CLEAPSS

STUDENT SAFETY SHEETS

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Student safety sheets

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Microorganisms

See also CLEAPSS *Student Safety Sheet 76, Bioreactors and Fermenters*

Source	Hazard	Comment
Samples from the environment	☣ BIOHAZARD	Air, water and soil samples could be used, but do not sample from high-risk areas, eg, toilets or the floors of changing rooms. All environmental samples could be contaminated with **pathogens** (organisms which cause disease).
Samples from humans	☣ BIOHAZARD	'Finger dabs' could be used. Samples may, however, be contaminated with pathogens (see above).
Foods	☣ BIOHAZARD	Any uncooked animal product (eggs, meat, cheese etc) may be contaminated with bacteria, especially *Salmonella* and *Escherichia coli* (*E. coli*) from the gut, which can cause food poisoning. Take care to prevent cross contamination between cooked and uncooked foods. Thorough cooking will destroy bacteria.
Purchased cultures (ie, samples of microorganisms bought from suppliers)	☣ BIOHAZARD	Cultures bought from reputable suppliers (but not those from hospitals, etc) should be safe but may have become contaminated. *E. coli* is often studied in schools, but this is **not** the same strain of bacterium that causes food poisoning.

Typical control measures to reduce risk

- When culturing, if possible, grow bacteria and fungi on solids (agar) rather than liquids (broth) to avoid spills and aerosol formation. Choose culture media, eg, nutrient agar, that do not favour the growth of pathogens. Incubate at temperatures which do not encourage growth of pathogens (avoid temperatures 30°C to 42°C).
- Do **not** seal cultures completely before incubation (otherwise hazardous anaerobic bacteria are encouraged) but make sure they cannot be opened accidentally.
- Incubated cultures taken from the environment or humans must never be opened.
- Use sterile equipment and aseptic technique(eg, by flaming loops and mouths of bottles, etc).
- Avoid draughts (from open windows and doors) which could contaminate cultures and cause spores from fungi (eg, mould) to spread.
- Work near Bunsen-burner flames so that the updraught helps to prevent contamination of cultures.
- After work is complete, treat surfaces using a suitable disinfectant for a sufficient length of time.
- Dispose of all cultures (including mould on food eg, mouldy bread) by sterilisation in an autoclave (pressure cooker).
- Always wash hands after using/handling cultures and before handling food.
- Wear a clean lab coat or overall to protect cultures and food from microbes on the skin, clothing, etc.
- In cooking, ensure that food is heated to at least 70 °C for at least 2 minutes.
- Do not reheat cooked food; prepare, store and display cooked and uncooked foods separately.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg, could a food or a culture be, or become, contaminated? Could microorganisms or their spores escape?
- How serious would it be if something did go wrong?
  eg, could material pathogenic to humans be released? Could food poisoning result?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Spilt on the floor, bench, etc	For spills of cultures, place paper towels over the spill, pour disinfectant (eg, Virkon) on top and leave for at least 15 minutes. Bleach is usually suitable in the home.

Enzymes

including **amylase, catalase, cellulase, diastase, lipase, proteases (eg, pepsin, trypsin), urease**

Substance	Hazard			Comment
Enzymes *Powders* 'Biological' detergents contain enzymes.	**CORROSIVE**	**HEALTH HAZARD**	**IRRITANT**	DANGER: Most enzymes are sensitisers (see below) and may cause allergy or asthma symptoms, or breathing difficulties if inhaled. DANGER: Some enzymes can cause serious eye damage. WARNING: Many enzymes irritate the eyes, skin and respiratory system.
Enzymes *Concentrated solutions*	**CORROSIVE**	**HEALTH HAZARD**	**IRRITANT**	DANGER: Most enzymes are sensitisers (see below) and may cause allergy or asthma symptoms, or breathing difficulties if inhaled. DANGER: Some enzymes can cause serious eye damage. WARNING: Many enzymes irritate the eyes, skin and respiratory system.
Enzymes *Dilute solutions (less than 1% w/w) or 5% Lipase*	**Currently not classified as hazardous**			Most at these concentrations are unlikely to offer any significant risk. Biological systems are rich sources of enzymes, eg, liver (catalase), saliva (amylase).

Note: Some people are ***allergic*** to particular substances; their bodies' immune system reacts to these substances to an unusual extent. ***Asthma*** is one type of allergy which results in breathing difficulties. A ***sensitiser*** is a substance that may produce only a small or even no allergic reaction when humans are first exposed to it (sometimes over an extended period of time) but can produce a much more severe reaction on subsequent occasions, even when the body is exposed to much smaller amounts.

Typical control measures to reduce risk

- Use the lowest concentration/smallest amount possible.
- Wear eye protection for enzyme at 1% or higher concentration
- Avoid powdered enzymes escaping into the air; use a fume cupboard (not switched on) when transferring/dispensing enzyme powders.
- Do not spray enzyme solutions.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg, could enzyme dust be breathed in?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
• Swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Dust breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is difficult.
• Spilt on the skin or clothing	Remove contaminated clothing. Wash off the skin with soap and plenty of water. Rinse contaminated clothing.
• Spilt on the floor, bench, etc	Scoop up powders, taking care not to raise dust. Wipe up solution spills or any traces of powders with a damp cloth.

Human body fluids and tissues

including **cheek cells, blood, saliva, sweat and urine**

Source	Hazard	Comment
Cheek cells	☣ BIOHAZARD	There is a very tiny risk of transmission of HIV or hepatitis virus but only if contact is made with samples other than your own. Sampling may be banned in some schools although this is now very unlikely.
Blood	☣ BIOHAZARD	There is some risk of transmission of HIV or hepatitis virus if contact is made with blood other than your own. Taking blood samples is possible if stringent precautions are taken but may not be permitted in some schools. Never share hypodermic needles or become 'blood brothers'.
Saliva	**Currently not classified as hazardous**	There is negligible risk of transmission of HIV or hepatitis virus even if you come into contact with saliva other than your own. Kissing is rarely banned for reasons of hygiene!
Sweat	**Currently not classified as hazardous**	There is negligible risk of transmission of diseases even if you come into contact with sweat other than your own, but this is no excuse for poor hygiene!
Urine	☣ BIOHAZARD	There is a very tiny risk of transmission of various diseases if you come into contact with urine other than your own, although urine is normally sterile. In investigations involving urine, take care when obtaining and transporting samples. Wash hands after using the toilet.

Typical control measures to reduce risk

- Only handle samples from your own body.
- After use, hygienically dispose of samples, disinfect contaminated containers by immersion for 30 minutes in a solution of 1% Virkon or sodium chlorate(I) (hypochlorite) for 10 minutes; treat benches for a sufficient length of time with a suitable disinfectant (Virkon is preferred) and wash hands. Any swabs, slides or other equipment contaminated with blood should be collected in a suitable container, then autoclaved. If necessary, use a 'sharps' container (eg, a sturdy box, clearly labelled and sealed and wrapped before disposal).
- Treat clinical thermometers, mouthpieces, etc in Milton for 30 minutes before and after use (unless disposable).

  If administering first aid, minimise contact with blood by wearing disposable surgical gloves or by asking the casualty to carry out her/his own treatment, eg, by applying pressure to a wound using a pad of cloth.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?

  eg, could somebody else come into contact with samples from your body, or vice versa?
  If first-aid treatment was not applied, could the casualty's condition put his or her life at risk?
- How serious would it be if something did go wrong?

  eg, could HIV or hepatitis virus or other pathogens be transmitted?
- How can the risk(s) be controlled for this activity?

  eg, can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Spilt on the floor, bench, etc	For spills of most body fluid samples, place paper towels over the spill, pour disinfectant (eg, 1% Virkon) on top and leave for at least 15 minutes. For blood, wear disposable gloves, wet paper towels or cloth with freshly prepared sodium chlorate(I) (hypochlorite, bleach) containing at least 10 000 ppm chlorine or 1% Virkon. Add more disinfectant to soak area and leave for 15-30 minutes. Still wearing gloves, rinse towels or cloth under running water. Wash hands thoroughly with soap and water.
• Disposal of bloody tissues, etc	Avoid skin contact with tissues etc contaminated with blood. In school, place in a container for sanitary towels, etc. Then incinerate or use a clinical waste-collection service. At home, flush down the toilet or wrap carefully and place in the refuse.

Food testing (1)

See also CLEAPSS *Student Safety Sheet 5, Food Testing (2)*

Source	Hazard	Comment
Food	**BIOHAZARD**	Uncooked samples of food may be contaminated with microbes. (See CLEAPSS *Student Safety Sheet 1, Microorganisms*.) Some people are allergic to some foods, especially peanuts.
Fehling's solution Used to test for reducing sugars	**CORROSIVE**	See CLEAPSS *Student Safety Sheets 31* and *40*. Solution A contains slightly-acidic copper sulfate solution. Solution B contains 3 M sodium hydroxide solution. Solution A: DANGER: Causes serious eye damage and skin irritation. Solution B: DANGER: Causes severe eye damage and skin burns. As the mixture has to be heated in a test tube, there is a risk of alkali spitting out.
Benedict's solution Used to test for reducing sugars	**IRRITANT**	See CLEAPSS *Student Safety Sheet 40*. Contains slightly-alkaline 0.07 M copper sulfate solution. WARNING: Irritant to skin and eyes. Some risk of spitting when heating test tubes.
Ethanol Used to test for fats (lipids)	**HIGHLY FLAMMABLE** **HARMFUL** **HEALTH HAZARD**	Most schools use IDA (industrial denatured alcohol) rather than pure ethanol. See CLEAPSS *Student Safety Sheet 60*. DANGER: highly flammable, harmful by ingestion, may cause damage to organs, causes serious eye irritation. If Bunsen burners are being used nearby for other food tests, there is a serious fire risk.
Iodine solution Used to test for starch	**Currently not classified as hazardous**	See CLEAPSS *Student Safety Sheet 56*. The solution is so dilute (about 0.01 M) that it is currently not classified as hazardous
Biuret test Used to test for proteins	**CORROSIVE**	See CLEAPSS Student *Safety Sheets 31* and *40*. DANGER/WARNING: The very dilute copper sulfate solution is currently not classified as hazardous. Sodium hydroxide solution may be CORROSIVE, IRRITANT or currently not classified as hazardous depending on concentration.

Typical control measures to reduce risk

- Do not taste foods in laboratories; avoid using products containing peanuts etc if there is a known allergy.
- Wear eye protection and use the smallest possible amounts of chemicals.
- Use Benedict's solution rather than Fehling's solution and heat with a water bath.
- Do not use ethanol if there are naked flames nearby.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg, could chemicals spit out of a heated test tube, or might somebody using a Bunsen be unaware of ethanol being used nearby?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

In the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
In mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently running tap water for 20 minutes. If a large area is affected or symptoms occur, call 999/111.
Clothing catches fire	Push casualty to the floor, roll the body or smother flames on clothing or skin with fire blanket or other material. Cool burnt skin with gently running tap water for 20 minutes. Unless trivial, call 999/111.
Other ethanol fires	Allow fires in sinks, etc to burn out. Fires at the top of test tubes, beakers etc can be smothered with a damp cloth or heat-resistant mat if this can be done safely.
Spilt on the floor, bench, etc	For small amounts, use a damp cloth. Rinse well. For larger amounts, cover with mineral absorbent (eg, cat litter) and scoop into a bucket. Neutralise alkali with citric acid. Rinse with water.

Food testing (2)

See also CLEAPSS *Student Safety Sheet 4*

Substance	Hazard	Comment
Sakaguchi test Used to test for proteins	**CORROSIVE** **HIGHLY FLAMMABLE** **ENVIRON. HAZARD**	The test involves mixing three solutions: sodium hydroxide (~1.3 M), napthalen-1-ol in ethanol (~0.07 M) and sodium chlorate(I) (hypochlorite) (~ 1.5 M). See relevant *CLEAPSS Student Safety Sheets*. Despite these hazards, it is safer to use than either form of Millon's reagent because it does not need to be heated and only a few drops are required. The biuret test is safer still (see *CLEAPSS Student Safety Sheet 4*). DANGER: Corrosive to skin and eyes, highly flammable.
DCPIP Used to test for Vitamin C	**Currently not classified as hazardous**	See *CLEAPSS Student Safety Sheet 70, Dyes and indicators*. Also known as PIDCP.
Saliva Used to break down starch	**Currently not classified as hazardous**	See CLEAPSS *Student Safety Sheet 3, Human body fluids and tissues*. Negligible risk.
Clinistix Used to test for glucose	**Currently not classified as hazardous**	The tip of the stick contains a minute amount of a known carcinogen and should not be touched. The sticks should be stored and disposed of safely. It is normally used for testing urine.
Albustix Used to test for proteins	**Currently not classified as hazardous**	This will not detect all proteins. It is normally used for testing urine.

Typical control measures to reduce risk

- Wear eye protection and use the smallest possible amounts of chemicals.
- Use the least-hazardous substance that achieves the required effect.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg, could chemicals spit out of a heated test tube?
- How serious would it be if something did go wrong?
  eg, could ethanol (in the Sakaguchi test) catch fire, or acid splash into the eye?
- How can the risk(s) be controlled for this activity?
  eg, can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Then drench the skin with plenty of water. If a large area is affected or symptoms occur, call 999/111.
• Other ethanol fires	Allow fires in sinks, etc to burn out. Fires at the top of test tubes, beakers etc can be smothered with a damp cloth or heat-resistant mat if this can be done safely.
• Spilt on the floor, bench, etc	For small amounts, use a damp cloth. Rinse well. For larger amounts, cover with mineral absorbent (eg, cat litter) and scoop into a bucket. Neutralise alkali with citric acid. Rinse with water.

Humans as the subject of investigation (1)

including **simple measurements on the body and senses and psychological effects**

See also CLEAPSS *Student Safety Sheets 3*, *7*, *8* and *9*

Source	Hazard	Comment
All investigations on pupils	⚠ **DANGER** ☣ **BIOHAZARD**	Pupils should never be pressurised to take part in investigations on themselves. Individual pupils may become alarmed or distressed, or be subject to unpleasant comments from others in the class, if the results for their bodies are significantly different from others. In fact, a wide spread of figures may be regarded as normal and, in any case, measurement methods used in schools may not be very accurate or reliable. Biohazards may result if body fluids are used (see *Student Safety Sheet 3*).
Investigations of body mass and size, sight, colour blindness, teeth, hearing, reaction time, touch sensitivity, ear lobe attachment, eye colour, etc	⚠ **DANGER**	Hazards include excessively loud sounds, bright light sources, sharp objects (touch testing), falling objects (reaction timing). Hygiene issues may arise with shared dental mirrors, etc. Individual pupils may become alarmed or distressed, or be subject to unpleasant comments from others in the class, if genetic tests raise questions about biological or adoptive parentage. Blue-eyed children can occasionally arise from biological parents with brown eyes because the inheritance of eye colour is a complex issue.

Typical control measures to reduce risk

- Ensure only willing volunteers are used and re-assure them if results are exceptional or surprising.
- Be aware of any medical conditions that could affect pupils' ability to participate and/or the results.
- Use hair grips rather than pins for touch sensitivity tests.
- Avoid sounds more than 85 dB(A).
- Ensure dental mirrors etc are properly disinfected between each use (see *Student Safety Sheet 9*).
- Use non-LED torches as light sources, as LED torches are known to be very bright.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg, could somebody be injured by the equipment?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

• Minor cuts	Wash the wound. Get the casualty to apply a small, sterilised dressing.
• Exposure to very loud sounds	Brief exposure to sounds of the loudness likely to be achieved in a school laboratory is unlikely to cause lasting damage. Reassure the casualty. Repeated exposure to loud music on portable media players or at festivals is much more damaging.
• Exposure to very bright lights	Although looking directly at the Sun and other very bright lights can cause permanent damage, the natural aversion response of the eyes of pupils will usually prevent this, unless deliberately over-ridden. Reassure the casualty.
• Impact injury	Rest the injured part; apply ice to reduce the bruising and pain; get attention from a first-aider.

Humans as the subject of investigation (2)

including **exercise, breathing and blood pressure**

See also CLEAPSS *Student Safety Sheets 3*, *6*, *8* and *9*

Source	Hazard	Comment
Investigating effects of exercise	⚠ **DANGER**	Over-exertion may be a hazard, especially for those with certain medical conditions. Competitive situations can lead to careless behaviour and accidents. Unsuitable footwear, uneven surfaces, running up and down stairs and unstable equipment may be hazards.
Investigating breathing	⚠ **DANGER** ☣ **BIOHAZARD**	Shared mouthpieces are sources of infection. When using manometers, fluid may be taken into the mouth. Use of spirometers, which have a large chamber filled with air or oxygen, must be closely supervised by the teacher. Use of lung-volume bags (or even water-filled bell jars), data-logging sensors and peak-flow meters are much safer. It is dangerous to carry out investigations involving rebreathed air for more than 1 minute. Lung volume bags need to be sterilised and dried between use.
Investigating blood pressure	⚠ **DANGER**	Using a sphygmomanometer with a mercury manometer and a stethoscope requires great skill. Electronic models, especially with automatic cuff inflation, are much more suitable but still require close teacher supervision.

Typical control measures to reduce risk

- Ensure only willing volunteers are used and reassure them if results are exceptional or surprising.
- Make sure you know how to use any equipment safely.
- When taking exercise, use step-ups on stable equipment rather than running upstairs. Do not exercise more than in PE and be aware of students with asthma, diabetes, circulatory problems, or those advised not to take part in normal PE lessons.
- Change and disinfect mouthpieces after each pupil.
- Ensure manometers have a trap to prevent fluid being taken into the mouth.
- Only use equipment for measuring blood pressure under the direct supervision of trained staff.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg, could somebody over-exert themselves or trip dangerously?
  If first-aid treatment were not applied, could the casualty's condition put his or her life at risk?
- How serious would it be if something did go wrong?
  eg, could it become life-threatening?
- How can the risk(s) be controlled for this activity?
  eg, can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Impact injury	Rest the injured part; apply ice to reduce the bruising and pain; get attention from a first aider.
• Asthma or breathing difficulties	Students should use their own inhalers (if any) and inform teacher

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Humans as the subject of investigation (3)

including **tasting, eating, drinking,** *and* **chemicals on the skin**

See also CLEAPSS *Student Safety Sheets 3*, *6* and *7*

Source	Hazard	Comment
Investigations where chemicals are placed on skin	**HEALTH HAZARD** **IRRITANT** **ENVIRON. HAZARD** **HIGHLY FLAMMABLE**	Hazardous chemicals may be placed on the skin during evaporation tests or when investigating perspiration. Where possible, it is safest to use substances which are deliberately intended for skin use, eg, alcohol-based gels. DANGER: Cobalt chloride (or thiocyanate) may cause allergic skin reaction or asthma-like symptoms if inhaled. Suspected of causing genetic defects or cancer if inhaled. May damage fertility. Toxic to aquatic life. These risks are negligible when impregnated on paper but skin contact must be minimised, although there is no evidence of problems from typical school use.
Investigations involving tasting, eating and drinking	**TOXIC** **BIOHAZARD**	Eating and drinking should not take place in laboratories. In some circumstances it may be illegal under the COSHH Regulations. Use of disclosing tablets in accordance with the manufacturer's instructions is considered low hazard. Tasting small amounts of dilute solutions (eg, sugar, salt) must be done under hygienic conditions, using a drinking straw, cotton bud or impregnated filter paper. DANGER: PTC (phenyl thiocarbamide, phenylthiourea, PTU), used in genetics testing, is fatal if swallowed and may cause an allergic skin reaction. It must be used only in carefully controlled, very small, amounts, eg on brought-in test strips. Consuming alcohol in any form or caffeine in the form of *ProPlus* tablets is not acceptable. Use caffeine in cola drinks or coffee instead, but limit total caffeine intake by avoiding it before and after testing. Limited amounts of *Red Bull*, or similar, might be used if students drink it anyway, although it contains other components as well.

