhaling vapour. Use a fume cupboard. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Science practical work**: Avoid the use of tetrachloroethene. Alternatives will be available for most school-based science practical activities. • **Design & Technology activities**: See CLEAPSS Design & Technology *Model Risk Assessments*. • **Leak-testing fume cupboards (TT)**: The use of trichloroethene is no longer recommended. Tetrachloroethene may be used but see *Fume cupboards in schools* (guide G9) for detailed information. **Disposal:** W2 (organohalogen)
Trichloroethene	 DANGER (See reverse)	TT	**Not recommended for school use.** **Schools are advised to dispose of existing stocks, W1 only.** **Leak-testing fume cupboards: see notes above for tetrachloroethene.** **Disposal**: W1 only

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Tetrachloromethane *carbon tetrachloride* CCl_4 (153.82)

DANGER

Toxic if swallowed [H301]. May cause an allergic skin reaction [H317]. Toxic in contact with skin [H311]. Toxic if inhaled [H331]. Suspected of causing cancer [H351]. Causes damage to organs through prolonged or repeated exposure [H372]. Harmful to aquatic life with long lasting effects [H412]. Harms public health and the environment by destroying ozone in the upper atmosphere [H420].

Tetrachloromethane is dangerous in contact with:

- REACTIVE METALS (eg, ALKALI METALS, MAGNESIUM, ALUMINIUM). Violent/explosive reactions occur.

WEL (mg m^{-3}): 6.4 (LTEL), 32 (STEL), Sk

Storage

Storage code: **T** (Organic) [Colourless liquid, unpleasantly ‘sweet’ odour]

- **Storage is pending disposal, W1 only**.

Legislation limits the use of tetrachloromethane to a small number of specific applications including *essential* laboratory processes and analysis. This would NOT include school practical activities.

Schools should dispose of existing stocks, W1 only. See also notes on reverse of this *Hazcard*.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **TOXIC (inhalation, ingestion, skin):** If spilled outside a fume cupboard, evacuate the room. If safe to do so, open outside windows to ventilate the spill area. Do **not** put yourself or others at risk of inhaling this toxic chemical. Contact CLEAPSS.

100 Risk Assessment Guidance Tetrachloromethane

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Tetrachloromethane	 DANGER (See reverse)	TT	**Do NOT use tetrachloromethane. Dispose of existing stocks, W1.** **Follow the control measures below if it is essential to transfer or manipulate existing stock (eg, the container is damaged).** **If in doubt, contact CLEAPSS.** • Wear splash-proof goggles. • Do **not** inhale vapour. Use a fume cupboard. • Take particular care to avoid skin contact. See GL 120. **Other notes**: • **Science practical work**: Check activity-specific guidance for safer alternatives. • **Design & Technology activities**: See CLEAPSS Design & Technology section *Model Risk Assessments*. **Disposal: W1 only. Avoid release to the environment**

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Thorium compounds

- **Thorium compounds are not in the 'Standard School Holding' (i.e. the list of radioactive sources that schools could be expected to keep) except for some consumer artefacts and radioactive rocks.**
- **Standard Operating Procedures for the use of radioactive sources must be followed. Consult *Managing Ionising radiations and Radioactive Substances in Schools and Colleges* (L93).**
- **Contact CLEAPSS for any further information about these substances.**

Thorium(IV) nitrate(V)

$Th(NO_3)_4$

Thorium(IV) oxide, carbonate and hydroxide

ThO_2, $Th(CO_3)_2$, $Th(OH)_4$

DANGER

Ionising radiation (Radioactive)

Fatal if swallowed [H300]. Fatal if inhaled [H330].

May cause damage to organs through prolonged or repeated exposure [H373].

Toxic to aquatic life with long-lasting effects.

Information relating to these compounds is variable. The nitrate is also oxidising.