Typical control measures to reduce risk

- Ensure only willing volunteers are used and reassure them if results are exceptional or surprising.
- Only use water or alcohol-based hand gels for testing evaporation on skin, no sources of ignition when using alcohol-based gels.
- If using cobalt chloride (or thiocyanate) paper on the skin, use forceps and wash the skin afterwards.
- Do not conduct taste tests in laboratories. Use dining areas or food technology rooms.
- Observe scrupulous hygiene - no sharing of cups, spoons, straws, etc.
- Use only specially purchased food, or pharmaceutical quality chemicals, for tasting.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg, could somebody taste the wrong substance by accident or as a result of mischief?
- How serious would it be if something did go wrong?
  eg, could it become life-threatening?
- How can the risk(s) be controlled for this activity?
  eg, can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.

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Disinfectants

Source	Hazard	Comment
Disinfectants containing active chlorine, eg, *Domestic, Milton*	*varies*	Effective against wide range of microorganisms. Less suitable for dirty conditions because disinfectant is degraded by organic matter. They corrode metals and generate toxic chlorine with acids. A good choice where blood is involved but use is discouraged by some employers. Requires a contact time of at least 15 minutes. See CLEAPSS *Student Safety Sheet 41*, Sodium chlorate(I) (sodium hypochlorite).
Disinfectants containing methanal (formaldehyde)	*varies*	Very effective at killing microorganisms but more concentrated solutions are hazardous. See CLEAPSS *Student Safety Sheet 67*, Methanal.
Ethanol, *70%,* **industrial denatured alcohol (IDA)** *70%*	**HIGHLY FLAMM.** **IRRITANT** **HEALTH HAZARD**	Active against most bacteria, viruses and fungi, within 5 minutes. Mainly useful for swabbing benches immediately before preparing cultures or for rapid disinfection of mouthpieces, dental mirrors, etc – rinse with clean water after sterilisation. DANGER: highly flammable, harmful by ingestion, may cause damage to organs, causes serious eye irritation. See CLEAPSS *Student Safety Sheet 60*, Ethanol.
VirKon, *powder*	**CORROSIVE**	Main active component is dipotassium peroxomonosulfate, which oxidises the infective material. Powder can be poured directly onto liquid spills, but is usually dissolved in water. DANGER: causes severe skin irritation and serious eye damage.
VirKon, *1% aqueous solution*	**Currently not classified as hazardous**	Very effective with 10 minutes contact against bacteria, fungi and viruses. Solution attacks metal after 10 minutes. The best choice for most situations.
Phenolic disinfectants	*varies*	Clear phenolics have been phased out under the *Biocidal Products Regulations*. Other phenolics (white or black, eg *Jeyes Fluid*, *Izal*, *Lysol*) are less effective and some are TOXIC/CORROSIVE. Not generally recommended for laboratory use.

Typical control measures to reduce risk

- Where possible, avoid the use of disinfectants classed as TOXIC or CORROSIVE and use freshly-made solutions.
- Wear eye protection, including when making or disposing of solutions.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg is the disinfectant effective against the organisms likely to be present and will it be left long enough to be effective?
- How serious would it be if something did go wrong?
  eg could a failure of disinfection lead to a serious illness?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Sodium chlorate(I) incidents	See CLEAPSS *Student Safety Sheet* 41 if sodium chlorate(I) used.
• Hazardous chemicals in the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
• Hazardous chemicals in mouth/ swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Brush off solids. Irrigate the affected skin area with gently running tap water for 20 minutes. Call 999/111 as appropriate.
• Spilt on the floor, bench, etc	Wear eye protection. Scoop up any solid and wipe up small amounts with a damp cloth and rinse it well. Cover solutions with mineral absorbent (eg, cat litter) and scoop into a bucket. Rinse well.

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Electricity

Substance	**Hazard**	**Comment**
230 V AC and above at high currents (over 5 mA).	**ELECTRIC SHOCK/BURN**	*In non-school contexts*: Electric power distribution, eg, over-head power lines and local sub-stations could cause accidents if children behave irresponsibly.
Above 30V AC or DC and at currents over 5 mA. *This includes the 230 V AC mains supply.*	**ELECTRIC SHOCK/BURN**	*In school science*: problems may arise from terminals of high voltage (high tension, HT) supplies or low-voltage units with an HT outlet (as some supply 150 mA); also in activities involving electrophoresis, model transformers or conductivity of molten glass. *In non-school contexts*: problems arise due to poor insulation (damaged wiring and plugs), incorrect wiring, over-loaded circuits, poor earthing or vandalism.
Less than 30 V AC or DC and at currents over 5 mA. *This includes almost all work with batteries in school or elsewhere.*	**ELECTRICAL HAZARD, LOW** **TOXIC** **CORROSIVE**	*In school science*: most school circuit work, including electrolysis, is in this category (although problems could arise if currents over 10 A were used). Some cells, batteries and accumulators contain TOXIC or CORROSIVE materials.
Any voltages at very low currents (well below 5 mA). *eg Static electricity*	**Currently not classified as hazardous**	*In school science*: examples include the Van de Graaff generator (but not induction coils which may give over 5 mA). Electronic equipment nearby may be damaged by static discharges or electromagnetic fields.

Typical control measures to reduce risk

- Use the lowest voltage possible (and, for electrolysis, the lowest current and concentration that gives good results).
- Avoid exposed conductors that are live above 30 V AC or DC.
- Avoid the possibility of water coming into contact with conductors which are live above 30 V AC or DC.
- Check that primary and secondary insulation (ie, both layers of plastic coating) are in good condition.
- Avoid over-loaded circuits, too many plugs in one socket, etc.
- Check that plugs are correctly wired with appropriate fuses.
- Ensure good earth connections where necessary.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg accidentally touching a live component through poor design or poor maintenance.
- How serious would it be if something did go wrong?
  eg could a current flow through the heart? How large a voltage and/or current?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

- Electric shock	**Take care for your own safety.** Break contact by switching off or removing the plug. If this is not possible, use a wooden broom handle or wear rubber gloves to pull the casualty clear. Consult a medic. If the casualty is unconscious, check that airways are clear and that the casualty is breathing and has a pulse. If so, place the casualty in the 'recovery position'. If a pulse is found but the casualty is not breathing, artificial ventilation is necessary. If no pulse is found and the casualty is not breathing, cardio-pulmonary resuscitation is necessary.

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Radioactive materials

Substance	Hazard	Comment
Alpha sources (α radiation) Low-activity α sources are used in domestic smoke alarms.	☢ IONISING RADIATION	Produce heavy ionisation (see *Additional Information*, below) but range is less than 1 mm in living tissue. Little problem if source is kept outside body.
Beta sources (β radiation) All samples of potassium and its compounds (including granite rocks, clays, etc) contain very small amounts of a natural β emitter.	☢ IONISING RADIATION	Produce medium ionisation (see *Additional Information*, below) but the range is a few centimetres in living tissue. There is little problem if source is kept away from the body.
Gamma sources (γ radiation) Very active γ sources are used in hospitals for killing cancer cells. Domestic smoke alarms emit a little γ radiation.	☢ IONISING RADIATION	Produce little ionisation (see *Additional Information*, below) but the range is long in living tissue, some passing right through the body. In schools, use a weak source and keep well away from the body.

Additional information

- When (ionising) radiation is absorbed by living tissue, mostly it results in a few extra hydrogen ions and hydroxide ions in the cytoplasm of cells. These rapidly recombine to form water.
- Some radiation is absorbed by more complex molecules and the ions from these can result in the death of the cell.
- Low levels of ionising radiation have little noticeable effect because biological organisms are continually replacing cells which die for other reasons anyway.
- High doses of radiation can result in skin burns (like sunburn) or radiation sickness (where so many cells have been killed that an organ ceases to function properly).
- Ionising radiation can also affect DNA in cells and change the genetic code. In reproductive organs, this could cause abnormal offspring but has never been confirmed in humans.
- Modified DNA may allow cells to reproduce out of control and form a cancer.

Typical control measures to reduce risk

- Use the lowest-activity source possible (only low-level sources are permitted in schools).
- Keep as far away from the source as possible. For school sources, use a handling tool which keeps the source at least 10 cm from the hand. Observers of demonstrations should generally keep at least 2 m away.
- Have a clear set of local rules, including "Sources must not be handled by under-16s".
- When radioactive solids, liquids or gases (open sources) are in use, prevent contamination of people (by use of laboratory coats and disposable plastic gloves), of benches (by use of trays and sheets of absorbing paper) and apparatus (by handling equipment with disposable tissues).

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg source is dropped, spilt or stolen or somebody moves too close to the source.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Sealed source dropped	Do not look directly at source. Use a mirror to examine source for damage. Check area for radioactivity where source was dropped.
• Spilt on the skin or swallowed	Wash the affected area thoroughly and check for radioactivity. If swallowed, go to a hospital specialising in radiation incidents.
• Open source spilt on the floor, bench, etc	Wipe up small amounts with damp tissues. Wipe the area until count rate is less than 50% above background. Place tissues in a plastic bag and dispose of it in solid waste.

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Electromagnetic radiation

Type of radiation	Hazard	Comment
Radio waves Wavelength 10^{3} m	**Currently not classified as hazardous**	There is no evidence that electric and magnetic fields at ordinary intensities affect the human body.
Microwaves Wavelength 10^{-2} m	⚠ **NON-IONISING RADIATION**	These are strong sources which produce local heating. Microwave ovens should be operated and maintained according to instructions, so that microwaves cannot leak out. Using mobile phones is safe if the power is less than 100 W m^{-2}. Microwave radiation has been used medically to give relief from pain.
Infra-red Wavelength 10^{-5} m	⚠ **NON-IONISING RADIATION**	It can produce skin burns and strong sources (eg, furnaces for melting iron) may damage the cornea of the eye. It may ignite combustible materials. Infra-red radiation has been used medically to give relief from pain. TV remote control units are safe.
Visible Wavelength 0.5×10^{-6} m	⚠ **NON-IONISING RADIATION** ⚠ **LASER RADIATION**	Intense sources (eg, from the Sun and narrow beams from class 3 & 4 lasers) may damage the retina. Class 1 (but not 1M) lasers (eg, in laser printers) are totally enclosed. Class 2 (but not 2M) lasers are low power (less than 1 mW) and safe unless the 'blink response' is over-ridden or ignored. Some cheap laser pointers are wrongly classified and may be class 3B (typical power 3 mW). Some are even 100 mW. These are dangerous, especially if misused. Direct observation of eclipses of the Sun often results in blindness.
Ultra-violet Wavelength 10^{-8} m UV-A, 315-400 x 10^{-9} UV-B, 218-315 x 10^{-9} UV-C, 100-280 x 10^{-9}	⚠ **NON-IONISING RADIATION**	It can cause sunburn. There is a risk of skin cancer. Do not sunbathe without adequate protection. Only class 1 UV lasers are safe. UV-A is used in sun beds. UV-B and UV-C can damage the eyes. Although UV-A is safer, many sources produce all wavelengths. UV is produced in electric-arc or oxy-acetylene welding. Glass which is 4 mm thick stops UV-B and UV-C. Wear snow goggles when skiing.
X-rays Wavelength 10^{-10} m	☢ **IONISING RADIATION**	X-rays are produced in low-pressure systems by sparks and discharges at more than 6 kV. Large doses cause burns and may induce cancer. X-rays are used in medicine for diagnosis and treatment (but should be avoided during pregnancy).
Gamma (γ) rays Wavelength 10^{-12} m	☢ **IONISING RADIATION**	See CLEAPSS *Student Safety Sheet 11, Radioactive materials*.

Typical control measures to reduce risk

- X-ray sets are permitted in schools only where there are suitably qualified staff.
- Ultra-violet lamps must be screened or personal protective equipment used (also for welding).
- Lasers for use in schools must be class 1 or class 2, when the rule is "Do not stare down the beam".
- Use sun lotions with a suitable protection factor and do not sunbathe without adequate protection.
- Never look directly at the Sun (even during an eclipse) or through a lens, filter or pin hole.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Radiation burns to the skin	Treat as for a heat burn, ie cool burnt skin under gently-running tap water for at least 20 minutes. Call 999/111 if more than an area the size of a small coin is affected.
• Suspected eye damage	Cover and call 999/11.

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Hydrochloric acid

also applied to **hydrogen chloride gas**

Substance	Hazard	Comment
Hydrogen chloride *Gas*	CORROSIVE TOXIC	DANGER. It causes severe skin burns and eye damage. It is toxic if breathed in. For a 15-minute exposure, the concentration in the atmosphere should not exceed 8 mg m^{-3}. 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.
Concentrated hydrochloric acid *(if 6.8 M or more)*	CORROSIVE IRRITANT	DANGER. It causes burns. The vapour irritates the lungs.
Moderately concentrated hydrochloric acid *(if less than 6.8 M but 2.7 M or more)*	IRRITANT	WARNING. It may irritate the eyes, and respiratory system.
Dilute hydrochloric acid *(if less than 2.7 M)*	**Currently not classified as hazardous**	This includes stomach acid. Dilute acid may still cause harm to the eyes or the skin. Treat as for more concentrated samples.

Typical control measures to reduce risk

- Use the lowest concentration possible.
- Use the smallest volume possible.
- Wear eye protection; goggles for concentrated acids.
- **Avoid breathing the gas or fumes from concentrated solutions, eg, by use of a fume cupboard.**

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg hazardous products (such as chlorine) produced as a result of a reaction with the acid or choking fumes if the concentrated acid is over-heated.
- How serious would it be if something did go wrong?
  NB There are occasional reports of students being taken to hospital as a result of breathing in chlorine.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

In the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
Vapour breathed in	Remove to fresh air. Call 999/111 if breathing is difficult.
In the mouth/swallowed	Do no more than wash out the mouth with drinking water. Do **not** induce vomiting. Call 999/111.
Spilt on the skin or clothing	Remove contaminated clothing. Quickly use a dry cloth or paper towel to wipe as much liquid off the skin as possible. Irrigate the affected area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111.
Spilt on the floor, bench, etc	**For release of gas, including larger spills, consider the need to evacuate the laboratory and open all windows**. For large spills, and especially for (moderately) concentrated acid, cover with mineral absorbent (eg cat litter), then scoop into a bucket. Neutralise with sodium carbonate. Rinse with plenty of water. Wipe up small amounts with a damp cloth and rinse well.

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Nitric(V) acid

Substance	Hazard	Comment
Concentrated nitric acid *(if 10 M or more)*	**CORROSIVE** **OXIDISING**	DANGER: May cause or intensify a fire in contact with combustible materials. Causes severe skin burns; skin is stained yellow and then peels. Causes eye damage. Toxic if inhaled. Corrosive to the respiratory tract For a 15-minute exposure, the vapour concentration in the atmosphere should not exceed 2.6 mg m^{-3}. Use a fume cupboard. Usually supplied in plastic bottles which will be attacked by the acid after a few years – transfer to borosilicate bottles with chemically-resistant cap.
Moderately concentrated nitric acid *(if less than 10 M but 0.8 M or more)*	**CORROSIVE**	DANGER: It causes severe skin burns and eye damage.
Moderately dilute nitric acid *(if less than 0.8 M but 0.1 M or more)*	**IRRITANT**	It is irritating to the eyes and skin.
Dilute nitric acid *(if less than 0.1 M)*	**Currently not classified as hazardous**	Dilute acid may still cause harm to the eyes or the skin. Treat as for more concentrated samples.

Typical control measures to reduce risk

- Use the lowest concentration possible.
- Use the smallest volume possible.
- Wear splash-proof goggles when making, dispensing and using solutions at or above 0.8 M. Wear eye protection when using solutions below 0.8 M, even when dilute solutions are used.
- Wear protective gloves if using concentrated solutions (at or above 3 M), especially if more than test tube amounts.
- Ensure good ventilation if oxides of nitrogen could be formed.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could hazardous products (such as oxides of nitrogen) be formed in reactions with the acid or corrosive fumes produced if concentrated acid is over-heated?
- How serious would it be if something did go wrong?
  eg peeling skin, from burns caused by concentrated acid, may be very painful.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
• Fumes breathed in	Remove the casualty to fresh air. Keep him/her warm. Call 999/111 even if no symptoms are apparent.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Quickly use a dry cloth or paper towel to wipe as much liquid off the skin as possible. Irrigate the affected area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111.
• Spilt on the floor, bench, etc	Wipe up small amounts with a damp cloth and rinse it well. For larger amounts, and especially for (moderately) concentrated acid, cover with mineral absorbent (eg, cat litter) and scoop into a bucket. Neutralise with sodium carbonate. Rinse with plenty of water.

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Sulfuric (VI) acid

Substance	Hazard	Comment
Concentrated sulfuric(VI) acid	**CORROSIVE**	DANGER. It causes severe skin burns and eye damage. It reacts violently, becoming very hot, when mixed with water. For a 15-minute exposure, the vapour concentration in the atmosphere should not exceed 0.15 mg m^{-3}.
Moderately concentrated sulfuric(VI) acid *(if 1.5 M or more)* Includes acid used in car batteries.	**CORROSIVE**	DANGER. It causes severe skin burns and eye damage.
Moderately dilute sulfuric(VI) acid *(if less than 1.5 M but 0.5 M or more)*	**IRRITANT**	WARNING. It may irritate the eye and skin.
Dilute sulfuric(VI) acid *(if less than 0.5 M)*	**Currently not classified as hazardous**	Dilute acid may still cause harm to the eyes or the skin. Treat as for more concentrated samples. For many activities in school science, 0.4 M is adequate.

Typical control measures to reduce risk

- Use the lowest concentration possible.
- Use the smallest volume possible.
- Wear eye protection; goggles for concentrated acids.
- Add the concentrated acid slowly to cold water (or preferably ice) when diluting, never the reverse; stir frequently to ensure good mixing.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg hazardous products are formed in reactions with the acid or corrosive fumes are produced if concentrated acid is over-heated.
- How serious would it be if something did go wrong?
  eg skin and eyes can be seriously burned if not treated quickly.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Quickly use a dry cloth or paper towel to wipe as much liquid off the skin as possible. Irrigate the affected area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111.
• Spilt on the floor, bench, etc	Wipe up small amounts with a damp cloth and rinse it well. For larger amounts, and especially for (moderately) concentrated acid, cover with mineral absorbent (eg, cat litter) and scoop into a bucket. Neutralise with sodium carbonate. Rinse with plenty of water.