Storage	Storage code: **Rad** • Store as a Toxic and Radioactive chemical, locked in the radioactives store. See L93.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120) BUT consult *Managing Ionising Radiations and Radioactive Substances in Schools and Colleges* (L93) for up-to-date and detailed information/guidance on dealing with:** • **Spills and decontamination (eg, of paper wipes, disposable gloves etc).** • **Spills on skin and/or clothes and general spills in the laboratory.**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

101 Risk Assessment Guidance

Thorium compounds

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Thorium compounds	   DANGER Ionising radiation (Radioactive) 	TT (Y12)	• **Thorium compounds are not in the 'Standard School Holding' (i.e. the list of radioactive sources that schools could be expected to keep), except for some consumer artefacts and radioactive rocks.** • **Thorium compounds are alpha emitters, with beta and gamma from the decay chain, and the generation of dust must be avoided.** • **Standard Operating Procedures for the use of radioactive sources must be followed. Consult Managing Ionising radiations and Radioactive Substances in Schools and Colleges (L93).** • **The use of radioactive sources may be of concern to those who are pregnant. In addition to L93, see also *Pregnant, new & breastfeeding mothers and school science*.** • **Contact CLEAPSS for any further information about these substances.** **Disposal**: **WSpec**, see notes below

Disposal	**Follow general guidance in *About Hazcards* (GL 120) but NOTE:** • **WSpec**: Consult *Managing Ionising radiations and Radioactive Substances in Schools and Colleges* (L93) for detailed information and guidance relating to the disposal of thorium compounds and articles.

102A Risk Assessment Guidance **Tin and tin(II) compounds**

Tin		Sn (118.71)
Tin(II) oxide	*stannous oxide*	SnO (134.71)
Currently not classified as hazardous but note: WEL (mg m^{-3}): 2 (LTEL), 4 (STEL); as tin (Sn). Avoid inhaling dust.		
Storage	Storage code: **GIn**	[Solids: tin, silver-grey; tin(II) oxide, varies (black/off-white)]

Tin(II) chloride-2-water	*stannous chloride (hydrated)*	$SnCl_2.2H_2O$ (225.65)
 DANGER	Harmful if swallowed [H302]. Causes severe skin burns and eye damage [H314]. *Note: some suppliers may also indicate various other hazards (information varies widely).* **Tin(II) chloride is dangerous in contact with**: • OXIDISING AGENTS (eg, nitrate(V) salts or peroxides). Explosive mixtures can form. WEL (mg m^{-3}): 2 (LTEL), 4 (STEL); as tin (Sn)	
Storage	Storage code: **GIn**	[White solid]

Tin(II) sulfate(VI)	*stannous sulfate*	$SnSO_4$ (214.77)
 WARNING	Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Note: some suppliers may also indicate various other hazards (information varies). The solid is hygroscopic (absorbs moisture) and reacts with water to form strongly acidic solutions. WEL (mg m^{-3}): 2 (LTEL), 4 (STEL); as tin (Sn)	
Storage	Storage code: **GIn**	[Colourless-white solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **CORROSIVE (skin,eyes)**: chloride salts, sulfate(VI) salts.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

102A Risk Assessment Guidance

Tin and tin(II) compounds

Do not prepare or isolate tin(II) nitrate(V); explosive reactions have been known to occur.

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
• Tin • Tin(II) oxide	Currently not classified as hazardous	Y7	• Wear eye protection. • Avoid raising dust. Wash hands thoroughly after use. • Take particular care to avoid skin contact (tin(II) chloride, solid). See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Preparing tin(II) chloride solutions**: Solutions are prepared using concentrated hydrochloric acid to dissolve the solid followed by dilution with water. Wear splash-proof goggles. Add a piece of tin metal to stabilise the solution. See *Recipe* 103.
• Tin(II) sulfate(VI)	WARNING (See reverse)	Y9	
• Tin(II) chloride hydrated, solid	DANGER (See reverse)	Y12	
• Tin(II) chloride 0.1 M solution in hydrochloric acid	WARNING Irritant (skin, eyes)	Y7	**Disposal**: W2, W4, see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W4 (chloride, sulfate)**: A slurry forms. Check that the mixture is alkaline and then flush away down a foul water drain with further dilution. This is only suitable for very small quantities (1 g).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

102B Risk Assessment Guidance — Tin(IV) compounds

Tin(IV) oxide	*stannic oxide*	SnO_2 (150.71)
Currently not classified as hazardous but note: WEL (mg m^{-3}): 2 (LTEL), 4 (STEL); as tin (Sn). Avoid inhaling dust.		
Storage	Storage code: **GIn**	[Tin(IV) oxide: off-white/grey solid]

Tin(IV) chloride	*stannic chloride (anhydrous)*	$SnCl_4$ (260.52)
Tin(IV) chloride-5-water	*stannic chloride (hydrated)*	$SnCl_4.5H_2O$ (350.59)
 DANGER	Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335]. Harmful to aquatic life with long lasting effects [H412]. **Tin(IV) chloride is dangerous in contact with**: • WATER. A violent, exothermic reaction occurs (anhydrous). • TURPENTINE. An explosive reaction may occur. WEL (mg m^{-3}): 2 (LTEL), 4 (STEL) as tin (Sn)	
Storage	Storage code: **CW**, *anhydrous* Storage code: **GIn**, *hydrated*	[Colourless-yellow fuming liquid] [White-yellow solid]

Tin(IV) iodide	*stannic iodide*	SnI_4 (626.33)
 DANGER	Harmful if swallowed, if in contact with the skin and if inhaled [H302, H312, H332]. Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335]. WEL (mg m^{-3}): 2 (LTEL), 4 (STEL); as tin (Sn)	
Storage	Storage code: **Situ** and **GIn**	[Yellow-brown solid]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (skin, eyes)**: chloride and iodide salts.

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

102B Risk Assessment Guidance **Tin(IV) compounds**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
• Tin(IV) oxide	Currently not classified as hazardous	Y7	• Wear eye protection. • Avoid raising dust. Wash hands thoroughly after use. **Disposal**: W2, W8
• Tin(IV) chloride • Tin(IV) iodide	 DANGER (See reverse)	Y12	• Wear splash-proof goggles. • Use a fume cupboard. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes**: as below but see also detailed activity-specific advice. • **Preparing and/or using tin(IV) compounds**: An efficiently-working fume cupboard is essential. See activity-specific guidance. **Disposal**: W2, W4, see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **W4 (tin(IV) chloride)**: A slurry will form. Use an indicator to check the mixture is alkaline and then flush away down a foul water drain with further dilution. Suitable for very small quantities (1 g).

103A Risk Assessment Guidance 1,1,1-trichloroethane

1,1,1-trichloroethane *methyl chloroform* CH_3CCl_3 (133.40)

WARNING

Harmful if inhaled [H332]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. Harms public health and the environment by destroying ozone in the upper atmosphere [H420].

1,1,1-trichloroethane is dangerous in contact with:

- REACTIVE METALS (eg, ALKALI METALS, MAGNESIUM, ALUMINIUM). Violent/explosive reactions occur.
- ALKALIS. Dangerous reactions may occur.

WEL (mg m^{-3}): 555 (LTEL), 1110 (STEL)

Storage

Storage code: **GOrg** [Colourless volatile liquid, ‘ether-like’ odour]

- **Storage is pending disposal, W1 only**.

Legislation limits the use of 1,1,1- trichloroethane to a small number of specific applications including *essential* laboratory processes and analysis. This would NOT include school practical activities.

Schools should dispose of existing stocks, W1. See also notes on reverse of this *Hazcard*.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120).