Ethanoic (acetic) acid

also methanoic (formic) acid

Substance	Hazard	Comment
Ethanoic acid (acetic acid) *Pure liquid, 'glacial'* Also **methanoic (formic) acid** *usually supplied as 90% solution (about 20 M)*	**CORROSIVE** **FLAMMABLE**	DANGER: both acids cause severe skin burns and eye damage. Ethanoic acid only: flammable vapour and liquid. For a 15-minute exposure, the concentration of methanoic acid vapour in the atmosphere should not exceed 28.8 mg m^{-3}. Some descalers for kettles, irons etc use methanoic acid.
Concentrated acids Solution in water *(if 4 M or more ethanoic acid;* *2.2 M or more methanoic acid)*	**CORROSIVE**	DANGER: both acids cause severe skin burns and eye damage.
Moderately concentrated acids *(if less than 4 M but 1.7 M or more ethanoic acid;* *less than 2.2 M but 0.4 M or more methanoic acid)*	**IRRITANT**	WARNING: both acids are irritating to the eyes and skin. Ant venom is about 1.5 M methanoic acid; stinging nettles are less concentrated.
Dilute acids *(if less than 1.7 M ethanoic acid;* *less than 0.4 M methanoic acid)*	**Currently not classified as hazardous**	Dilute acid may still cause harm to the eyes or the skin. Treat as for more concentrated samples. This includes vinegar (about 0.8 M ethanoic acid).

Typical control measures to reduce risk

- Use the lowest concentration possible.
- Use the smallest volume possible.
- Wear eye protection; goggles for concentrated acids.
- Avoid breathing gas or fumes from concentrated solutions, eg, by use of a fume cupboard.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg choking fumes if concentrated acid is over-heated.
- How serious would it be if something did go wrong?
  Note – we put vinegar on chips!
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove to fresh air. Call 999/111 if breathing is difficult.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Split on the skin or clothing	Remove contaminated clothing. Quickly use a dry cloth or paper towel to wipe as much liquid off the skin as possible. Irrigate the affected area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111.
• Spilt on the floor, bench, etc	Wipe up small amounts with a damp cloth and rinse it well. For larger amounts, and especially for (moderately) concentrated acid, cover with mineral absorbent (eg cat litter) and scoop into a bucket. Neutralise with sodium carbonate. Rinse with plenty of water.

Phosphoric(V) acid

also known as **orthophosphoric acid**

Substance	Hazard	Comment
Concentrated phosphoric(V) acid *(if 2.6 M or more)* *Usually sold as 85% w/w (about 9 M)*	 **CORROSIVE**	DANGER: cause severe skin burns and eye damage. For a 15-minute exposure, the concentration of phosphoric acid vapour in the atmosphere should not exceed 2.0 mg m^{-3}. It reacts violently, becoming very hot, when mixed with water. It decomposes if heated strongly, forming toxic oxides of phosphorus. This includes phosphoric acid used in most descaling and rust treatments.
Moderately concentrated phosphoric(V) acid *(if less than 2.6 M but 1.0 M or more)*	 **IRRITANT**	WARNING: irritating to eyes and skin.
Dilute phosphoric(V) acid *(if less than 1.0 M)*	**Currently not classified as hazardous**	Dilute acid may still cause harm to the eyes or the skin. Treat as for more concentrated samples. This includes acid used in cola drinks, etc. Over long periods of time, the acid may attack teeth.

Typical control measures to reduce risk

- Use the lowest concentration possible.
- Use the smallest volume possible.
- Wear eye protection - goggles for concentrated acids.
- **Add the concentrated acid slowly to cold water when diluting, never the reverse; stir frequently to ensure good mixing.**

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg hazardous products are formed in reactions with the acid or corrosive fumes are produced if concentrated acid is over-heated.
- How serious would it be if something did go wrong?
  eg the skin and eyes can be seriously burned if not treated quickly.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Quickly use a dry cloth or paper towel to wipe as much liquid off the skin as possible. Irrigate the affected area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111.
• Spilt on the floor, bench, etc	Wipe up small amounts with a damp cloth and rinse it well. For larger amounts, and especially for (moderately) concentrated acid, cover with mineral absorbent (eg cat litter) and scoop into a bucket. Neutralise with sodium carbonate. Rinse with plenty of water.

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Citric, oxalic & tartaric acids

2-hydroxypropane-1,2,3-tricarboxylic acid, ethanedioic acid *and* 2,3-dihydroxybutanedioic acid

Substance	Hazard	Comment
Citric acid (2-hydroxypropane-1,2,3-tricarboxylic acid) *solid and most solutions (if 0.5 M or more)*	⚠ **IRRITANT**	WARNING: causes serious eye and skin irritation and may cause respiratory irritation. It is an approved food additive, E330. Concentrated lemon juice may contain citric acid up to 1.7 M.
Dilute citric acid (2-hydroxypropane-1,2,3-tricarboxylic acid) *(if less than 0.5 M)*	**Currently not classified as hazardous**	Even dilute solutions will cause discomfort in the eye. It is found in citrus fruits, eg, lemons, oranges, grapefruit. Lemons contain citric acid up to about 0.25 M.
Oxalic acid (ethanedioic acid) *solid and most solutions (if 0.1 M or more)*	⚠ **HARMFUL**	WARNING: harmful in contact with the skin and if swallowed. May cause eye damage. It removes calcium ions from the blood, forming insoluble calcium ethanedioate (calcium oxalate); this can block kidneys. It is found in rhubarb, especially in the leaves and in unripe leaf stalks (ie, the part which is eaten). Cases of poisoning have been reported, although very rarely fatal. The toxic effects of rhubarb may be due to other substances.
Dilute oxalic acid (ethanedioic acid) *(if less than 0.1 M)*	**Currently not classified as hazardous**	Even dilute solutions will cause discomfort in the eye.
Tartaric acid (2,3-dihydroxybutanedioic acid) *solid and most solutions (if 0.7 M or more)*	⚠ **HARMFUL**	WARNING: causes serious eye and skin irritation and may cause respiratory irritation. It is an approved food additive, E334. It is used in baking powder and is found in many food products.
Dilute tartaric acid (2,3-dihydroxybutanedioic acid) *(if less than 0.7 M)*	**Currently not classified as hazardous**	Even dilute solutions will cause discomfort in the eye.

Typical control measures to reduce risk

- Use the lowest concentration possible.
- Wear eye protection for all but the most-dilute solutions; goggles for concentrated acids.
- Avoid the possibility of swallowing oxalic acid or its salts, eg, by using a safety pipette filler.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg specks of solid transferred into the eye by rubbing with a contaminated finger.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently running tap water for at least 20 minutes. Call 999/111 as appropriate.
• Spilt on the floor, bench, etc	Wipe up small amounts with a damp cloth and rinse it well. For larger amounts, cover with mineral absorbent (eg cat litter) and scoop into a bucket. Neutralise with sodium carbonate. Rinse with plenty of water.

Salicylic acid, aspirin, salol, oil of wintergreen

also known as ***2-hydroxybenzoic acid, 2-ethanoyloxybenzoic acid, phenyl 2-hydroxybenzoate*** *and* **methyl 2-hydroxybenzoate**

Substance	Hazard	Comment
Salicylic acid (2-hydroxybenzoic acid) *solid*	**IRRITANT** **CORROSIVE** **HEALTH HAZARD**	DANGER: causes serious eye damage; harmful if swallowed; suspected of damaging the unborn child.
Aspirin (2-ethanoyloxy benzoic acid, o-acetylsalicylic acid) *solid*	**IRRITANT**	WARNING: Causes skin and serious eye irritation; may cause respiratory irritation; harmful if swallowed. For a 15-minute exposure, the concentration in the atmosphere should not exceed 15 mg m^{-3}. Used as a medication to treat pain, fever, and inflammation. Aspirin given shortly after a heart attack decreases the risk of death and is also used long-term to help prevent heart attacks, strokes, and blood clots, in people at high risk. Common side effects include an upset stomach. Aspirin can be extracted from the leaves of willow trees and has been used for its health effects for hundreds of years.
Salol (phenyl 2-hydroxybenzoate, phenyl salicylate) *solid*	**IRRITANT** **ENVIRON. HAZARD**	WARNING: Causes skin and serious eye irritation; may cause respiratory irritation; may also be labelled toxic to aquatic life with long-lasting effects. Has a relatively low melting point (41 °C) so releases a significant amount of vapour when heated. Insert a mineral wool plug in test tubes to minimise escape of vapour and ensure good ventilation.
Oil of wintergreen (methyl 2-hydroxybenzoate, methyl salicylate) *liquid*	**IRRITANT**	WARNING: Causes skin and serious eye irritation; may cause respiratory irritation; harmful if swallowed. Used for pain relief, especially for muscles and joints where it is rubbed into the skin. Used as flavouring agent in chewing gums, mints and mouth washes.

Typical control measures to reduce risk

- Use the smallest amount possible.
- Wear eye protection.
- Ensure good ventilation.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg specks of solid transferred into the eye by rubbing with a contaminated finger.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
In the mouth/ swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate.
Spilt on the floor, bench, etc	Wipe up small amounts with a damp cloth and rinse it well. Brush up larger amounts, trying to avoid raising dust. Rinse with plenty of water.

Ammonia (gas and solution)

also applies to **ammonium hydroxide**

Substance	Hazard	Comment
Ammonia *(Gas)*	CORROSIVE TOXIC ENVIRON. HAZARD	DANGER: Causes severe skin burns and eye damage. Toxic if inhaled. Flammable gas. Very toxic to aquatic organisms. For a 15-minute exposure, the concentration in the atmosphere should not exceed 25 mg m^{-3}. Effects of exposure develop or increase over some time. Inhalation may exacerbate the problems of those with asthma etc. However, the human nose can detect ammonia at well below danger levels.
Concentrated ammonia solution *(if 3 M or more)* **Ammonium hydroxide solution** 35 % w/w (18 M) ammonia is commercially available (known as '880 ammonia' as has density of 0.880 g cm^{-3}).	CORROSIVE IRRITANT ENVIRON. HAZARD	DANGER: Causes severe skin burns and eye damage. Respiratory irritant. Very toxic to aquatic organisms. Ammonia gas will be present and the pressure of gas builds up on hot days – open cautiously in a fume cupboard. 'Household' ammonia is about 6 M.
Moderately concentrated ammonia solution *(If less than 3M but 1.8 M or more)*	CORROSIVE	DANGER: Causes severe eye damage; irritates skin. Its odour can cause distress.
Moderately dilute ammonia solution *(If less than 1.8 M but 0.6 M or more)*	IRRITANT	WARNING: irritates skin and eyes.
Dilute ammonia solution *(If less than 0.6 M)*	**Currently not classified as hazardous**	It may still cause harm in eyes or in a cut.

Typical control measures to reduce risk

- Use the lowest concentration possible.
- Wear suitable eye protection including when making or disposing of solutions
- Use a fume cupboard for all but test tube amounts of the gas and more concentrated solutions (including opening bottles); ensure good laboratory ventilation.
- If smelling the gas, follow the safe technique for sniffing gases: use your hand to waft the gas towards your nose.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg, solution spurting out of test tubes when being heated; release of ammonia gas as a product of a chemical reaction; possibility of the ammonia gas concentration reaching dangerous levels.
- How serious would it be if something did go wrong?
  Note – alkali in the eye causes more damage than acid of equivalent concentration.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111. If it is necessary to go to hospital, continue washing the eye during the journey in an ambulance.
• Vapour breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is difficult.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Quickly use a dry cloth or paper towel to wipe as much liquid off the skin as possible. Irrigate the affected area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111. Rinse clothing.
• Spilt on the floor, bench, etc	**Consider the need to evacuate the laboratory and open windows** if large amounts are spilt and especially for (moderately) concentrated solutions. Cover with mineral absorbent (eg cat litter) and scoop into a bucket. Neutralise with citric acid. Rinse with plenty of water. Wipe up small amounts with a damp cloth and rinse it well.

Sodium hydroxide

also applies to **soda lime** *and* **potassium hydroxide**

Substance	Hazard	Comment
Sodium or potassium hydroxide *Solid* *Also known as* **caustic soda** *and* **caustic potash**. **Soda lime** contains about 5% sodium hydroxide, 1% potassium hydroxide, 0.2% silicon dioxide, 14 – 19% water and the remainder calcium hydroxide (it is used to absorb carbon dioxide). **Carbosorb** in addition contains an indicator.	**CORROSIVE** **HARMFUL**	DANGER: causes severe skin burns and eye damage. Potassium hydroxide is also harmful if swallowed. It gives out heat when added to water which can cause boiling or create a choking mist. It is used in the home for clearing drains.
Sodium or **potassium hydroxide solution** *(if 0.5 M or more sodium hydroxide;* *0.4 M or more potassium hydroxide)*	**CORROSIVE** **HARMFUL**	DANGER: causes severe skin burns and eye damage. Potassium hydroxide is also harmful if swallowed if 3 M or more. Fehling's solution contains sodium hydroxide of this concentration. It is used in the home as an oven cleaner.
Dilute sodium or **potassium hydroxide solution** *(if less than 0.5 M but 0.125 M or more sodium hydroxide; if less than 0.4 M but 0.1 M or more potassium hydroxide)*	**IRRITANT**	WARNING: irritating to the eyes and skin.
Very dilute sodium or **potassium hydroxide solution** *(if less then 0.125 M sodium hydroxide; if less than 0.1 M potassium hydroxide)*	**Currently not classified as hazardous**	It may still cause harm in the eyes or in a cut.

Typical control measures to reduce risk

- Use the lowest concentration possible; avoid using the solid if possible.
- Use the smallest amount possible.
- **Wear eye protection**, including when making or disposing of solutions. Protect the face when transferring/dispensing large quantities of corrosive substance.
- If possible, use a safer alternative, eg, sodium carbonate when making salts or Benedict's solution rather than Fehling's solution for food tests.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg solution spurting out of test tubes when being heated.
- How serious would it be if something did go wrong?
  Note – alkali in the eye causes more damage than acid of equivalent concentration.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111. If it is necessary to go to hospital, continue washing the eye during the journey in an ambulance.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Quickly use a dry cloth or paper towel to wipe as much liquid off the skin as possible. Irrigate the affected area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111. Rinse clothing.
• Spilt on the floor, bench, etc	Wipe up small amounts with a damp cloth and rinse it well. For larger amounts, and especially for (moderately) concentrated solutions, cover with mineral absorbent (eg cat litter) and scoop into a bucket. Neutralise with citric acid. Rinse with plenty of water.

Calcium hydroxide and oxide

including **slaked lime**, **quick Lime** *and* **limewater**

Substance	Hazard	Comment
Calcium oxide *Solid* **Quick lime** *Solid* (Old samples of calcium oxide are mostly calcium hydroxide.)	CORROSIVE IRRITANT	DANGER: Causes serious eye damage and skin irritation. Reacts violently with water, becoming very hot - dust particles may shoot out. For a 15-minute exposure, the concentration of the powder in the atmosphere should not exceed 6 mg m^{-3}. Used in making mortar, cement and concrete – careless handling of these has caused injuries in the building industry. Added to soil to neutralise the acidity.
Calcium hydroxide *Solid* **Slaked lime, garden lime**	CORROSIVE IRRITANT	DANGER: Causes serious eye damage and skin irritation. For a 15-minute exposure, the concentration of the powder in the atmosphere should not exceed 15 mg m^{-3}. Used in making mortar, cement and concrete – careless handling of these has caused injuries in the building industry. Added to soil to neutralise the acidity.
Calcium hydroxide *Solution* **Limewater** Limewater is a saturated solution of calcium hydroxide, less than 0.02 M.	IRRITANT	Even a saturated solution of calcium hydroxide is so dilute that it is not classed as IRRITANT, despite pH = 12.4. However, limewater is usually made in schools by adding excess solid calcium hydroxide (or oxide) to water. Undissolved solid will remain and that is irritating to the eyes and skin (but any solid present might well be calcium carbonate, currently not classified as hazardous).

Typical control measures to reduce risk

- Wear eye protection.
- Eye protection is advisable when using limewater, especially if blowing into it.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg solid particles spitting when adding water, dust blowing around or liquid splashing into the eye when blowing into limewater.
- How serious would it be if something did go wrong?
  Note – alkali in the eye causes more damage than acid of equivalent concentration.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111. If it is necessary to go to hospital, continue washing the eye during the journey in an ambulance. Limewater is unlikely to cause serious problems. Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111. Limewater is unlikely to cause serious problems. Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111 as appropriate
• Spilt on the skin or clothing	Brush off the solid. Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Wipe up limewater or small amounts of solid with a damp cloth and rinse it well. For larger amounts of solid, scoop into a bucket, add water to the area followed by mineral absorbent (eg cat litter).

Student safety sheets 33

Sodium, potassium, magnesium, calcium carbonates

including **hydrogencarbonates (bicarbonates)**

Substance	Hazard	Comment
Sodium carbonate *Hydrated or anhydrous solid* **Washing soda** **Potassium carbonate**	⚠ IRRITANT	WARNING: cause serious eye irritation. Anhydrous solid presents a bigger risk because it is finely powdered, whereas the hydrate is crystalline (usually large crystals). Soda ash is an impure (industrial) form. Hydrated sodium carbonate is used as washing soda. They are approved food additives, E500 & E501.
Sodium & **Potassium carbonate** *Concentrated solution (If 0.8 M or more)*	⚠ IRRITANT	WARNING: cause serious eye irritation.
Sodium & **Potassium carbonate** *Dilute solution (If less than 0.8 M)*	**Currently not classified as hazardous**	They are used as a dilute solution in bath salts.
Sodium & **Potassium hydrogencarbonate (bicarbonate)** *Solid and solution* Also **Sodium sesquicarbonate**		They liberate carbon dioxide on gentle heating (or with acids). Sodium hydrogencarbonate is an approved food additive, E500, and is used as baking soda. 'Bicarb' or 'bicarbonate of soda' are old-fashioned names. Bath salts contain sodium sesquicarbonate, (sodium carbonate hydrogencarbonate), $Na_2CO_3.NaHCO_3.H_2O$.
Calcium & **Magnesium carbonate** **Magnesium carbonate hydroxide** ('light' and 'heavy' magnesium carbonate) *Solid*		Calcium carbonate occurs naturally as calcite, marble, chalk and limestone. It decomposes if heated above 800 °C and gives carbon dioxide with acids (unless the calcium salt is insoluble in water). It is an approved food additive, E170. Blackboard chalk may be calcium carbonate but is more likely to be calcium sulfate. Magnesium carbonate also occurs naturally. It decomposes more easily than calcium carbonate and is also an approved food additive, E504.
Calcium & **Magnesium hydrogencarbonate (bicarbonate)** *Solution*		The solid does not exist. The solution is the cause of temporary hardness of water. On warming, calcium (or magnesium) carbonate is deposited as 'limescale' or 'fur', eg on kettles. The solution reacts with soap to produce insoluble calcium (or magnesium) salts ('scum').

Typical control measures to reduce risk

- Wear eye protection,
- Avoid raising dust.
- Avoid contact with acids, especially in sealed containers, because large volumes of carbon dioxide will be formed.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg specks of solid transferred into the eye by rubbing with a contaminated finger.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Brush solid off contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes as appropriate. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth. Wipe up solution spills with a cloth and rinse it well.