103A Risk Assessment Guidance **1,1,1-trichloroethane**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
1,1,1-trichloroethane	 WARNING (See reverse)	TT	**Do NOT use 1,1,1-trichloroethane. Dispose of existing stocks, W1.** **Follow the control measures below if it is essential to transfer or manipulate existing stock (eg, the container is damaged).** **If in doubt, contact CLEAPSS.** • Wear eye protection. • Avoid inhaling vapour. Use a fume cupboard. **Other notes**: • **Science practical work**: Check activity-specific guidance for safer alternatives. See also *Safer chemicals, safer reactions*. **Disposal: W1 only. Avoid release to the environment**

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

103B Risk Assessment Guidance — Other halogenated ethanes

1,2-dichloroethane *ethylene dichloride* CH_2ClCH_2Cl (98.96)

DANGER

Highly flammable liquid and vapour [H225]. Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. May cause cancer [H350].

1,2-dichloroethane is dangerous in contact with:

- ALKALI METALS, METAL POWDERS. Violent/explosive reactions occur.
- OXIDISING AGENTS, NITRIC ACID. Dangerous reactions may occur.

Note:	Flash point (°C)	Boiling point (°C)	WEL (mg m^{-3})
	13	84	21 (LTEL), 63 (STEL); Carc, Sk

Storage Storage code: **FL** (Organic), pending disposal (**W1**) [Colourless 'oily' volatile liquid, distinct odour]

1,2-dibromoethane *ethylene dibromide* CH_2BrCH_2Br (187.86)

DANGER

Toxic if swallowed, in contact with skin, if inhaled [H301, H311, H331]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. May cause cancer [H350]. Toxic to aquatic life with long lasting effects [H411].

1,2-dibromoethane is dangerous in contact with:

- ALKALI METALS, STRONG ALKALIS, AMMONIA, OXIDISERS. Dangerous reactions occur.
- MAGNESIUM. Explosive products may form.

Note:	Boiling point (°C)	WEL (mg m^{-3})
	131	3.9 (LTEL), 11.7 (STEL); Carc, Sk

Storage Storage code: **Situ** [Colourless liquid, 'sweetish' odour]

Emergencies **Follow standard procedures (see *Emergency Hazcards* and GL 120)**.

103B Risk Assessment Guidance **Other halogenated ethanes**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
1,2-dichloroethane	 DANGER (See reverse)	TT	**Do not purchase these chemicals. Safer alternatives can be used for most activities. Check activity-specific guidance.** • Wear eye protection. • Avoid inhaling vapour. Use a fume cupboard. Ensure laboratory is well-ventilated. • Ensure no naked flames/other ignition sources (1,2-dichloroethane). • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific advice**: • **Testing ethene gas for unsaturation with bromine or bromine water**: 1,2-dibromoethane and other compounds are formed. However, the amounts formed are small and both exposure and risk to health are very low if risk assessment guidance is followed. See *Testing for unsaturation* (includes disposal of residues from these activities). **Disposal:** W1
1,2-dibromoethane	 DANGER (See reverse)	TT (Y9)	

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Trichloromethane *chloroform* $CHCl_3$ (119.38)


DANGER

Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. Toxic if inhaled [H331]. May cause drowsiness or dizziness [H336]. Suspected of causing cancer [H351]. Suspected of damaging the unborn child [H361d]. Causes damage to organs through prolonged or repeated exposure [H372].

Trichloromethane is dangerous in contact with:
- ALUMINIUM, MAGNESIUM, SODIUM, POTASSIUM, LITHIUM. Violent or explosive reactions may occur.
- PROPANONE. An explosive reaction can occur under certain conditions.

WEL (mg m^{-3}): 9.9 (LTEL), 29.7 (STEL), Sk

Storage

Storage code: **GOrg** [Colourless liquid, ‘sweet’ odour]
- **Storage pending disposal, W1**.

Triiodomethane *iodoform* CHI_3 (393.70)


WARNING

Harmful if swallowed, in contact with skin and if inhaled [H302, H312, H332]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335].

WEL (mg m^{-3}): 9.8 (LTEL), 16 (STEL)

Storage

Storage code: **GOrg** [Yellow solid, ‘disinfectant-like’ odour]

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:
- **General spills (trichloromethane)**: If spilled outside a fume cupboard, evacuate the room. On leaving, open outside windows to ventilate the spill area (the vapour is denser than air and will disperse quite slowly so technicians/teachers should have time to safely ventilate the area). Only return when the spill has evaporated. Do **not** put yourself or others at risk of inhaling this toxic chemical. Contact CLEAPSS.