Sodium *and* potassium salts

Substance	Hazard	Comment
Sodium and **potassium chloride, bromide** and **iodide** *Solid & solution*	**Currently not classified as hazardous**	People have been killed through consuming very large amounts of salt. At 'normal' levels, can cause high blood pressure, hence heart disease. Adults should not eat more than 6 g/day, children less. Potassium chloride is approved food additive, E508, used as a 'low-salt' substitute.
Sodium sulfate(VI) *Also* **potassium sulfate(VI)** *Solid & solution*		Hydrated sodium sulfate(VI), Na$_2$SO$_4$.10H$_2$O is known as Glauber's salt. Sodium sulfate(VI) is an approved food additive, E514, as is the potassium salt, E515.
Sodium hydrogensulfate(VI) (**bisulfate**) *Solid and concentrated solution* *(if 0.25 M or more)*	**CORROSIVE**	DANGER: Causes serious eye damage. It is strongly acidic because of acidic hydrogen in NaHSO$_4$. It is used in some toilet cleaners.
Sodium hydrogensulfate(VI) (**bisulfate**) *Dilute solutions (if less than 0.25 M but 0.1 M or more)*	**IRRITANT**	WARNING: Causes serious eye irritation. It is strongly acidic because of acidic hydrogen in NaHSO$_4$.
Sodium hydrogensulfate(VI) (**bisulfate**) *Very dilute solutions (if less than 0.1 M)*	**Currently not classified as hazardous**	It is strongly acidic because of acidic hydrogen in NaHSO$_4$.
Sodium and **potassium ethanedioate (oxalate)** *Solid*	**HARMFUL**	WARNING: harmful if swallowed and in contact with skin.
Sodium and **potassium ethanedioate (oxalate)** *Solution*	**Currently not classified as hazardous**	Note that all sodium and potassium ethanedioate (oxalate) solutions are currently not classified as hazardous **Except** potassium ethanedioate is WARNING: **HARMFUL** if swallowed (if 1.5 M or more).
Sodium nitrate(V) *Also* **potassium nitrate(V)** *Solid and solutions*	**OXIDISING** **IRRITANT**	WARNING: Oxidiser Sodium nitrate(V) solid and solutions are harmful if swallowed (if more than 3 M) and irritating to eyes and skin (if more than 1 M).
Sodium or **potassium carbonate** and **hydrogencarbonate**		See *CLEAPSS Student Safety Sheet* 33
Sodium chlorate(I) (**hypochlorite**)		See CLEAPSS *Student Safety Sheet* 41
Sodium or **potassium chromate(VI)** or **dichromate(VI)**		See CLEAPSS *Student Safety Sheet* 47
Sodium or **potassium manganate(VII)** (**permanganate**)		See CLEAPSS *Student Safety Sheet* 48

Typical control measures to reduce risk

- Wear eye protection.
- Avoid raising dust.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg specks of solid transferred into the eye by rubbing with a contaminated finger.
- How serious would it be if something did go wrong?
  eg are there hazardous reaction products (such as chlorine from the electrolysis of sodium chloride)?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Brush solid off contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes as appropriate. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth. Wipe up solutions spills and rinse well

Sodium *and* potassium sulfites, metabisulfites, hydrogensulfites, thiosulfates *and* persulfates

Substance	Hazard	Comment
Sodium & **potassium sulfite [sulfate(IV)]** **Sodium** & **potassium metabisulfite [disulfate(IV)]** *Solid and concentrated solution* (*if 0.15 M or more*)	**HARMFUL** **CORROSIVE**	DANGER: Harmful if swallowed, cause serious eye damage. With acids, produce sulfur dioxide (SO_2) (a TOXIC gas, see *Sheet 52*); do not inhale. Smell of SO_2 due to acidification by CO_2 in air. Approved food additives: sodium sulphite E221, potassium sulphite E225, sodium metabisulfite E223, potassium metabisulfite E224 all used as preservatives. For a 15-minute exposure, concentration of metabisulfite in the atmosphere should not exceed 15 mg m^{-3}.
Sodium & **potassium sulfite [sulfate(IV)]** **Sodium** & **potassium metabisulfite [disulfate(IV)]** *Dilute solution (if less than 0.15 M)*	**Currently not classified as hazardous**	They smell of sulfur dioxide due to acidification by carbon dioxide in the air; do not inhale.
Sodium & **potassium hydrogensulfite [hydrogensulfate(IV)]** *Concentrated solution* *(if 0.15 M or more)*	**HARMFUL** **CORROSIVE**	DANGER: Harmful if swallowed, cause serious eye damage. With acids, produce sulfur dioxide (SO_2) (a TOXIC gas, see *Sheet 52*); do not inhale. Smell of SO_2 due to acidification by CO_2 in air. Sodium and potassium hydrogensulfites are approved food additives, E222 and E228, as preservatives. The pure solid $NaHSO_3$ does not exist. Products sold as bisulfite contain metabisulfite.
Sodium & **potassium metabisulfite [disulfate(IV)]** *Dilute solution (if less than 0.15 M)*	**Currently not classified as hazardous**	Although sodium metabisulfite solid is $Na_2S_2O_5$, it behaves as sodium hydrogensulfite, $NaHSO_3$, in solution.
Sodium & **potassium thiosulfate** *Solid and solutions*	**Currently not classified as hazardous**	Produce sulfur (see *Sheet 82*) & sulfur dioxide (a TOXIC gas, see *Sheet 52*) with acids, including carbon dioxide. Carbon dioxide may cause solutions to go cloudy.
Sodium & **potassium persulfate [peroxodisulfate(VI)]** *Solid and most solutions* *(if 0.04 M or more)*	**OXIDISING** **IRRITANT** **HEALTH HAZARD**	Danger: oxidisers; skin irritants; cause serious eye irritation; harmful if swallowed; may cause respiratory irritation, allergy or asthma. Sodium persulfate is used for bleaching hair, etching printed-circuit boards and to initiate polymerisation reactions. Solutions are currently not classified as hazardous if less than 0.04 M.
Sodium sulfate(VI) & **hydrogensulfate(VI)** – See CLEAPSS *Student Safety Sheet 34.*		

Typical control measures to reduce risk

- Use the smallest quantity or concentration possible.
- Wear eye protection.
- Take care not to inhale sulfur dioxide; asthmatics should be especially careful; use a fume cupboard to avoid exposure.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg accidental inhalation of sulfur dioxide when opening a bottle or dissolving a solid in water.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Brush solid off contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes as appropriate. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth. Wipe up solution spills with a cloth and rinse it well.

Student safety sheets

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Magnesium *and* calcium salts

Substance	Hazard	Comment
Magnesium chloride	**Currently not classified as hazardous**	It is an approved food additive, E511.
Calcium chloride *Anhydrous / hydrated solid & concentrated solution (if 0.9M or more)*	**IRRITANT**	WARNING: causes skin and serious eye irritation and may cause respiratory irritation. Anhydrous calcium chloride can cause water to boil; often used as a drying agent. Approved food additive E509.
Calcium chloride *Dilute solution (if less than 0.9 M)*	**Currently not classified as hazardous**	–
Magnesium sulfate(VI) *Hydrated and anhydrous*		Hydrated magnesium sulfate, known as Epsom salts, is used as a medicine (a purgative). It is a cause of permanently hard water.
Calcium sulfate(VI) ($CaSO_4 \cdot 0.5H2O$, plaster of Paris) ($CaSO_4 \cdot 2H_2O$, gypsum)		Plaster of Paris used for setting broken bones: $CaSO_4 \cdot 0.5H_2O$ absorbs water, becomes hot and expands slightly forming $CaSO_4.2H_2O$ (gypsum). It is not safe to attempt to make a cast of the whole hand or encase any other part of the body. Unlike magnesium sulfate(VI), calcium sulfate(VI) is only sparingly soluble. It is commonly used as blackboard chalk. It is a cause of permanently hard water. It is an approved food additive, E516.
Magnesium nitrate *Solid*	**OXIDISING** **IRRITANT**	DANGER: may intensify fire; causes skin and serious eye irritation and may cause respiratory irritation.
Magnesium nitrate *Most solutions (if 0.5M or more)*	**IRRITANT**	WARNING: irritating to eyes and skin.
Magnesium nitrate *Dilute solutions (if less than 0.5M)*	**Currently not classified as hazardous**	–
Calcium nitrate *Solid and most solutions (if 0.15M or more)*	**OXIDISING** **CORROSIVE**	DANGER: the solid may intensify fire; solid and solutions cause serious eye damage.
Calcium nitrate *Dilute solutions (if less than 0.15M but 0.05M or more)*	**IRRITANT**	WARNING: irritating to eyes.
Calcium nitrate *Very dilute solution (if less than 0.05M)*	**Currently not classified as hazardous**	–
Calcium (and **magnesium**) **carbonate** and **hydrogencarbonate**		See *CLEAPSS Student Safety Sheet 33*
Calcium oxalate (**ethanedioate**)		See *CLEAPSS Student Safety Sheet 25*

Typical control measures to reduce risk

- Wear eye protection.
- Avoid raising dust.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg specks of solid transferred into the eye by rubbing with a contaminated finger.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Brush solid off contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes as appropriate. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth. Wipe up solution spills with a cloth and rinse it well.

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Ammonium salts

Substance	Hazard	Comment
Ammonium chloride *Solid and concentrated solution* *(if 1.8 M or more)*	**HARMFUL**	WARNING: harmful if swallowed, causes serious eye irritation. It decomposes on heating to form ammonia gas (see *Sheet 30*) and hydrogen chloride gas (see *Sheet 20*) but they recombine on cooling. Warming with alkali will generate ammonia gas. Old name: sal ammoniac.
Ammonium chloride *Dilute solution (if less than 1.8 M)*	**Currently not classified as hazardous**	Warming with alkali will generate ammonia gas (see CLEAPSS Student Safety Sheet 30).
Ammonium sulfate(VI) *Solid and solutions*	**Currently not classified as hazardous**	It decomposes on heating to form ammonia gas (see *Sheet 30*) and sulfuric acid 'gas' (see *Sheet 22*) but they recombine on cooling. Warming with alkali will generate ammonia gas. It is an approved food additive, E517.
Ammonium carbonate *Solid and concentrated solution* *(if 1.0 M or more)*	**HARMFUL**	WARNING: harmful if swallowed. The solid decomposes, even at room temperature, to ammonia (see *Sheet 30*) and carbon dioxide (see *Sheet 58*). Warming with alkali generates ammonia gas. It is an approved food additive, E503. Old name: sal volatile; used as smelling salts.
Ammonium carbonate *Dilute solution (if less than 1.0 M)*	**Currently not classified as hazardous**	Warming with alkali generates ammonia gas (see *Sheet 30*).
Ammonium nitrate(V) *Solid*	**OXIDISING** **IRRITANT**	WARNING: oxidiser, causes serious eye irritation, may cause skin or respiratory irritation. It may decompose explosively if heated or on grinding; many industrial accidents have occurred in this way. Warming with alkali will generate ammonia gas (see *Sheet 30*).
Ammonium nitrate(V) *Solution*	**Currently not classified as hazardous**	The solution does have oxidising properties. Do not heat the solution to dryness. Warming with alkali will generate ammonia gas (see *Sheet 30*).
Ammonium dichromate(VI) – See *CLEAPSS Student Safety Sheet 47*.		

Typical control measures to reduce risk

- Wear eye protection.
- Do not heat solid ammonium nitrate(V) and do not heat ammonium nitrate(V) solution to dryness.
- Avoid exposure to hazardous decomposition products if ammonium carbonate, chloride or sulfate(VI) are heated, eg by using a fume cupboard.
- Avoid exposure to ammonia gas when reacting ammonium salts with alkalis, eg, by using a fume cupboard.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?

  eg specks of solid transferred into the eye by rubbing with a contaminated finger.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?

  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
Spilt on the floor, bench, etc	Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth. Wipe up solution spills with a cloth and rinse it well.

Iron *and its* compounds

including **iron(II)** and **iron(III) oxides**, **carbonate**, **sulfate(VI)**, **chlorides**, **bromide**
note: **iron(II)** compounds are often called **ferrous**, and **iron(III)** compounds **ferric**

Substance	Hazard	Comment
Iron (metal) *powder*	**FLAMMABLE**	WARNING: the powder is a flammable solid. Iron filings/powder in the eye are very painful because the iron oxidises rapidly in the saline environment. Samples of iron are often not very pure and on reacting with dilute acids may produce the TOXIC gas hydrogen sulfide (smelling of bad eggs) (see *Sheet 59*). For reaction with sulfur, see *Sheet 82*. Iron often coated with zinc (galvanised) to protect it from corrosion.
Iron (metal) *filings, sheets or bars of metal*	**Currently not classified as hazardous**	
Iron oxides and **iron(II) carbonate**	**Currently not classified as hazardous**	Applies to all iron oxides: iron(III) oxide (haematite), iron(II) iron(III) oxide (magnetite or ferrosoferric oxide). Iron(II) carbonate is usually sold mixed with a sugar (saccharated), to slow down oxidation.
Iron(II) and **iron(III) sulfate(VI)** **ammonium iron(II) sulfate** (Mohr's salt) **ammonium iron(III) sulfate** (ferric alum) *Solid or concentrated solutions (iron(II): if 0.5 M or more; iron(III): if 0.3 M or more)*	**IRRITANT**	WARNING: Causes skin and serious eye irritation. Iron(III) also harmful by ingestion if 0.6 M or more. Usually solutions are made up in dilute sulfuric acid, which may itself be hazardous (see *Sheet 22*), to slow down oxidation. Ammonium iron(II) and ammonium iron(III) solutions are more stable but are still made up in acid to limit oxidation.
Iron(II) and **iron(III) sulfate(VI)** **ammonium iron(II)** or **iron(III) sulfate** *Dilute solutions* *(iron(II): if less than 0.5 M; iron(III): if less than 0.3 M)*	**Currently not classified as hazardous**	Solutions which have been made up in sulfuric acid, which may itself be hazardous (see *Sheet 22*).
Iron(II) and **iron(III) chloride** *Hydrated or anhydrous solid, or concentrated solutions (if 0.1 M or more).*	**HARMFUL** **CORROSIVE**	DANGER: harmful if swallowed; causes skin irritation and serious eye damage. Some suppliers classify anhydrous solids and solutions more concentrated than 0.2 M as corrosive. Usually solutions are made up in hydrochloric acid (see *Sheet 20*) to slow down oxidation. Solution (about 2 M) used for etching printed circuit boards.
Iron(II) and **iron(III) chloride** *Dilute solutions (if less than 0.1 M)*	**Currently not classified as hazardous**	Usually solutions are made up in hydrochloric acid (see *Sheet 20*) to slow down oxidation.

Typical control measures to reduce risk

- Use the lowest possible quantities and concentrations.
- Take care not to rub the eye with fingers contaminated with iron filings or powder.
- Wear eye protection.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg solutions spurting out of test tubes when heated or solutions heated to dryness and decomposing.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Dust breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is difficult.
• Spilt on the skin or clothing	Brush solid off contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes as appropriate. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth. Wipe up solution spills with a cloth and rinse it well.

Boron compounds

including borax, boric acid, sodium perborate & sodium borohydride

Substance	Hazard	Comment
Borax (sodium tetraborate, disodiumtetraborate-10-water) *Solid and concentrated solutions (if 80 g dm^{-3}, ie 0.2 M, or more)*	**HEALTH HAZARD**	DANGER: may damage fertility and the unborn child. It has been/is used in some laundry and cleaning products, as a fire retardant and as a food additive (E285, to aid food preservation and improve the texture).
Borax *Dilute solutions* *(if less than 80 g dm^{-3}, ie less than 0.2 M)*	**Currently not classified as hazardous**	The borax solution commonly used for making slime is usually either 80 g dm^{-3} if using low molar mass PVA (< 85 000 g mol-1) or 40 g dm^{-3} if using high molar mass PVA (> 85 000 g mol-1).
Boric acid (boracic acid) *Solid and concentrated solutions (if 0.9 M or more)*	**HEALTH HAZARD**	DANGER: may damage fertility and the unborn child. In solution used as a mild antiseptic. The powder is used as an insecticide and to treat wood that is rotten and as a food additive (E284, to aid food preservation and improve the texture).
Boric acid *Dilute solutions (if less than 0.9 M)*	**Currently not classified as hazardous**	–
Sodium perborate (sodium peroxoborate-4-water)	**OXIDISING** **HARMFUL** **CORROSIVE** **HEALTH HAZARD**	DANGER: oxidiser; harmful if swallowed; causes serious damage to eyes; may cause respiratory irritation; may damage unborn child; suspected of damaging fertility. Used in the past in detergents, bleaches, cleaning products and for tooth-whitening but almost entirely replaced now. Releases oxygen if heated above 60°C, or in presence of catalyst.
Sodium borohydride (sodium tetrahydridoborate(III))	**FLAMMABLE** **CORROSIVE** **TOXIC**	DANGER: Contact with water liberates flammable gases which may ignite spontaneously (hydrogen); toxic if swallowed; causes skin burns and eye damage; may damage fertility or the unborn child. Widely used in chemistry as a reducing agent.

Typical control measures to reduce risk

- Wear eye protection when transferring/dispensing hazardous solids and solutions.
- Wear gloves when transferring these solids – take particular care to avoid skin contact.
- Avoid the risk of inhaling dust from sodium tetraborate or boric acid, eg by weighing in a fume cupboard that is **not** switched on and has the sash partially down.
- Avoid naked flames when transferring/dispensing sodium borohydride.
- Slime made using sodium tetraborate should not be taken home; the slime should only be handled wearing gloves.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Brush solid off contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes as appropriate. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth (EXCEPT sodium borohydride). Wipe up small solution spills with a cloth and rinse the cloth well.

Copper *and its* compounds

including copper oxides, carbonate, sulfate, chloride *and* nitrate

Substance	Hazard	Comment
Copper (metal)	**Currently not classified as hazardous**	Sharp edges can present a risk of cuts. *Granulated* copper may be classified by some suppliers as toxic to aquatic life with long lasting effects.
Copper(I) oxides (Cuprous oxides) **Copper(II) oxides** (Cupric oxides)	**CORROSIVE** **IRRITANT** **ENVIRON. HAZARD**	DANGER – copper(I) oxide – *causes serious eye damage; skin irritant; harmful if swallowed/inhaled; toxic to aquatic life. WARNING – copper(II) oxide – causes serious eye irritation; skin irritant; harmful if swallowed/ inhaled; toxic to aquatic life.
Copper(II) carbonate hydroxide (Basic copper carbonate, malachite)	**IRRITANT** **ENVIRON. HAZARD**	WARNING – copper(II) carbonate hydroxide – causes serious eye irritation; skin irritant; harmful if swallowed/inhaled; toxic to aquatic life.
Copper(II) sulfate **Copper(II) nitrate** *Solids and concentrated solutions*	**CORROSIVE** **IRRITANT** **ENVIRON. HAZARD**	DANGER – solids and solutions (≥ 1.0M **sulfate**, ≥ 1.3 M **nitrate**) – cause serious eye damage; skin irritant; harmful if swallowed (especially saturated solutions for crystal-growing). *Solid only – very toxic to aquatic life. Water added to anhydrous solid copper(II) sulfate(VI) produces heat.
Copper(II) sulfate **Copper(II) nitrate** *Dilute solutions*	**CORROSIVE** **IRRITANT**	DANGER – **sulfate** (< 1.0 M and ≥ 0.2 M) and **nitrate** (< 1.3 M and ≥ 0.2 M) – skin irritant; cause serious eye damage. WARNING – **sulfate** (< 0.2 M and ≥ 0.02 M) and **nitrate** (< 0.15 M and ≥ 0.05 M) – skin and eye irritant. Currently not classified as hazardous – **sulfate** (< 0.02 M) and **nitrate** (< 0.05 M). Benedict's solution and Fehling's solution both contain dilute copper(II) sulfate(VI) but Fehling's solution has other hazards.
Copper(II) chloride *Solid*	**IRRITANT** **ENVIRON. HAZARD**	WARNING – eye and skin irritant; harmful if swallowed; toxic to aquatic life.
Copper(II) chloride Solutions *(if 0.8M or more)*	**IRRITANT**	WARNING – eye and skin; harmful if swallowed (≥ 1.8M).
Copper(II) chloride *Solution (if less than 0.8M)*	**Currently not classified as hazardous**	–

Typical control measures to reduce risk

- Wear eye protection.
- Use the lowest concentration possible.
- Avoid raising dust, eg by dampening powders.
- Take care if evaporating solutions to dryness.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg solutions spurting out of test tubes when heated or solutions decomposing to toxic products when heated to dryness.
- How serious would it be if something did go wrong?
  eg are there hazardous reaction products (such as chlorine from the electrolysis of copper chloride)?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Dust breathed in	Remove the casualty to fresh air. Consult a medic if breathing is difficult.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Scoop up solid (take care not to raise dust). Wipe up small solution spills or any traces of solid with cloth; for larger spills use mineral absorbent (eg cat litter).

Sodium chlorate(I)

also known as **sodium hypochlorite**

<table>
<tr><th>Substance</th><th>Hazard</th><th>Comment</th></tr>
<tr><td colspan="3">Note: Sodium chlorate(I) does not exist as a <i>solid</i>.
Note: Sodium chlorate(I) is NaClO. Do not confuse this with sodium chlorate(V), $NaClO_3$, or sodium chlorate(VII), $NaClO_4$.</td></tr>
<tr><td>Concentrated sodium chlorate(I)
<i>Solution</i>
<i>(if: 0.7 M or more; 5% or more (w/v) available chlorine)</i></td><td>CORROSIVE
ENVIRON. HAZARD</td><td>DANGER: causes severe burns and eye damage, similar to sodium hydroxide solution. It is toxic to aquatic life.
It produces a toxic gas (chlorine) with acids.
Pressure may build up in bottles during storage, due to slow decomposition.
It removes the colour from many dyes.</td></tr>
<tr><td>Moderately dilute sodium chlorate(I)
<i>Solution</i>
<i>(if: less than 0.7 M but 0.4 M or more; less than 5% but 3% or more (w/v) available chlorine)</i></td><td>CORROSIVE
ENVIRON. HAZARD</td><td>DANGER: causes severe eye damage; irritating to skin. It is toxic to aquatic life.
It produces a toxic gas (chlorine) with acids.
This includes most domestic bleach.
It removes the colour from many dyes.</td></tr>
<tr><td>Dilute sodium chlorate(I)
<i>Solution</i>
<i>(if: less than 0.4 M but 0.15 M or more; less than 3% but 1% or more (w/v) available chlorine)</i></td><td>IRRITANT</td><td>WARNING: irritating to eyes and skin.
Microbiological spills can be dealt with using a 10% solution diluted 100 times (ie, 0.1%), but it is quickly made inactive by organic matter and so a 10 times dilution (ie, 1%) is often preferred.</td></tr>
<tr><td>Very dilute sodium chlorate(I)
<i>Solution</i>
<i>(if: less than 0.15 M; less than 1% (w/v) available chlorine)</i></td><td>Currently not classified as hazardous</td><td>Microbiological spills can be dealt with using a 10% solution diluted 100 times (ie, 0.1%), but it is quickly made inactive by organic matter and so a 10 times dilution (ie, 1%) is often preferred.</td></tr>
<tr><td colspan="3">Note: Available chlorine
Sodium chlorate(I) is normally made by reacting chlorine gas with sodium hydroxide solution. Sodium chloride is produced as a by-product and this is left mixed in the solution. As such, only part of the chlorine in the mixture (the Cl in the NaClO but not the Cl in the NaCl) is available for oxidising or bleaching purposes. One gram of a 10% available chlorine bleach has the same bleaching power as 0.1 gram of pure chlorine.</td></tr>
</table>

Typical control measures to reduce risk

- Use the lowest concentration possible.
- Use the smallest volume possible.
- Wear eye protection, including when making or disposing of solutions.
- Wear gloves if transferring/dispensing anything larger than a test-tube scale of the concentrated solution.
- Never mix domestic bleach with other household cleaners as these could be acidic.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg hazardous products of reaction (such as chlorine gas) are formed if sodium chlorate(I) is mixed with acid.
- How serious would it be if something did go wrong?
  Note: alkali in the eye causes more damage than acid of equivalent concentration.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111. If a visit to hospital is necessary, continue washing the eye during the journey in an ambulance.
• Chlorine breathed in	Remove the casualty to another room to rest. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Wipe up small amounts with a damp cloth and rinse it well. For larger amounts, open the windows and, especially for quite-concentrated solutions, cover with mineral absorbent (eg cat litter) and scoop into a bucket. Rinse with plenty of water.

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Barium compounds

Substance	Hazard	Comment
Barium chloride *Solid*	**TOXIC**	DANGER: toxic if swallowed, harmful if inhaled. For a 15-minute exposure, the concentration of barium should not exceed 1.5 mg m^{-3}.
Barium chloride *Solution* *(if 0.4 M or more)*	**HARMFUL**	WARNING: harmful if swallowed.
Barium chloride *Solution* *(if less than 0.4 M)*	**Currently not classified as hazardous**	–
Barium nitrate(V) *Solid* **Barium peroxide** *Solid*	**OXIDISING** **HARMFUL**	DANGER: oxidiser; harmful if swallowed or inhaled. For a 15-minute exposure, the concentration of barium should not exceed 1.5 mg m^{-3}.
Barium nitrate(V) *Solution*	**Currently not classified as hazardous**	–
Barium sulfate(VI) *Solid*	**Currently not classified as hazardous**	Unlike most barium compounds, barium sulfate(VI) is currently not classified as hazardous because it does not dissolve in water or acids. Hence it is safe to eat a ‘barium (sulfate) meal’, before being X-rayed.

Typical control measures to reduce risk

- Use the lowest concentration possible.
- Use the smallest quantity possible.
- Wear eye protection.
- Wash hands after transferring/dispensing barium compounds.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg, somebody drinking a toxic solution by mistake.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Brush solid off contaminated clothing and remove clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes as appropriate. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Scoop up any solid. Try to avoid raising dust. Rinse the area with water, diluting greatly. Solutions should be treated with mineral absorbent (eg cat litter).

Lead *and its* compounds

including **lead oxides, bromide, nitrate(V), ethanoate (acetate)** *etc*

Substance	Hazard	Comment
Lead (metal) *Solid* **Lead compounds (bromide, carbonates, chloride, chromate, ethanoate (acetate), iodide, nitrate, oxides, sulfate, sulfide)** *Solid*	**HARMFUL** **HEALTH HAZARD** **ENVIRONMENTAL HAZARD**	DANGER: harmful if swallowed or inhaled; may damage organs through repeated or prolonged exposure; may damage the unborn child. Very toxic to aquatic life. **Avoid the use of powdered lead metal.** Includes cerussite, white lead, litharge, massicot, red lead, galena. Lead chromate(VI) is used in the yellow lines on roads. Old paints often contained lead sulfate or other lead pigments. Young children may be at risk if they chew old objects painted with a lead-based paint. Tetraethyl lead was added to petrol to improve the combustion characteristics. However, combustion produces particles of lead compounds. Leaded petrol has been phased out now. Handling lead metal is safe as long as good hand washing is implemented. Note that most lead compounds are insoluble or sparingly soluble in water. In soft-water areas, (old) lead pipes may very slowly dissolve, exposing people to low levels of lead over very long periods of time.
Lead nitrate and **Lead ethanoate (acetate)** *Concentrated solutions (if 1 M or more)*		
Lead nitrate and **Lead ethanoate (acetate)** *Most solutions (if less than 1 M but 0.015 M or more)*	**HEALTH HAZARD**	DANGER: harmful if swallowed or inhaled; may damage organs through repeated or prolonged exposure; may damage the unborn child. Very toxic to aquatic life.
Lead nitrate and **Lead ethanoate (acetate)** *Extremely dilute solutions (if less than 0.015 M)*	**Currently not classified as hazardous**	–

Typical control measures to reduce risk

- Wear eye protection.
- Use the lowest possible amounts and concentrations.
- Preferably, heat lead compounds in a fume cupboard; avoid raising dust (eg by dampening powders).
- Less-volatile compounds (eg oxides) may be heated in small amounts in a well-ventilated room (but not if those who are, or who might be, pregnant are present).
- Use lead nitrate rather than lead ethanoate (acetate) when a soluble lead salt is needed.
- Wash hands after using lead or its compounds.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg solution spurts out of a test tube when heated or dust is breathed in.
- How serious would it be if something did go wrong?
  eg could anybody be exposed to dangerous lead levels for long periods of time?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Brush solid off contaminated clothing and remove clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes as appropriate. Call 999/111 as appropriate. Rinse clothing
• Spilt on the floor, bench, etc	Scoop up any solid. Try to avoid raising dust. Rinse the area with water, diluting greatly. Solutions should be treated with mineral absorbent (eg cat litter).

Mercury *and its* compounds

including **mercury chlorides, sulfides**

Substance	Hazard	Comment
Mercury (metal)	TOXIC HEALTH HAZARD ENVIRON. HAZARD	DANGER: fatal if inhaled; causes damage to organs through prolonged or repeated exposure; may damage unborn child. Very toxic to aquatic life. Mercury is very dense and difficult to manipulate, eg in teat pipettes. Containers may be unexpectedly heavy. Elemental mercury vapour is **not** trapped by filter fume cupboards. Spills need to be cleaned up promptly. The main risk is from inhaling low concentrations of vapour over long periods of time from spills that were not noticed/cleared up. Wear gloves when transferring/dispensing mercury. It forms alloys with gold, silver, etc (eg jewellery), so remove rings.
Mercury(II) chloride **Mercury(II) oxide** **Mercury(I) sulfide** *Solids* **Mercury(II) chloride** *Solution (if 0.1 M or more)*	TOXIC CORROSIVE HEALTH HAZARD ENVIRON. HAZARD	DANGER: fatal if swallowed or in contact with skin; causes severe burns and eye damage; suspected of causing genetic defects and damaging fertility; causes damage to organs through prolonged or repeated exposure. Very toxic to aquatic life. Older button batteries contain mercury(II) oxide and should be recycled. Mercury compounds used in making Victorian hats caused disease, as in the 'Mad hatter' of Alice in Wonderland.
Mercury(II) chloride *Solution (if 0.01 M or more but less than 0.1 M)*	TOXIC HEALTH HAZARD	DANGER: fatal if swallowed or in contact with skin; suspected of causing genetic defects and damaging fertility; causes damage to organs through repeated or prolonged exposure. Very toxic to aquatic life.
Mercury(II) chloride *Solution (if 0.002 M or more but less than 0.01 M)* **Mercury(I) chloride** **Mercury(II) sulfide** *Solids*	HARMFUL ENVIRON. HAZARD	WARNING: harmful if swallowed or in contact with skin; suspected of causing genetic defects and damaging fertility; causes damage to organs through repeated or prolonged exposure. Very toxic to aquatic life. Pollution by mercury compounds in a Japanese river in the 1950s caused serious poisoning of humans who ate river fish (Minimata disease).

Mercury compounds are very toxic. **Avoid their use** and try to find alternatives.

Typical control measures to reduce risk

- Wear eye protection and suitable gloves; use the lowest possible concentration.
- Avoid the use of mercury compounds where possible (eg, avoid Millon's reagent).
- Transfer/dispense liquid mercury over a tray to contain spills; do not leave mercury surfaces exposed to the air.
- Avoid raising dust (eg, by dampening powder); work in a ducted (not filter) fume cupboard; clear up spills promptly.
- If mercury thermometers are used, take care to avoid breakages. Be prepared in case of spillage.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg solution spurts out of a test tube when heated, mercury metal spills on the floor or a thermometer is broken.
- How serious would it be if something did go wrong?
  eg could anybody be exposed to dangerous mercury levels for long periods of time?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	There is little problem with mercury metal (but call 999/111). For compounds, do no more than wash out the mouth with drinking water. Do not induce vomiting. Call 999/111.
• Vapour breathed in	Dangerous only if large amounts of vapour are breathed in over a short period of time (eg when heating metal) or from long-term exposure. Call 999/111.
• Spilt on the skin or clothing	For mercury metal, remove contaminated clothing and wash off the skin. Check jewellery for damage. For mercury compounds, remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	For metal, remove jewellery, collect mechanically (eg with syringe). Mop up remainder with a hot paste of 1:1 calcium oxide/sulfur in water. Spread same (dry) mixture over cracks etc. For compounds, scoop up solid. Rinse area with water, diluting greatly. For solutions, use mineral absorbent (eg cat litter).

Aluminium *and its* compounds

including **aluminium oxide, hydroxide, sulfate(VI), chloride;** *also* **potash alum**

Substance	Hazard	Comment
Aluminium (metal) *Solid (large pieces, sheets, etc)*	**Currently not classified as hazardous**	Used in cooking utensils and generally considered safe. Suggestions at one time it might cause Alzheimer's disease, now considered unlikely.
Aluminium (metal) *Fine powder*	**FLAMMABLE**	DANGER: flammable solid; in contact with water releases flammable gas (hydrogen, see *Sheet 50*). A dust explosion is possible if it is exposed to flame. Although difficult to ignite, it is difficult to extinguish. Used as a food additive, E173.
Aluminium oxide (alumina) and **aluminium hydroxide** – *Solid*	**Currently not classified as hazardous**	Used in indigestion tablets.
Aluminium potassium sulfate(VI) (potash alum) *Solid or solution*		Often used for crystal-growing in schools.
Aluminium sulfate(VI) *Hydrated solid and most solutions (if 0.1 M or more)*	**CORROSIVE**	DANGER: causes serious eye damage. Solutions are acidic. Used as a mordant in dyeing. Added in small amounts to cloudy water in reservoirs to coagulate clay particles. When large amounts were accidentally added to a reservoir at Camelford in Cornwall, some ill effects were reported.
Aluminium sulfate(VI) *Dilute solutions (if less than 0.1 M but 0.03 M or more)*	**IRRITANT**	WARNING: irritating to eyes.
Aluminium sulfate(VI) *Very dilute solutions (less than 0.03M)*	**Currently not classified as hazardous**	Note these solutions are extremely dilute.
Aluminium chloride *Anhydrous solid*	**CORROSIVE**	DANGER: causes severe skin burns and eye damage. Reacts exothermically & violently with water to produce fumes of hydrogen chloride (see *Sheet 20*). Pressure may build up in closed containers due to absorbed moisture.
Aluminium chloride *Hydrated solid or concentrated solution (if 0.8 M or more)*	**IRRITANT**	WARNING: irritating to eyes and skin (if ≥ 0.8 M) and respiratory system (if ≥ 1.5 M). The solution is acidic.
Aluminium chloride *Dilute solution (if less than 0.8 M)*	**Currently not classified as hazardous**	In antiperspirants and deodorants, it is mixed with other substances and is not classed as hazardous. However, it may be an irritant to people with sensitive skin.

Typical control measures to reduce risk

- Use the lowest possible concentration.
- Wear eye protection.
- Avoid the use of aluminium powder or anhydrous aluminium chloride if possible.
- Avoid raising dust and keep aluminium powder away from naked flames.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg solution spurts out of a test tube when heated or a solution decomposes when heated to dryness.
- How serious would it be if something did go wrong?
  eg are there hazardous reaction products (eg hydrogen chloride gas from the action of water on anhydrous aluminium chloride)?
- How can the risk(s) be controlled for this activity?
  eg, can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Dust breathed in	Remove the casualty to fresh air. Consult a medic if breathing is difficult.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Scoop up the solid. Take care not to raise dust. Wipe up small solution spills or any traces of solid with a cloth.
• Fire	Powdered aluminium fires should be extinguished by smothering with clean, dry sand.

Silver *and its* compounds

including **silver bromide, chloride, iodide, nitrate(V)** *and* **oxide**

Substance	Hazard	Comment
Silver (metal) *Solid*	**Currently not classified as hazardous**	It is used in jewellery. It is an approved food additive, E174.
Silver bromide, **chloride** and **iodide** *Solids*		Widely used in photographic emulsions. They are decomposed by light to give silver metal and the halogen (which then reacts with other substances in the emulsion).
Silver nitrate(V) *Solid and fairly concentrated solutions (if 0.3 M or more)*	**OXIDISING** **CORROSIVE** **ENVIRONMENTAL HAZARD**	DANGER: oxidiser; causes severe skin burns and eye damage; very toxic to aquatic life. If swallowed, it may cause internal damage due to absorption into the blood, followed by deposition of silver in various tissues. The solid explodes dangerously with magnesium powder and a drop of water. Accidents have caused many injuries and a very careful risk assessment is required before attempting this.
Silver nitrate(V) *Dilute solutions (if less than 0.3 M but 0.18 M or more)*	**CORROSIVE**	DANGER: causes severe eye damage; irritating to skin. It may produce black stains on the skin, which wear off in a few days.
Silver nitrate(V) *Very dilute solutions (if less than 0.18 M but 0.06 M or more)*	**IRRITANT**	WARNING: irritating to eyes and skin. Very dilute solutions are adequate for most school work when testing for halides in solution.
Silver nitrate(V) *Extremely dilute solutions (if less than 0.06 M)*	**Currently not classified as hazardous**	–
Silver nitrate(V) (ammoniacal) (Dissolved in ammonia solution) (Tollen's Reagent)	**EXPLOSIVE** **IRRITANT**	It is used for aldehyde tests and should be prepared only on a test-tube scale, when needed. Dispose of into plenty of water within 30 minutes, otherwise explosives may form. Failure to do this has caused accidents.
Silver oxide *Solid*	**Currently not classified as hazardous**	It is used in some batteries, eg button cells for watches and calculators.

Typical control measures to reduce risk

- Use the lowest possible concentration.
- Wear eye protection.
- Avoid keeping solutions of silver compounds and ammonia for more than a few minutes.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg silver nitrate accidentally coming into contact with the skin.
- How serious would it be if something did go wrong?
  eg are there hazardous reaction products such as from solutions of silver compounds with ammonia?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Wear eye protection and gloves. Scoop up the solid. Rinse the area with water and wipe up, rinsing repeatedly. Rinse the mop or cloth thoroughly.