104 Risk Assessment Guidance

Trichloromethane and triiodomethane

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	Hazard information	User	Suggested general control measures and guidance
Trichloromethane (*Chloroform*)	  DANGER (See reverse)	TT	Trichloromethane is subject to EU-wide restrictions, including in 'diffusive applications'. The use of trichloromethane in school practical activities is **not** recommended. Check activity-specific guidance for safer alternatives. For Design & Technology activities (eg, adhesives, cements): see CLEAPSS Design & Technology *Model Risk Assessments*. Follow the control measures below if it is essential to transfer or manipulate existing stock (eg, the container is damaged). • Wear eye protection. • Use an efficiently-working fume cupboard. Do **not** inhale vapour. • Take particular care to avoid skin contact. See GL 120. **Disposal**: W1 only
Triiodomethane (*Iodoform*)	 WARNING (See reverse) Check relevant *Hazcards* for other reagents used in the iodoform test.	Y12	• Wear splash-proof goggles when carrying out the iodoform test. • Use a fume cupboard. Iodoform test products are irritating to eyes. **Other notes**: as below, but see also detailed activity-specific advice. • **Preparation of iodoform/the iodoform test:** see *Recipe* 102 and other activity-specific guidance. **Disposal**: W2

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

Uranium compounds

- **Uranium nitrate in limited quantities, and uranium oxide in encapsulated devices such as Becquerel plates are in the ‘Standard School Holding’ (i.e. the list of radioactive sources that schools could be expected to keep).**
- **Standard Operating Procedures for the use of radioactive sources must be followed. Consult *Managing Ionising radiations and Radioactive Substances in Schools and Colleges* (L93).**
- **Contact CLEAPSS for any further information about these substances.**

Uranyl(VI) nitrate(V)-6-water

$UO_2(NO_3)_2.6H_2O$

Also applies to uranium oxide, uranyl(VI) ethanoate, uranyl(V) magnesium ethanoate, uranyl(VI) zinc ethanoate.



DANGER

Ionising radiation (Radioactive)

Fatal if swallowed [H300]. Fatal if inhaled [H330].

May cause damage to organs through prolonged or repeated exposure [H373].

Toxic to aquatic life with long-lasting effects.

The nitrate is also oxidising.

Storage	Storage code: **Rad** [Yellow, crystalline solids] • Store as a Toxic and Radioactive chemical, locked in the radioactives store. See L93.
Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120) BUT consult *Managing Ionising Radiations and Radioactive Substances in Schools and Colleges* (L93) for up-to-date and detailed information/guidance on dealing with:** • **Spills and decontamination (eg, of paper wipes, disposable gloves etc).** • **Spills on skin and/or clothes and general spills in the laboratory.**

105 Risk Assessment Guidance **Uranium compounds**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Uranium compounds	   DANGER Ionising radiation (Radioactive) 	TT (Y12)	• **Uranium nitrate in limited quantities, and uranium oxide in encapsulated devices such as Becquerel plates are in the 'Standard School Holding' (i.e. the list of radioactive sources that schools could be expected to keep).** • **Uranium compounds are alpha emitters, with beta from the decay chain, and the generation of dust must be avoided.** • **Standard Operating Procedures for the use of radioactive sources must be followed. Consult *Managing Ionising radiations and Radioactive Substances in Schools and Colleges* (L93).** • **The use of radioactive sources may be of concern to those who are pregnant. In addition to L93, see also *Pregnant, new & breastfeeding mothers and school science*.** • **Contact CLEAPSS for any further information about these substances.** **Disposal**: **WSpec**, see notes below

Disposal	**Follow general guidance in *About Hazcards* (GL 120) but NOTE:** • **WSpec**: See *Managing Ionising radiations and Radioactive Substances in Schools and Colleges* (L93) for detailed information and guidance relating to the disposal of uranium sources.