Chromium *and its* compounds

including **chromium(III) salts, chrome alum, chromates and dichromates**

Substance	Hazard	Comment
Chromium (metal) *Solid*	**Currently not classified as hazardous**	Chromium plating gives a shiny, protective surface on steel.
Chromium(III) oxide *Solid*		It is used as a green pigment, eg in pottery.
Chromium(III) sulfate *Solids and solutions*		It has various chemical formulae. It is variously red or purple.
Chromium(III) potassium sulfate(VI) (chrome alum) *Solid and most solutions*	**IRRITANT**	WARNING: irritating to eyes and skin (if 0.4 M or more). Often used for crystal growing. Currently not classified as hazardous if less than 0.4 M.
Potassium chromate(VI) *Solid and solutions*	**HEALTH HAZ.** **IRRITANT** **ENVIRONMENTAL HAZARD**	DANGER: skin & serious eye irritant; genetic effects, cancer by inhalation and allergic skin reaction. Very toxic to aquatic life (if 0.9 M or more). DANGER: respiratory irritant (if 0.4 M or more). DANGER: skin sensitiser (if 0.04 M or more). DANGER: serious health hazard (if 0.01 M or more). Currently not classified as hazardous if less than 0.01 M.
Sodium chromate(VI) *Solid and solutions*	**TOXIC** **CORROSIVE** **HEALTH HAZARD** **ENVIRON. HAZARD**	DANGER: toxic if swallowed; harmful in contact with skin; causes severe skin burns and eye damage; fatal if inhaled; may cause allergic skin reaction; may cause allergy or asthma if inhaled; may cause cancer or genetic defects; may damage fertility or the unborn child; causes damage to organs through prolonged or repeated exposure. Very toxic to aquatic life (if 0.8 M or more). DANGER: corrosive to skin and eyes; harmful by ingestion; respiratory irritant (if 0.2 M or more). DANGER: irritating to skin and eyes; skin and respiratory sensitiser; serious health hazard (if 0.01 M or more). Currently not classified as hazardous if less than 0.01 M.
Ammonium, **potassium**, **sodium dichromates(VI)** *Solid and solutions*	**OXIDISING** **TOXIC** **CORROSIVE** **HEALTH** **ENVIRONMENTAL HAZARD**	DANGER: oxidiser; toxic if swallowed; harmful in contact with skin; causes severe skin burns and eye damage; fatal if inhaled; may cause allergic skin reaction; may cause allergy or asthma if inhaled; may cause cancer or genetic defects; may damage fertility or the unborn child; causes damage to organs through prolonged or repeated exposure. Very toxic to aquatic life (if 0.4 M or more). Solid ammonium dichromate decomposes if heated and will explode in confined spaces. It was used in indoor fireworks. DANGER: corrosive to skin and eyes; harmful by ingestion, respiratory irritant (if 0.1 M or more). DANGER: irritating to skin and eyes; skin and respiratory sensitiser; serious health hazard (if 0.004 M or more). Currently not classified as hazardous if less than 0.004 M.
Lead chromate(VI)		See CLEAPSS *Student Safety Sheet 43*

Typical control measures to reduce risk

- Use the lowest possible concentration; wear eye protection; use of gloves for chromates/dichromates.
- For volcano experiment, prevent exposure to dust by using a fume cupboard or mineral-wool plug in the vessel.
- Avoid inhaling chromate/dichromate dust or spray (eg during electrolysis).

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg chromate or dichromate dust or solution is accidentally inhaled.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Wear eye protection and gloves. Scoop up the solid. Rinse the area with water and wipe up, rinsing repeatedly until no colour remains. Rinse the mop or cloth thoroughly.

Manganese *and its* compounds

including **manganese(IV) oxide (dioxide)** *and* **potassium manganate(VII) (permanganate)**

Substance	Hazard	Comment
Manganese (metal) *Solid*	**Currently not classified as hazardous**	Note that the powder would be highly flammable.
Manganese(II) carbonate *Solid*		Insoluble in water.
Manganese(II) chloride *Solid and concentrated solutions (if 1.5 M or more)*	**IRRITANT**	WARNING: harmful if swallowed.
Manganese(II) chloride *Dilute solutions (if less than 1.5 M)*	**Currently not classified as hazardous**	–
Manganese(II) sulfate *Solid and concentrated solutions (if 0.7 M or more)*	**HEALTH HAZ.** **ENVIRON. HAZ.**	WARNING: may cause damage to organs though prolonged or repeated exposure. Toxic to aquatic life with long-lasting effects.
Manganese(II) sulfate *Dilute solutions (if less than 0.7 M)*	**Currently not classified as hazardous**	–
Manganese(IV) oxide (Manganese dioxide) *Solid*	**HARMFUL**	WARNING: Harmful by inhalation or if swallowed. It is often used as a fine powder. Many hazardous reactions occur with reducing agents or concentrated acids. It is used in dry cells (batteries). Insoluble in water.
Potassium manganate(VII) (potassium permanganate) *Solid*	**OXIDISING** **HARMFUL** **HEALTH HAZ.** **ENV. HAZ**	DANGER: oxidiser; harmful if swallowed; suspected of damaging the unborn child; very toxic to aquatic life with long-lasting effects. Stains the hands and clothing. Many hazardous reactions occur with concentrated acids or reducing agents. On heating, releases a fine dust of potassium manganate(VI) [OXIDISING; IRRITANT] and oxygen gas.
Potassium manganate(VII) (potassium permanganate) *Solutions (if 0.1 M or more)*	**IRRITANT**	WARNING: irritating to eyes and skin. Stains the hands and clothing.
Potassium manganate(VII) (potassium permanganate) *Very dilute solutions (if less than 0.1M)*	**Currently not classified as hazardous**	They stain hands and clothing.

Typical control measures to reduce risk

- Wear eye protection.
- Avoid inhaling dusts.
- Avoid skin contact, especially with manganates(VII).
- Avoid contact between manganates(VII) or manganese(IV) oxide, and concentrated acids or reducing agents.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg dust is accidentally inhaled.
- How serious would it be if something did go wrong?
  eg are there hazardous reactions such as violent oxidations or decompositions?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing. Manganate(VII) will permanently stain clothing. Stains to the skin will wear off in a few days.
• Spilt on the floor, bench, etc	Wear eye protection and gloves. Scoop up the solid. Rinse the area with water and wipe up, rinsing repeatedly. Manganate(VII) will give permanent stains. Rinse the mop or cloth thoroughly.

Zinc *and its* compounds

including zinc oxide, carbonate, sulfate(VI), chloride and bromide

Substance	Hazard	Comment
Zinc (metal) *granulated or sheets of metal*	**Currently not classified as hazardous**	Pure zinc does not react readily with dilute acids without a catalyst (usually copper(II) sulfate). Iron or steel is often coated with zinc (galvanised) to protect it from rusting.
Zinc (metal) *powder or dust*	**FLAMMABLE** **ENVIRON. HAZARD**	DANGER: in contact with water releases flammable gases which ignite spontaneously; catches fire spontaneously if exposed to air; toxic to aquatic life with long-lasting effects. Reacts violently with iodine, sulfur and copper(II) oxide. Most school samples have a surface coating of zinc oxide, making reactions unpredictable.
Zinc oxide **Zinc carbonate**	**Currently not classified as hazardous**	The zinc oxide fumes ('philosopher's wool') formed when zinc dust burns in air are regarded as hazardous dust.
Zinc salts *Solids or concentrated solutions* **Sulfate(VI)** (*if 1.5 M or more*) **Chloride / bromide** (*if 1 M or more*)	**CORROSIVE** **HARMFUL** **ENVIRON. HAZARD**	DANGER: Harmful if swallowed (especially saturated solutions for crystal growing); causes serious eye damage (sulfate); causes severe skin burns and eye damage (chloride & bromide); toxic to aquatic life with long lasting effects. When preparing zinc sulfate by reacting zinc and sulfuric acid, the reaction can be slow and is often incomplete.
Zinc salts (*most solutions*) **Sulfate(VI)** (*if less than 1.5 M but 0.2 M or more*) **Chloride** (*if less than 1M but 0.2 M or more*) **Bromide** (*if less than 1 M but 0.1 M or more*)	**CORROSIVE** **IRRITANT**	DANGER: corrosive to eyes (all) and to skin (chloride and bromide); respiratory irritant (chloride if more than 0.4 M, bromide if more than 0.2 M).
Zinc salts (*dilute solutions*) **Sulfate(VI)** (*if less than 0.2 M but 0.06 M or more*) **Chloride** (*if less than 0.2 M but 0.1 M or more*) **Bromide** (*if less than 0.1 M but 0.05 M or more*)	**IRRITANT**	WARNING: irritating to eyes (all) and skin (chloride & bromide).
Zinc salts (*very dilute solutions*) **Sulfate(VI)** (*if less than 0.06 M*) **Chloride** (*if less than 0.1 M*) **Bromide** (*if less than 0.05 M*)	**Currently not classified as hazardous**	–

Typical control measures to reduce risk

- Use the lowest possible quantities and concentrations.
- Only electrolyse zinc chloride/bromide solutions briefly, unless in a fume cupboard (essential for molten compounds).
- Assume zinc powder/dust is fresh and not partially oxidised on the surface.
- When reacting zinc and acid, check no acid remains before evaporating solutions (pH should be 4 or higher).
- Wear eye protection.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg solutions spurting out of test tubes when heated or solutions heated to dryness and decomposing.
- How serious would it be if something did go wrong?
  eg are there hazardous reaction products (such as chlorine from the electrolysis of zinc chloride)?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Dust breathed in	Remove the casualty to fresh air. Consult a medic if breathing is difficult.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Scoop up solid (take care not to raise dust). Wipe up small solution spills or any traces of solid with cloth; for larger spills use mineral absorbent (eg cat litter).

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Hydrogen

Substance	Hazard	Comment
Hydrogen *Gas*	**EXTREMELY FLAMMABLE** **GAS UNDER PRESSURE**	DANGER: extremely flammable gas; contains gas under pressure, may explode if heated (cylinders and canisters). It forms explosive mixtures with air and oxygen. Mixtures with air between 4% and 74% hydrogen by volume are explosive. Explosive mixtures will ignite below 500 °C and well below this temperature in the presence of catalysts such as transition metals and their oxides. The explosion with oxygen produces a very loud noise which can damage hearing. Mixtures of hydrogen and oxygen can arise when recharging a car battery (or model cells in schools); ensure good ventilation, avoid sparks and naked flames.

Typical control measures to reduce risk

- If preparing the gas in test-tube reactions, use the smallest possible amounts.
- Wear eye protection and stand well back.
- Use safety screens for all but test-tube amounts of the gas; ensure good laboratory ventilation.
- If preparing the gas on anything larger than a test-tube scale, make sure the apparatus has the smallest possible volume, so that only a little air has to be flushed out. If lighting the gas at a jet, test a sample to make sure that all the air has been flushed out and light from a distance.
- If possible, use a gas cylinder rather than generate your own hydrogen, because the cylinder produces a more rapid flow which flushes air more quickly from the apparatus.
- When carrying out reduction reactions, for example with metal oxides, consider alternative reducing agents such as methane or ammonia gas.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could the hydrogen be ignited accidentally? How easy is it to make sure that all the air has been flushed out?
- How serious would it be if something did go wrong?

  Note: there are occasional reports of pupils being taken to hospital (for treatment to cuts or for splashes of chemicals) because of damage to apparatus in hydrogen explosions.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Gas escape	Open all the windows. Make sure there are no naked flames.
• Explosion	If there are cuts from flying glass, apply pressure using a clean pad of cloth. Do not attempt to remove large pieces of embedded glass etc. If there is arterial bleeding, the casualty should be laid down and the injured limb raised up. Call 999/111.

Oxygen *and* ozone

Substance	Hazard	Comment
Oxygen (O_2) *Gas*	OXIDISING GAS UNDER PRESSURE	DANGER: may cause or intensify fire; contains gas under pressure, may explode if heated (cylinders). Air contains about 21% oxygen. Combustible substances burn much more fiercely in air which has been only slightly enriched with oxygen (eg, 25%). Products of combustion are often strongly acidic or basic (alkaline) oxides. If the amount of oxygen in the air becomes too low, headaches, unconsciousness and death may result. First effects may be noticed when the percentage drops to 18%. Similar effects may be observed on high mountains due to lower air pressure.
Ozone (O_3) *Gas*	OXIDISING TOXIC IRRITANT	DANGER: may cause or intensify fire; causes serious eye irritation; fatal if inhaled. For a 15-minute exposure, the concentration in the atmosphere should not exceed 0.4 mg m^{-3}. It is not normally made or used in school science. In the presence of sunlight, traces of hydrocarbons in the air react with nitrogen oxides (see CLEAPSS *Student Safety Sheet 53*), eg from car exhausts, to form ozone. This causes photochemical smog in certain hot weather conditions. Small amounts of ozone are also formed in some photocopiers but this is only likely to be a problem in a small room with poor ventilation. Although dangerous if breathed in, ozone in the upper atmosphere performs a very important role, where it absorbs much of the ultraviolet radiation reaching the Earth, thus preventing dangerous exposures (see CLEAPSS *Student Safety Sheet 12*). Certain chlorinated hydrocarbons (see CLEAPSS *Student Safety Sheet 62*) have a role in damaging the ozone layer.

Typical control measures to reduce risk

- Wear eye protection when preparing oxygen or burning substances in oxygen.
- Never look directly at the very bright light from magnesium burning in oxygen. Wear eye protection and view through a passive welding filter lens, shade 9. Note: viewing through fingers, sunglasses, smoked glass, blue glass or polaroid filter is **no longer recommended**.
- Avoid inhaling products when non-metals or metals are burning in oxygen.
- Use safety screens when burning substances in oxygen on anything larger than a test tube scale.
- If using cylinders of oxygen, do not lubricate controls with oil or grease as this might catch fire.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could substances burn much more fiercely than expected?
- How serious would it be if something did go wrong?
  eg would there be widespread health effects if the ozone layer is damaged by pollution?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Gas escape	Open all the windows. Extinguish all naked flames.
• Clothing catches fire	Smother flames on clothing or the skin with a fire blanket or other material. Cool any burnt skin with gently-running tap water for 20 minutes. Call 999/111 if the area of burn is larger than a small coin.
• Other fires	Allow fires in sinks etc to burn out. Fires at the top of test tubes, beakers etc should be smothered with a damp cloth or heat resistant mat.

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Sulfur dioxide

Substance	Hazard	Comment
Sulfur dioxide *Gas*	CORROSIVE TOXIC	DANGER: causes severe skin burns and eye damage; toxic if inhaled. Effects of exposure by inhalation may not be immediately apparent and can develop or increase over time. Inhalation by those with known breathing difficulties, eg asthma, may exacerbate such pre-existing conditions. Adverse health effects may be apparent even at very low levels, ~ 0.3 mg m^{-3} (0.1 ppm). Previously, the HSE has said for a 15-minute exposure, the concentration of the gas in the atmosphere should not exceed 2.7 mg m^{-3}. It is produced naturally in large amounts by volcanoes. Most fossil fuels contain traces of sulfur compounds. When burnt, these result in sulfur dioxide released into the atmosphere, causing acid rain. It may be produced in the laboratory by the action of heat or dilute acid on sulfites or thiosulfates. It is used in small amounts as a preservative in some foodstuffs and wines. Approved food additive, E220.
Sulfur dioxide *Dilute solution in water*	IRRITANT	The gas is very soluble in water and may cause suck back. Alternatively, a sulfur dioxide solution can be prepared using sodium metabisulfite and adding sulfuric acid. The gas escapes easily from solution, especially if this is warmed, and should not be inhaled.

Typical control measures to reduce risk

- If preparing the gas in test-tube reactions, use the smallest amounts possible.
- Wear eye protection.
- Take steps to prevent suck back of water, eg by the use of Bunsen valves.
- Use a fume cupboard for anything larger than test tube amounts of gas; ensure good laboratory ventilation and quickly dispose of solutions containing sulfur dioxide.
- If testing for the gas by its smell, follow the safe technique for sniffing gases: use your hand to waft the gas towards your nose.
- Do not expose asthmatics to the gas.
- Use fuels which are naturally low in sulfur, remove sulfur compounds before use or use scrubbers to absorb sulfur dioxide from the exhaust gases of coal or oil burning power stations.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg a leak of gas into the laboratory from apparatus or a warmed solution, or suck back.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
Vapour breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is difficult.
Gas escape in a laboratory	Open all windows. If over 1 litre of gas is released, evacuate the laboratory.

Nitrogen oxides

including nitrogen monoxide, nitrogen dioxide, dinitrogen tetroxide *and* dinitrogen oxide

Substance	Hazard	Comment
Nitrogen monoxide (Nitric oxide; NO) *Gas*	OXIDISING CORROSIVE TOXIC	DANGER: May cause or intensify fire. Causes severe skin burns and eye damage; fatal if inhaled; may cause respiratory irritation; corrosive to the respiratory tract. Effects of exposure by inhalation may or may not be immediately apparent and can develop or increase over time. Inhalation by those with known breathing difficulties (eg asthma) may exacerbate such pre-existing conditions. In the past, HSE has said for 15-minute exposure, the concentration in the atmosphere should not exceed 2.5 mg m^{-3}. It reacts with oxygen in the atmosphere to form nitrogen dioxide (see below). It may be formed by the reaction between oxygen and nitrogen in the air, especially in car engines. This is a major contributor to acid rain and photochemical smog. The mixture of NO and NO_2 formed in this way is often referred to as NO_x.
Nitrogen dioxide (NO_2) **Dinitrogen tetroxide** (N_2O_4) *Gases*	OXIDISING CORROSIVE TOXIC	DANGER: May cause or intensify fire. Causes severe skin burns and eye damage; fatal if inhaled; may cause respiratory irritation. Effects of exposure by inhalation may or may not be immediately apparent and can develop or increase over time. Inhalation by those with known breathing difficulties (eg asthma) may exacerbate such pre-existing conditions. For 15-minute exposure, the concentration in the atmosphere should not exceed 1.91 mg m^{-3}. They are formed as air pollutants from nitrogen monoxide (see above). They are formed in the laboratory by the action of heat on many nitrates and by the reaction of nitric acid on some metals. They are very soluble in water; there is a risk of suck back.
Dinitrogen oxide (Nitrous oxide; N_2O; Laughing gas) *Gas*	OXIDISING	DANGER: May cause or intensify fire. For 15-minute exposure, the concentration in the atmosphere should not exceed 549 mg m^{-3}. This is an anaesthetic in large amounts. It has been used as a general anaesthetic in controlled environments, eg by dentists. An approved food additive, E942, where it is used as a propellant and foaming agent, eg for cream.

Typical control measures to reduce risk

- If preparing the gas in test-tube reactions, use the smallest amounts possible and take steps to avoid suck-back (eg a Bunsen valve).
- Wear eye protection.
- Use a fume cupboard for anything larger than test-tube amounts of gas; ensure good laboratory ventilation.
- Do not expose asthmatics to the gas.
- Use catalytic converters in car exhausts to reduce the amount of nitrogen oxides released into the air.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg a leak of a gas from apparatus into the laboratory atmosphere.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is difficult.
• Gas escape in a laboratory	Open all windows. If over 1 litre of gas is released, evacuate the laboratory.

Chlorine

including **chlorine water**

Substance	Hazard	Comment
Chlorine *Gas*	 **OXIDISING**  **TOXIC**  **ENVIRONMENTAL HAZARD**	DANGER: may cause or intensify fire; causes skin and serious eye irritation; toxic if inhaled; may cause respiratory irritation; very toxic to aquatic organisms. Effects of exposure by inhalation may or may not be immediately apparent and can develop or increase over time. Inhalation by those with known breathing difficulties (eg asthma) may exacerbate such pre-existing conditions. For a 15-minute exposure, the concentration of the gas in the atmosphere should not exceed 1.5 mg m^{-3}. It is used to kill microbes in public water supplies, at a concentration between about 0.1 and 1.0 mg per litre. It is also used to treat swimming pool water at a concentration between about 1.4 and 4.0 mg per litre. It may be formed in the laboratory by electrolysis and the oxidation of some chlorides. It may be formed in the laboratory, in the home or at work by the action of acid on bleaches; see CLEAPSS *Student Safety Sheet 41*.
Chlorine water *Solution in water*	**Currently not classified as hazardous** (but beware of **TOXIC** gas given off)	It can be made in a fume cupboard by diluting a saturated solution with a little more than its own volume of water. Chlorine gas escapes easily from the solution, especially if it is warmed. For a 15-minute exposure, the concentration of chlorine gas in the atmosphere should not exceed 1.5 mg m^{-3} and this could easily be approached in localised situations, eg just above open test tubes or bottles.

Typical control measures to reduce risk

- If preparing the gas in test-tube reactions, use the smallest possible amounts; where possible, absorb excess gas with a soda lime tube.
- Wear eye protection.
- Use a fume cupboard for anything larger than test tube amounts of gas; ensure good laboratory ventilation.
- If testing for the gas by its smell, follow the safe technique for sniffing gases: use your hand to waft the gas towards your nose.
- Do not expose asthmatics to the gas; even with chlorine water, take care not to breathe in chlorine.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
  Note: there are occasional reports of pupils being taken to hospital as a result of breathing in chlorine.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is even slightly affected.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	Open all windows. For a release of more than 1 litre of chlorine gas, evacuate the laboratory. Mop up chlorine water and rinse with plenty of water.
• Gas escape in a laboratory	Open all windows. If over 1 litre of gas is released, evacuate the laboratory.

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Bromine

including **bromine water**

Substance	Hazard	Comment
Bromine *Liquid*	TOXIC CORROSIVE ENVIRON. HAZARD	DANGER: fatal if inhaled; causes severe skin burns and eye damage; very toxic to aquatic organisms. Effects of exposure by inhalation can increase over time. Inhalation by those with known breathing difficulties (eg asthma) may exacerbate such pre-existing conditions. For a 15-minute exposure, the concentration of the vapour in the atmosphere should not exceed 1.3 mg m^{-3}. 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.
Moderately concentrated bromine solution *In water or organic solvents (if 0.2M or more)*	CORROSIVE	DANGER: causes severe eye damage; irritating to skin. Bromine rapidly diffuses out of solution, producing a vapour which is very toxic if breathed in. Effects of exposure by inhalation can increase over time. Inhalation by those with known breathing difficulties (eg asthma) may exacerbate such pre-existing conditions. A saturated solution in water is about 0.25 M. There may also be hazards associated with the organic solvent; see relevant CLEAPSS *Student Safety Sheets*.
Moderately dilute bromine solution *In water or organic solvents (if 0.06 M or more but less than 0.2 M)*	IRRITANT	WARNING: irritating to eyes and skin. Bromine rapidly diffuses out of solution, producing a vapour which is very toxic if breathed in. Effects of exposure by inhalation can increase over time. Inhalation by those with known breathing difficulties (eg asthma) may exacerbate such pre-existing conditions. There may be hazards associated with the organic solvent; see relevant CLEAPSS *Student Safety Sheets*.
Very dilute bromine solution *In water or organic solvents (if less than 0.06 M)*	IRRITANT	There may be hazards associated with the organic solvent; see relevant CLEAPSS *Student Safety Sheets*. 0.002 M is suitable for testing alkenes for unsaturation and for halogen/halide displacement reactions.

Typical control measures to reduce risk

- Use the lowest concentration and smallest volume possible.
- Wear eye protection and protective nitrile gloves for all but very dilute bromine solution.
- Avoid breathing the fumes from concentrated solutions, eg by using a fume cupboard.
- When bromine liquid is in use, have plenty of 1 M sodium carbonate solution available to deal with spills.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is even slightly affected.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate. Rinse clothing.
• Spilt on the floor, bench, etc	**For spills of all but a few drops of liquid bromine, open windows and evacuate the laboratory.** For small bromine spills, add solid hydrated sodium carbonate (or 1 M sodium carbonate solution) and leave for 1 hour. Mop up and rinse with plenty of water.

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Iodine

including **iodine solutions**

Substance	Hazard	Comment
Iodine *Solid*	**HARMFUL** **ENVIRONMENTAL HAZARD**	WARNING: harmful in contact with skin and if inhaled. Very toxic to aquatic life. It is easily vapourised if heated – the violet vapour is dangerous to the eyes. For a 15 minute exposure, the concentration in the atmosphere should not exceed 1.1 mg m^{-3}.
Iodine solution *in potassium iodide / water or in organic solvent* *(if 1 M or more)*	**HARMFUL** **ENVIRONMENTAL HAZARD**	WARNING: harmful in contact with skin and if inhaled. Very toxic to aquatic life. Even dilute solutions will stain the skin. There may be hazards associated with the organic solvent; see relevant CLEAPSS *Student Safety Sheets*. Ethanol is often used; it is HIGHLY FLAMMABLE.
Dilute iodine solution *in potassium iodide / water or in organic solvent* *(if less than 1 M)*	**Currently not classified as hazardous**	Even dilute solutions will stain the skin. Solutions 0.01 to 0.1 M are suitable for many activities, eg testing for starch, work with enzymes etc. There may be hazards associated with the organic solvent; see relevant CLEAPSS *Student Safety Sheets*. Ethanol is often used; it is HIGHLY FLAMMABLE. 'Tincture of iodine', used as a mild antiseptic, is a dilute solution in ethanol (about 0.1 M).

Typical control measures to reduce risk

- Use the lowest concentration and smallest volume possible.
- Wear eye protection.
- Wear gloves when transferring or dispensing large quantities of the solid or more-concentrated solutions.
- Avoid breathing iodine vapour, eg by using a fume cupboard.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
  Note: iodine can crystallise painfully on the eyeball.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is even slightly affected.
• Swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Brush off solid iodine. Remove and soak contaminated clothing. Irrigate the affected area with gently-running tap water for at least 20 minutes. Call 999/111 if a large area is affected or symptoms occur.
• Spilt on the floor, bench, etc	Scoop up any solid iodine, add sodium thiosulfate solution (20%, 1 M) to the remaining spill and leave for 1 hour. Mop up and rinse with plenty of water.

Hydrogen peroxide

Substance	Hazard	Comment
Concentrated hydrogen peroxide solution *(if less than 8.3 M but 2.3 M or more) or* *(if '100 volume strength' or less but over '28 volume strength) or* *(if 30% w/v or less but over 8%)*	**CORROSIVE**	DANGER: causes serious eye damage and may be harmful if swallowed. This is the most-concentrated solution found in schools. Take care to avoid skin contact. It decomposes slowly to produce oxygen gas (see CLEAPSS Student Safety Sheet 51); pressure may build up and care needs to be taken when opening a bottle. It should be stored in the dark. Decomposition is speeded up by catalysts such as some metal oxides and some enzymes. The oxygen formed will assist fires.
Dilute hydrogen peroxide solution *(if less than 2.3 M but 1.5 M or more) or* *(if less than '28 volume strength' or but '18 volume strength' or more) or* *(if less than 8% w/v but 5% or more)*	**IRRITANT**	WARNING: irritating to the eyes (and to the skin, although not officially classified as such). The typical concentration used in school science practical work. It decomposes slowly to produce oxygen gas (see CLEAPSS Student Safety Sheet 51); pressure may build up and care needs to be taken when opening a bottle. It should be stored in the dark. Decomposition is speeded up by catalysts such as some metal oxides and some enzymes.
Very dilute hydrogen peroxide solution *(if less than 1.5 M) or* *(if less than '18 volume strength') or* *(if less than 5% w/v)*	**Currently not classified as hazardous**	It is used for bleaching hair. It decomposes slowly to produce oxygen gas (see CLEAPSS Student Safety Sheet 51); pressure may build up and care needs to be taken when opening a bottle. It should be stored in the dark. Decomposition is speeded up by catalysts such as some metal oxides and some enzymes. Old stock may have insufficient peroxide molecules for the intended activity.

Additional information: Concentration of hydrogen peroxide solutions may be expressed in several different ways:

- Molarity: as with any chemical, the concentration may be given as x mol dm-3, or x M, ie x mol in 1 dm3 of solution
- Percentage, w/v: a y % w/v solution will contain y g hydrogen peroxide in 100 cm3 of solution
- Volume strength: 1 cm3 of z volume strength will give z cm3 of oxygen when it decomposes.

Typical control measures to reduce risk

- Use the lowest concentration and smallest volume possible.
- Wear eye protection for all but the most-dilute solutions.
- Store concentrated solutions away from heat and light, in bottles with special vented caps. Beware of a rapid release of pressure when opening a bottle.
- Avoid accidental contamination of solutions which may speed up the formation of oxygen and pressure build-up.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could an impurity / catalyst cause rapid decomposition and frothing?
- How serious would it be if something did go wrong?
  eg if the solution splashes onto the skin, is it sufficiently concentrated to cause burns?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove and soak contaminated clothing. Irrigate the skin affected area with gently-running tap water for at least 20 minutes. Call 999/111 as appropriate.
• Spilt on the floor, bench, etc	For large spills, and especially for (moderately) concentrated solutions, cover with mineral absorbent (eg, cat litter) and scoop into a bucket. Dilute with at least ten times its own volume of water. Rinse the floor etc with plenty of water. Wipe up small amounts with a damp cloth and rinse it well.

Carbon *and its* oxides

including carbon dioxide and carbon monoxide

Substance	Hazard	Comment
Carbon dioxide *Gas*	**GAS UNDER PRESSURE**	WARNING (if supplied in cylinder) may explode if heated. Otherwise, not classed as hazardous. Can cause asphyxiation if the proportion of carbon dioxide in the air becomes too high, eg as a result of the rapid evaporation of the solid in a confined space. Because it is denser than air, it may build up in low areas, eg at floor level. A greenhouse gas that contributes to global warming. For a 15-minute exposure, the concentration in the atmosphere should not exceed 27 000 mg m^{-3}.
Carbon dioxide (dry ice) *Solid*	**COLD**	It causes frostbite (burns) and needs careful dispensing/transferring. If it evaporates rapidly in a closed vessel, it may cause an explosion or, in a confined space, it may cause asphyxiation as the air is forced out.
Carbon monoxide *Gas*	**HIGHLY FLAMMABLE** **TOXIC** **HEALTH HAZARD**	DANGER: extremely flammable gas; toxic if inhaled; may damage the unborn child; causes damage to organs through prolonged or repeated inhalation. As little as 0.01% can cause headaches. The gas has no taste or smell and is not trapped by the filters in filter fume cupboards. It is often formed when hydrocarbon fuels burn in a limited supply of air, eg car engines especially in confined spaces, or gas-powered water heaters with poor ventilation. Traces also occur in cigarette smoke and are implicated in heart and artery diseases. It also contributes to the greenhouse effect. For a 15-minute exposure, the concentration in the atmosphere should not exceed 117 mg m^{-3}. It forms explosive mixtures with air and oxygen. Mixtures with air between 12% and 74% carbon monoxide by volume are explosive.
Carbon (Graphite, diamond, buckminsterfullerene)	**Currently not classified as hazardous**	Applies to lampblack, charcoal, activated carbon, decolourising charcoal. Soot is also mainly carbon but may be contaminated with carcinogenic chemicals. This was a cause of cancer amongst chimney sweeps in Victorian times. The hazards of buckminsterfullerene and carbon nanotubes are not yet fully known. Hot charcoal (carbon blocks), even if not glowing red, can slowly combust and stay hot for many hours.

Typical control measures to reduce risk

- Wear protective thermal gloves or use tongs for transferring/dispensing solid carbon dioxide.
- Use a ducted fume cupboard (not a recirculatory filter fume cupboard) for dispensing/transferring carbon monoxide.
- After use, allow hot charcoal blocks to cool in air; store them in air-tight metal containers.
- Use energy-efficient vehicles and power stations and/or non-fossil fuels or wind or solar power to limit the amount of carbon dioxide or monoxide emitted.
- Have gas appliances serviced regularly and consider installing a carbon monoxide detector.
- Use catalytic converters in car exhausts to reduce the amount of carbon monoxide released into the air.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Solid in the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Solid on the skin or clothing	Brush off quickly and immerse the affected area in cold water. If there are any signs of burning from solid carbon dioxide call 999/111
• Vapour breathed in	For carbon monoxide, or carbon dioxide in larger quantities, remove the casualty to fresh air. Consult a medic if carbon monoxide was inhaled or breathing is difficult.
• Gas escape in laboratory	Open all windows. For large amounts of carbon monoxide, evacuate the laboratory/building.

Hydrogen sulfide *and other* sulfides

including **carbon disulfide, ammonium sulfide** *and most* **metal sulfides**

Substance	Hazard	Comment
Hydrogen sulfide *Gas*	FLAMM. TOXIC ENVIRON. HAZARD	DANGER: extremely flammable gas; fatal if inhaled; very toxic to aquatic organisms. Mixtures of hydrogen sulfide with air containing between 4% and 45% hydrogen sulfide are explosive. For a 15-minute exposure, the concentration of the gas in the atmosphere should not exceed 14 mg m^{-3}. It has a very strong smell of rotten eggs and the human nose can detect as little as 0.01 mg m^{-3}. At higher concentrations it anaesthetises (deadens) the sense of smell and so the danger may not be realised. It may sometimes be found in coal mines (stinkdamp) and is produced by rotting seaweed and is the commonest cause of death in sewer workers.
Hydrogen sulfide *Solution in water*	TOXIC	DANGER: hydrogen sulfide gas is acutely toxic by inhalation and diffuses readily from solutions. However, use of solutions of hydrogen sulfide is safer than using the gas.
Carbon disulfide *Liquid*	FLAMM. IRRITANT HEALTH HAZARD	DANGER: highly flammable liquid and vapour; causes skin and serious eye irritation; suspected of damaging fertility and the unborn child; causes damage to organs through prolonged or repeated exposure. For a 15-minute exposure, the concentration of the gas in the atmosphere should not exceed 45 mg m^{-3}; flash point -30 °C. Very volatile. The demonstration involving the reaction with nitrogen monoxide (the 'barking dog') is very dangerous, especially if the oxide is not pure.
Ammonium sulfide *Solution in water*	FLAMM. CORROSIVE ENVIRON. HAZARD	DANGER (if more than 20%, ~3M): flammable liquid & vapour; causes severe skin burns & eye damage; contact with acids liberates toxic gas; very toxic to aquatic organisms. DANGER (if more than 0.4 M but less than ~3M): causes severe skin burns & eye damage; contact with acids liberates toxic gas. WARNING (if more than 0.1 M but less than 0.4M): irritating to eyes & skin; contact with acids liberates toxic gas. All the solutions are strongly alkaline. Dilute acid reacts to produce hydrogen sulfide. Absorbs carbon dioxide from the atmosphere, producing hydrogen sulfide.
Sodium sulfide *Hydrated solid & solutions in water*	CORROSIVE TOXIC ENVIRON. HAZARD	DANGER (solid): harmful if swallowed; toxic in contact with skin; causes severe skin burns & eye damage; contact with acid liberates toxic gas; very toxic to aquatic organisms. DANGER (solution if more than 0.4M): harmful if swallowed; causes severe skin burns & eye damage; contact with acid liberates toxic gas. WARNING (solution if more than 0.1M but less than 0.4M): irritating to skin and eyes; contact with acid liberates toxic gas. All the solutions are strongly alkaline. Absorbs carbon dioxide from the atmosphere, producing hydrogen sulfide.
Most metal sulfides *Insoluble solids*	**Currently not classified as hazardous**	Includes **copper(II) sulfide**, **copper pyrites**, **iron(II) sulfide**, **iron pyrites** ('fool's gold'), **zinc sulfide**. Dilute acid reacts to produce hydrogen sulfide. If heated strongly in air, may produce toxic sulfur dioxide (see *Sheet 52*).

Typical control measures to reduce risk

- If producing the gas, use the smallest amounts possible, eg no more than a few drops of acid on excess sulfide.
- Wear eye protection.
- Use a fume cupboard if adding more than a few drops of dilute acid to excess sulfide; ensure good laboratory ventilation and quickly dispose of solutions containing hydrogen sulfide.
- If smelling the gas, follow the safe technique: use your hand to waft the gas towards your nose.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg a leak of gas into the laboratory from apparatus or a warmed solution.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
Vapour breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is difficult.
Gas escape in laboratory	Open all windows. If over 1 litre of gas is released, evacuate the laboratory.

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Ethanol

also applies to **denatured alcohol** *and* **methylated spirit**

Substance	Hazard	Comment
Ethanol (pure) *Liquid*	**HIGHLY FLAMMABLE**	DANGER: highly flammable liquid & vapour. There is a serious risk of liquid catching fire; its vapour may catch fire above 13 °C. The vapour/air mixture is explosive (from 3.3 to 19% ethanol). The concentration in the air should not exceed 5760 mg m^{-3}. 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.
Industrial denatured alcohol (IDA) (formerly Industrial methylated spirit or IMS)	**FLAMM.** **HARMFUL** **HEALTH HAZARD**	DANGER: highly flammable liquid & vapour; harmful if swallowed; may cause damage to organs, causes serious eye irritation. This is ethanol, containing 5% methanol (v/v). It is often used in schools in place of pure ethanol (because it is cheaper) and usually labelled just as 'Ethanol' but it is more hazardous than pure ethanol because of the methanol. Commonly used as a solvent, eg for chlorophyll, for indicators (universal indicator, phenolphthalein).
Completely denatured alcohol (CDA)	**FLAMM.** **HARMFUL** **HEALTH HAZARD**	It contains methanol, propan-2-ol, methyl ethyl ketone (a bitter-tasting compound) and sometimes a purple dye. CDA is not suitable for use indoors.
Surgical spirit	**FLAMM.** **CORROSIVE** **ENVIRON. HAZARD**	Ethanol, with small amounts of castor oil, methyl salicylate and diethyl phthalate. It is prescribed for medical purposes, eg foot infections. It must not be swallowed. Use only as prescribed. Do not use for skin evaporation experiments
Ethanol *Dilute solution in water*	**Currently not classified as hazardous**	Alcoholic drinks contain ethanol, typically 3 to 7% (v/v) (beers), 11 to 14% (v/v) (wines), 30 to 40% (v/v) (spirits). Although chemical hazards are low, there may be considerable effects on the body leading to a loss of judgement, slower reaction times, etc. Consumption is dangerous if driving a vehicle or operating machinery.

Typical control measures to reduce risk

- Use the smallest volume possible; wear eye protection.
- Make sure the room is well ventilated.
- Check that equipment for extinguishing fires is nearby, eg, damp cloth, bench mat, fire blanket.
- Do not use near naked flames; if heating necessary, use an electrically-heated water bath or hot water from kettle.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg does ethanol need to be heated? Could quantities of the vapour be breathed in? Might there be fooling around?
- How serious would it be if something did go wrong?
  eg some of the most serious accidents in school science have involved ethanol fires, including clothing fires and badly-burnt skin.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing and rinse it. Wash the affected area and clothing with plenty of water.
• Clothing catches fire	Smother flames on clothing or the skin with a fire blanket or other material. Cool any burnt skin with gently-running tap water for 20 minutes. Call 999/111 if the area of burn is larger than a small coin.
• Other ethanol fires	Allow fires in sinks, etc to burn out. Fires at the top of test tubes, beakers, etc should be smothered with a damp cloth or heat-resistant mat.
• Spilt on the floor, bench, etc	Extinguish all Bunsen flames. Wipe up small amounts with a cloth and rinse well. Open windows for larger amounts, cover with mineral absorbent (eg, cat litter), scoop into a bucket and add water.