106 Risk Assessment Guidance ‘Volasils’

Octamethylcyclotetrasiloxane $C_8H_{24}O_4Si_4$ (296.62)

Decamethylcyclopentasiloxane $C_{10}H_{30}O_5Si_5$ (370.72)

WARNING

Flammable liquid and vapour [H226]. Suspected of damaging fertility. [H361f]. May cause long lasting harmful effects to aquatic life [H413].

These compounds are dangerous in contact with:

- HEAT: On combustion, fine clouds of silicon(IV) oxide form along with water and carbon dioxide.

Flash point: ~ 50-58 °C (depending on composition)

Storage

Storage code: **GOrg** [Colourless liquids, slight odour]

- Solvents containing one or more cyclic silicones (such as octamethylcyclotetrasiloxane and decamethylcyclopentasiloxane) are sold under a range of trade names, including *Volasil*.

  Volasils (eg, *Volasil* 244, *Volasil* 344) were marketed as alternatives to the use of chlorinated hydrocarbon solvents for some practical activities (eg, testing for unsaturation). They are now expensive and, for many activities, other solvents may be used.

  Check activity-specific guidance for suitability before purchasing.

Emergencies

Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:

- **If it catches fire:** The boiling points of *Volasils* are much higher than that of water. Do **not** add water to hot *Volasils* as this may result in a spray of hot liquid, rather like a fat-pan fire.

  For small fires, and only if safe to do so, use a damp cloth, heatproof mat or fire blanket to starve the fire of oxygen. Be aware that burning *Volasil* will produce clouds of silica dust, which can cause health problems if inhaled.

  Do **not** put yourself in danger of inhaling fine particulate silica (see *Hazcard* 86A).

106 Risk Assessment Guidance **‘Volasils’**

Detailed guidance on specific activities and techniques involving these substances can be found: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
‘Volasils’	 WARNING (See reverse)	TT (Y7)	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **General use of ‘Volasils’**: These are expensive and, for many activities, other solvents will be suitable. Check activity-specific guidance for suitability before purchasing. • **As a non-aqueous solvent for bromine**: Solutions of bromine in Volasil are not stable and need to be prepared shortly before being used. Bromine causes the cyclic siloxane rings to break open and polymerise. The resulting ‘jelly’ is not easy to remove from bottles. • **Combustion**: Do not burn in the open laboratory. Use an efficiently operating ducted fume cupboard. Burn no more than 1 cm^3 in a crucible. **Disposal**: W2, WSpec; see below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only:** • **WSpec:** Use an efficiently-operating ducted fume cupboard. Burn no more than 1 cm^3 in a crucible. The products are carbon dioxide, water and silicon dioxide.

107 Risk Assessment Guidance

Zinc

Zinc powder	Zn (63.38)
 DANGER	In contact with water releases flammable gases which ignite spontaneously [H260]. Catches fire spontaneously if exposed to air [H250]. Very toxic to aquatic life with long lasting effects [H410]. Note: Classification/labelling vary. Some suppliers may omit information about flammability and only indicate H410 with the GHS 09 pictogram and signal word WARNING. **Zinc powder is dangerous in contact with**: • WATER. ALKALINE SOLUTIONS. Moist zinc dust can ignite spontaneously. • ACIDS and ALKALIS. Hydrogen gas (extremely flammable) is formed. • IODINE, MANGANESE(IV) OXIDE, POTASSIUM CHLORATE(V). Violent reactions can occur. • SULFUR. A violent or explosive reaction occurs. • AMMONIUM SULFIDE SOLUTION. Hydrogen sulfide gas (extremely flammable, very toxic) is evolved. Zinc residues (powder/dust) from some practical activities have ignited, leading to fires (eg, in waste bins), when incorrectly disposed of. Follow correct disposal procedures.
Storage	Storage code: **FW** [Dull-grey powder] • Zinc 'dust' is very fine zinc powder which is almost inevitably oxidised (i.e. is only about 90% zinc metal). Zinc 'powder' usually refers to the metal in a slightly more 'gritty form. • Keep containers tightly closed and dry.

Zinc granules, foil	Zn (63.38)
Currently not classified as hazardous.	
Storage	Storage code: **GIn** [Silver-grey shiny metal]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE**: • **If zinc powder catches fire**: Smother small fires with **clean**, **dry** sand (keep a container of sand for this purpose).

107 Risk Assessment Guidance **Zinc**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Zinc powder/dust	 DANGER (See reverse)	Y7	• Wear eye protection. • Avoid raising dust when using the powder. **Other notes**; **see also detailed activity-specific guidance**: • **General use**: Reactions with dilute acids/alkalis and salts may be carried out on a test-tube scale using zinc granules or powder. • **Burning zinc powder (TT)**: The zinc oxide fumes produced (also called 'philosopher's wool') when the powder burns are considered hazardous. Ensure the laboratory is well-ventilated. Do not inhale fumes. • **Large-scale preparation of hydrogen (TT)**: See *Recipe* 44.
Zinc foil/granules	Currently not classified as hazardous		**Disposal**: see notes below

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u>**: • **W5** (zinc powder/dust). • **W3 or W8** (zinc granules/foil). **Note: Zinc residues (powder/dust) from some practical activities have ignited, leading to fires (eg, in waste bins) when incorrectly disposed of. Check activity-specific guidance.**

108A Risk Assessment Guidance (see also **107** and **108B**)

Zinc compounds (1)

Zinc chloride	$ZnCl_2$ (136.32)
Zinc bromide	$ZnBr_2$ (225.2)
 DANGER	Harmful if swallowed [H302]. Causes severe skin burns and eye damage [H314]. May cause respiratory irritation [H335]. Very toxic to aquatic life with long lasting effects [H400/410]. WEL (mg m^{-3}): 1 (LTEL), 2 (STEL); zinc chloride as a fume (very tiny particles)
Storage	Storage code: **CW** [Colourless/white crystalline solids]

Zinc chromate(VI)	$ZnCrO_4$ (181.4)
 DANGER	Harmful if swallowed [H302]. May cause an allergic skin reaction [H317]. May cause cancer [H350]. Very toxic to aquatic life with long lasting effects [H410]. WEL (mg m^{-3}): 0.05 (LTEL); 0.15 (STEL); as chromium
Storage	Storage code: **Situ** [Yellow solid] • Keep damp and retain for disposal by registered waste carrier (**W1**).

Zinc nitrate(V)-6-water *Hydrated zinc nitrate*	$Zn(NO_3)_2.6H_2O$ (297.49)
 DANGER	May intensify fire; oxidiser [H272]. Harmful if swallowed [H302]. Causes skin irritation [H315]. Causes serious eye irritation [H319]. May cause respiratory irritation [H335]. Very toxic to aquatic life with long lasting effects [H400/410].
Storage	Storage code: **Ox** [Colourless crystals]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). NOTE:** • **CORROSIVE (skin, eyes): Chloride/bromide** (solids, solutions).

Read this *Hazcard* in conjunction with *About Hazcards* (guide GL 120)

108A Risk Assessment Guidance (see also **107** and **108B**) Zinc compounds (1)

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Solids: chloride, bromide, nitrate	DANGER (See reverse)	Y12 (Y9)	• Wear splash-proof goggles. • Take particular care to avoid skin contact. See activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: • **Use of anhydrous zinc chloride**: Hydrogen chloride gas (toxic, corrosive) is produced when added to water (use a fume cupboard). See also *Hazcard* 49. **Disposal**: W4, see below
Solutions: < 1M and ≥ 0.4 M ($ZnCl_2$) < 1 M and ≥ 0.2 M ($ZnBr_2$)	DANGER Corrosive (skin, eyes) Irritant (respiratory)	Y9	
< 0.4 M and ≥ 0.2 M ($ZnCl_2$) < 0.2 M and ≥ 0.1 M ($ZnBr_2$)	DANGER Corrosive (skin, eyes)		
Solutions: < 0.2 M and ≥ 0.1 M ($ZnCl_2$) < 0.1 M and ≥ 0.05 M ($ZnBr_2$)	WARNING Irritant (skin, eyes) Zinc nitrate: Harmful (ingestion), ≥ 0.7 M	Y7	• Wear eye protection. **Other notes; see also detailed activity-specific guidance**: • **Use of zinc nitrate(V) solutions**: 0.4 M solutions are suitable for most purposes. **Disposal**: W7 → 0.1 M
Zinc nitrate solutions: < 0.7 M and ≥ 0.3 M			

Disposal	**Follow general guidance in *About Hazcards* (GL 120). NOTE for <u>small amounts</u> only**: • **W4 (zinc chloride, zinc bromide)**: Use a fume cupboard. Add to 1 M sodium carbonate solution to absorb hydrogen halide gas. Pour the suspension down a foul-water drain.

108B Risk Assessment Guidance (see also **108A**) **Zinc compounds (2)**

Zinc sulfate(VI)-7-water	*Hydrated zinc sulfate*	$ZnSO_4.7H_2O$ (287.54)
   DANGER	Harmful if swallowed [H302]. Causes serious eye damage [H318]. Very toxic to aquatic life with long lasting effects [H410].	
Storage	Storage code: **GIn**	[Colourless/white crystalline solid]

Zinc oxide	*Zinc white, calamine*	ZnO (81.41)
 WARNING	Very toxic to aquatic life with long lasting effects [H410].	
Storage	Storage code: **GIn**	[White solid]

Zinc carbonate	*Zinc carbonate basic*	$2ZnCO_3.3Zn(OH)_2$ (549.01)
Zinc sulfide	*Zinc blende, sphalerite*	ZnS (97.47)
Currently not classified as hazardous.		
Storage	Storage code: **GIn**	[White solids if pure]

Emergencies	**Follow standard procedures (see *Emergency Hazcards* and GL 120). Note:** • **CORROSIVE (eyes)**: zinc sulfate (solid, solutions).

108B Risk Assessment Guidance (see also **108A**) **Zinc compounds (2)**

Detailed guidance on specific activities and techniques involving these substances can be found at: www.cleapss.org.uk

General use of:	**Hazard information**	**User**	**Suggested general control measures and guidance**
Zinc sulfate(VI)-7-water solid, and solutions ≥ 1.5 M	  DANGER Corrosive (eyes) Harmful (ingestion)	Y7	- Wear eye protection even when using dilute solutions. Wear splash-proof goggles when transferring/dispensing large volumes of the corrosive solutions. **Other notes; see also detailed activity-specific guidance**: - Solutions below 0.2 M will be suitable for many activities. - **Preparing zinc sulfate solutions**: See *Recipe* 106. - **Preparation of salts**: Do **not** heat zinc sulfate(VI) solutions to dryness. Decomposition occurs, producing toxic/corrosive fumes. **Disposal**: W7 → 0.1 M
Zinc sulfate(VI) solutions < 1.5 M and ≥ 0.2 M	 DANGER Corrosive (eyes)		
Zinc sulfate(VI) solutions < 0.2 M and ≥ 0.06 M	 WARNING Irritant (eyes)		
Zinc carbonate solid Zinc oxide solid Zinc sulfide solid	Currently not classified as hazardous, except zinc oxide (very toxic to aquatic life with long lasting effects)		- Eye protection and/or other control measures may be advised for some procedures. Check activity-specific guidance and/or GL 120. **Other notes; see also detailed activity-specific guidance**: - In contact with acids, zinc sulfide reacts to produce hydrogen sulfide gas (toxic). If heated strongly in air, zinc sulfide may produce sulfur dioxide gas (toxic). **Disposal**: W8

Disposal	**Follow general guidance in *About Hazcards* (GL 120).**