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Propanone

also known as ***acetone***

Substance	Hazard	Comment
Propanone (acetone) *Liquid*	**HIGHLY FLAMMABLE** **IRRITANT**	DANGER: highly flammable liquid & vapour. Causes serious eye irritation; may cause drowsiness or dizziness; repeated exposure may cause skin dryness and cracking. Its vapour may catch fire above -20°C. For a 15-minute exposure, the concentration in the atmosphere should not exceed 3620 mg m^{-3}. The smell can be detected by most people at about 47 mg m^{-3}, well below the level which could cause harm. Sometimes used as nail varnish/polish remover . However, ethyl ethanoate (ethyl acetate) is more commonly used.

Typical control measures to reduce risk

- Wear eye protection.
- Make sure the room is well ventilated or, in a laboratory, use a fume cupboard if possible.
- Transfer or dispense in a fume cupboard.
- Ensure no naked flames or other sources of ignition.
- Pressure can build in containers on warm days. Open bottles with care in a working fume cupboard.
- Check ways of putting out any fires.
- If heating is necessary, use an electrically-heated water bath or hot water from a kettle.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg does propanone need to be heated? Could there be high levels of vapour, perhaps as a result of chromatograms drying?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Keep him/her warm. Contact 111 /999 if breathing is difficult.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. If more than a test-tube amount was involved, wash the affected area and clothing with plenty of water.
• Clothing catches fire	Smother flames on clothing or the skin with a fire blanket or other material. Cool any burnt skin with gently-running tap water for 20 minutes. Call 999/111 if the area of burn is larger than a small coin.
• Other propanone fires	Allow fires in sinks, etc to burn out. Fires at the top of test tubes, beakers etc should be smothered with a damp cloth or heat-resistant mat.
• Spilt on the floor, bench, etc	Extinguish all Bunsen flames. Wipe up small amounts with a cloth and rinse well. Open windows for larger amounts, cover with mineral absorbent (eg cat litter), scoop into a bucket and add water.

Chlorinated hydrocarbons

Substance	Hazard	Comment
Dichloromethane (Methylene dichloride) *liquid*	HEALTH HAZARD IRRITANT	DANGER: suspected of causing cancer; causes skin & serious eye irritation; may cause respiratory irritation, drowsiness or dizziness and damage to organs through prolonged or repeated exposure. It is used in some paint strippers. For a 15-minute exposure, the concentration in the atmosphere should not exceed 706 mg m^{-3}.
Trichloromethane (Chloroform) *liquid*	TOXIC HEALTH HAZARD	DANGER: harmful if swallowed; causes skin & serious eye irritation; toxic if inhaled; may cause drowsiness or dizziness; suspected of causing cancer and of damaging the unborn child; causes damage to organs through prolonged or repeated exposure. For a 15-minute exposure, the concentration in the atmosphere should not exceed 30 mg m^{-3}. Used in the past as an anaesthetic.
Tetrachloromethane (Carbon tetrachloride) *liquid*	TOXIC HEALTH HAZARD	DANGER: toxic if swallowed, inhaled or in contact with skin; may cause allergic skin reaction; suspected of causing cancer; causes damage to organs through prolonged or repeated exposure; harmful to aquatic life with long-lasting effects; harms public health & the environment by destroying ozone in the upper atmosphere. For a 15-minute exposure, the concentration in the atmosphere should not exceed 32 mg m^{-3}. It can no longer be legally bought and existing stocks should not be used in work with open test tubes.
1,1,1-trichloroethane (Methyl chloroform) *liquid*	HARMFUL	WARNING: harmful if inhaled; causes skin and serious eye irritation; harms public health & the environment by destroying ozone in the upper atmosphere. For a 15-minute exposure, the concentration in the atmosphere should not exceed 1110 mg m^{-3}. It can no longer be legally bought; existing stocks should not be used in work with open test tubes.
Tetrachloroethene (tetrachloroethylene) ***liquid***	HEALTH HAZARD ENVIRON. HAZARD	WARNING: suspected of causing cancer; toxic to aquatic life with long-lasting effects; may cause skin and serious eye irritation. Used in dry cleaning. For 15-minute exposure, concentration in atmosphere should not exceed 275 mg m^{-3}.
Trichloroethene (Trichloroethylene) *liquid*	HEALTH HAZARD IRRITANT	DANGER: causes skin and serious eye irritation; may cause cancer, drowsiness or dizziness; suspected of causing genetic defects; harmful to aquatic life with long-lasting effects. For a 15-minute exposure, the concentration in the atmosphere should not exceed 820 mg m^{-3}. It was used in dry cleaning but has been replaced by tetrachloroethene.

Typical control measures to reduce risk

- Use the smallest volume possible and wear suitable eye protection. Many now have restricted uses as they are known Ozone layer depleting agents Use a fume cupboard for anything larger than test-tube amounts; ensure good laboratory ventilation.
- When choosing a solvent, pick the safest one with suitable properties - cyclohexane, Volasils or Lotoxane are safer than chlorinated hydrocarbons and usually work satisfactorily.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Wash the skin with soap and water. Take contaminated clothing outside for the solvent to evaporate.
• Spilt on the floor, bench, etc	Open windows if large amounts are spilt. Consider the need to evacuate for large spills. Cover with mineral absorbent (eg cat litter) and scoop into a bucket. Add washing-up liquid and work into an emulsion. Wash to waste with plenty of water.

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Hydrocarbons

Substance	Hazard	Comment
Methane (natural gas); **ethane**; **propane** (Calor gas, camping gas); **butane** (lighter fuel); **LPG** (mixture of propane & butane)	FLAMMABLE	DANGER: Extremely flammable gases; asphyxiants. Mixtures with air between 6% and 12% methane by volume are explosive, others similar. Mixtures may ignite below 650 °C. **Butane** is easily liquefied under pressure (it normally boils at 0 °C) and both it and propane are denser than air. For a 15-minute exposure, the concentration of butane in the atmosphere should not exceed 1810 mg m^{-3}.
Pentane, **hexane**, **heptane**, etc; **cyclohexane**, **cyclohexene**; **petrol** (gasoline); **paraffin** (kerosine); **benzene**; **methylbenzene** (toluene); **dimethylbenzene** (xylene)	HIGHLY FLAMM. HEALTH HAZARD HARMFUL ENVIRON. HAZARD	DANGER: (highly) flammable liquid & vapour; may be fatal if swallowed and enters airways; may cause drowsiness or dizziness; (very) toxic to aquatic life with long-lasting effects. **Pentane**: repeated exposure may cause skin dryness/cracking. **Hexane**: causes skin irritation (also **heptane**, **cyclohexane**, **paraffin**, **benzene**); suspected of damaging fertility; may cause damage to organs through prolonged/repeated exposure (also benzene). **Benzene**: causes serious eye irritation; may cause genetic defects and cancer. **NOT RECOMMENDED** for school use. **Petroleum spirits** (ethers) 40-60, 60-80, 80-100; 100-120 °C and petrol are mixtures of alkanes of variable composition – assume similar hazards if similar boiling points. Use of benzene is no longer banned in educational laboratories but is not recommended. For a 15-minute exposure, concentration of benzene in the atmosphere should not exceed 9.75 mg m^{-3}. **Dimethylbenzene** - WARNING: flammable liquid and vapour, skin irritant, harmful if inhaled
Diesel fuel; **engine oil**	CORROS. IRRIT. ENV. HAZ.	DANGER: **Diesel fuel** causes serious eye damage & skin irritation; toxic to aquatic life with long-lasting effects. Some oils may contain substances which cause cancer. After oil has been used in car engines, it may have broken down into more hazardous products.
Naphthalene	HEALTH HAZ. HARMFUL ENV. HAZ.	WARNING: Harmful if swallowed; suspected of causing cancer by inhalation; very toxic to aquatic life with long-lasting effects. Used in moth balls. If heated, concentration of vapour increases considerably.
Waxes; **oils**	**Currently not classified as hazardous**	Includes: paraffin wax, candle wax, petroleum jelly, Vaseline; medicinal paraffin, liquid paraffin, oil for oil baths.

Typical control measures to reduce risk

- Use smallest amount possible; wear eye protection; avoid skin contact; make sure room is well ventilated. Commercially available petrol and diesel contains various amounts of Benzene, so should not be used.
- Use fume cupboard or prevent escape of vapour, eg with mineral wool plug in test tube.
- Check gas supplies for leaks; store bottled gas in a cool place; use 'spirit burners' with care.
- Check equipment to put out fires, eg damp cloth, bench mat, fire blanket.
- Do not use the highly flammable liquids near naked flames; if heating is necessary, use an electrically-heated water bath or hot water from a kettle.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg does hydrocarbon need to be heated? Could quantities of the vapour be breathed in?
- How serious would it be if something did go wrong? How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove contaminated clothing. Wash the skin with soap and water. Take contaminated clothing outside for the solvent to evaporate.
• Spilt on the floor, bench, etc	Open windows if large amounts are spilt. Consider the need to evacuate for large spills. Cover with mineral absorbent (eg, cat litter) and scoop into a bucket. Add washing-up liquid and work into an emulsion. Wash to waste with plenty of water.

Carbohydrates

Substance	Hazard	Comment
Sucrose *Solid*	**Currently not classified as hazardous**	This is ordinary table sugar. It is cane sugar (also obtained from sugar beet). Acids formed by bacterial decomposition of sugar in the mouth cause tooth decay. Excess sugars in the diet, coupled with a lack of exercise can cause obesity and diabetes, and can lead to heart disease. Eating in laboratories is usually illegal under the *COSHH Regulations* because of the risk of contamination.
Glucose *Solid*	**Currently not classified as hazardous**	It is also known as dextrose. Acids formed by bacterial decomposition in the mouth cause tooth decay. Excess sugars in the diet, coupled with a lack of exercise can cause obesity and diabetes, and can lead to heart disease.
Fructose *Solid*	**Currently not classified as hazardous**	It is also known as laevulose or fruit sugar. Acids formed by bacterial decomposition in the mouth cause tooth decay. Excess sugars in the diet, coupled with a lack of exercise can cause obesity and diabetes, and can lead to heart disease.
Maltose *Solid*	**Currently not classified as hazardous**	It is also known as malt sugar.
Lactose *Solid*	**Currently not classified as hazardous**	It is also known as milk sugar.
Starch *Solid*	**Currently not classified as hazardous**	Starch is broken down by saliva and stomach acids into simple sugars.
Cellulose *Solid*	**Currently not classified as hazardous**	It is an approved food additive, E460. Cellulose is derived from the cell walls of fruit, vegetables and cereals. It is not digested. Dietary fibre (roughage) is an important part of the diet, helping prevent various diseases.
Food testing on carbohydrates		See CLEAPSS *Student Safety Sheet 4*

Typical control measures to reduce risk

- Wear eye protection when transferring/dispensing hazardous solids and solutions, eg, when food testing.
- Do not consume sugars or indeed any food or drink in laboratories; taste-testing investigations must be done outside laboratories unless scrupulous hygiene and no contamination can be ensured.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
  eg small amounts of contaminants entering the mouth during taste-testing activities.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	In small amounts, unlikely to be hazardous unless contaminated.
• Spilt on the skin or clothing	Brush solid off contaminated clothing. Rinse clothing or the skin as necessary.
• Spilt on the floor, bench, etc	Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth.

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Methanol

also known as **methyl alcohol** *and* **wood alcohol**

Substance	Hazard	Comment
Methanol (methyl alcohol, wood alcohol) *Liquid*	**HIGHLY FLAMMABLE** **TOXIC** **HEALTH HAZARD**	DANGER: highly flammable liquid and vapour; toxic if swallowed; toxic in contact with skin; toxic if inhaled; causes damage to organs if swallowed, through contact with skin or if inhaled. For a 15-minute exposure, the concentration in the atmosphere should not exceed 333 mg m^{-3}. The flash point is 11°C, ie the liquid gives off sufficient vapour at 11°C to ignite if a flame or spark is applied. Methanol is often added deliberately to ethanol ('methylated spirit') to make it undrinkable. A purple dye and an unpleasant smelling chemical (pyridine) make the product sold to the general public even less palatable. This is called denaturing. 'Industrial denatured alcohol' (IDA) lacks the purple dye and unpleasant smelling chemical. See *Sheet 60*.

Typical control measures to reduce risk

- Wear eye protection.
- Avoid skin contact.
- Make sure the room is well ventilated or, in a laboratory, use a fume cupboard if possible.
- Check availability of ways of putting out any fires.
- Do not use near naked flames; if heating is necessary, use an electrically heated water bath or hot water from a kettle.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg does methanol need to be heated? Could there be high levels of vapour?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
Vapour breathed in	Remove the casualty to fresh air. Keep them warm. Call 999/111 if breathing is difficult.
In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
Clothing catches fire	Smother flames on clothing or the skin with a fire blanket or other material. Cool any burnt skin with gently-running tap water for 20 minutes. Call 999/111 if the area of burn is larger than a small coin.
Other methanol fires	Allow fires in sinks, etc to burn out. Fires at the top of test tubes, beakers, etc should be smothered with a damp cloth or heat-resistant mat.
Spilt on the skin or clothing	Remove contaminated clothing. If more than a test-tube amount was involved, wash the affected area and clothing with plenty of water.

Higher alcohols

including **propanol, butanol** *and* **pentanol**

Substance	Hazard	Comment
Propan-1-ol (*n*-propanol) **Propan-2-ol** (*iso*-propanol) *Liquids*	FLAMMABLE IRRITANT CORROSIVE	DANGER: highly flammable liquid and vapour; may cause drowsiness or dizziness; causes serious eye damage (**propan-1-ol**)/irritation (**propan-2-ol**). For a 15-minute exposure, the concentration of vapour in the atmosphere should not exceed 625 mg m^{-3} (**propan-1-ol**), 1250 mg m^{-3} (**propan-2-ol**). The liquid gives off sufficient vapour at 22°C (**propan-1-ol**)/12°C (**propan-2-ol**) to ignite if a flame or spark is applied. **Propan-2-ol** is sometimes used as 'rubbing alcohol', especially in the USA. Also used to clean optical surfaces, eg spectacle and camera lenses.
Butan-1-ol (*n*-butanol) **2-methylpropan-1-ol** (*iso*-butanol) *Liquids*	FLAMMABLE IRRITANT CORROSIVE	DANGER: flammable liquid and vapour; causes skin irritation and serious eye damage; may cause respiratory irritation and drowsiness or dizziness; **butan-1-ol** is harmful if swallowed. For a 15-minute exposure, the concentration of vapour in the atmosphere should not exceed 154 mg m^{-3} (**butan-1-ol**), 231 mg m^{-3} (**2-methylpropan-1-ol**). The flash point of **butan-1-ol** is 37°C (**2-methylpropan-1-ol,** 28°C), ie the liquid gives off sufficient vapour at 37°C/28°C to ignite if a flame or spark is applied.
2-methylpropan-2-ol (*tert*-butyl alcohol) Liquid but may be solid on cold day	FLAMMABLE IRRITANT	DANGER: highly flammable liquid and vapour; causes serious eye irritation; harmful if inhaled; may cause respiratory irritation. For a 15-minute exposure, the concentration of vapour in the atmosphere should not exceed 462 mg m^{-3}. Liquid gives off sufficient vapour at 11°C to ignite if a flame or spark is applied.
Butan-2-ol (*sec*-butyl alcohol) *Liquid*	FLAMMABLE IRRITANT	WARNING: flammable liquid and vapour; causes serious eye irritation; may cause respiratory irritation and drowsiness or dizziness. For a 15-minute exposure, the concentration of vapour in the atmosphere should not exceed 462 mg m^{-3}. The flash point is 24°C, ie the liquid gives off sufficient vapour at 24°C to ignite if a flame or spark is applied.
Pentan-1-ol (*n*-amyl alcohol) **3-methylbutan-1-ol** (*iso*-amyl alcohol) *Liquids*	FLAMMABLE IRRITANT	WARNING: flammable liquid and vapour; may cause skin, respiratory and serious eye irritation; may be harmful if swallowed. For a 15-minute exposure, the concentration of **3-methylbutan-1-ol** in the atmosphere should not exceed 458 mg m^{-3}.

Typical control measures to reduce risk

- Wear eye protection.
- Make sure the room is well ventilated or, in a laboratory, use a fume cupboard if possible.
- Check availability of ways of putting out any fires.
- **Do not use near naked flames; if heating is necessary, use an electrically-heated water bath or hot water from kettle.**
- **NEVER** boil or distil organic liquids to dryness. Some, such as propan-2-ol and other secondary alcohols, present a remote explosion risk due to the presence of peroxides.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg does alcohol need to be heated? Could there be high levels of vapour?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Keep them warm. Call 999/111 if breathing is difficult.
• In the mouth swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111
• Clothing catches fire	Smother flames on clothing or the skin with a fire blanket or other material. Cool any burnt skin with gently-running tap water for 20 minutes. Call 999/111 if the area of burn is larger than a small coin.
• Other fires	Allow fires in sinks etc to burn out. Fires at the top of test tubes, beakers, etc should be smothered with a damp cloth or heat-resistant mat.
• Spilt on the skin or clothing	Remove contaminated clothing. If more than a test tube amount was involved, wash the affected area and clothing with plenty of water.
• Spilt on the floor, bench, etc	Put out Bunsen flames. Wipe up small amounts with cloth and rinse it well. For larger amounts, open windows, cover with mineral absorbent (eg, cat litter), scoop into a bucket and add water.

Methanal

including **formaldehyde, formalin**

Substance	Hazard	Comment
Methanal (formaldehyde) *Gas*	HEALTH HAZARD TOXIC CORROSIVE	DANGER: toxic if swallowed, inhaled or in contact with skin; causes severe skin burns and eye damage; may cause cancer or allergic skin reaction; suspected of causing genetic defects. For a 15-minute exposure, concentration should not exceed 2.5 mg m^{-3}. Vapour may arise when dispensing/transferring solution. Commonly supplied for laboratory use as a saturated solution, about 13 M (40%). Methanal is used to make polymers, eg for cavity wall insulation – there have been suggestions that small amounts may be released into houses if polymerisation is incomplete. A methanal resin is also used as a binding agent in MDF and machining it may cause decomposition and release methanal.
Very concentrated methanal solution (formalin) *If 10 M (30%) or more*		
Concentrated methanal solution (formalin) *If less than 10 M (30%) but 8 M (25%) or more*	HEALTH HAZARD HARMFUL CORROSIVE	DANGER: causes severe skin burns and eye damage; harmful by skin contact or if swallowed; irritating to eyes, skin and respiratory system; may cause cancer or allergic skin reaction; suspected of causing genetic defects.
Moderately dilute methanal solution (formalin) *If less than 8 M (25%) but more than 0.07 M (0.2%)*	HEALTH HAZARD HARMFUL	DANGER: Harmful by skin contact (if ≥ 5M (15%)). Harmful if swallowed; irritating to skin, eyes and respiratory system (if ≥ 1.7 M (5%)). Suspected of causing genetic effects (if ≥ 0.3M (1%)). May cause cancer or allergic skin reaction. A 1.3 M (4%) solution was commonly used in the past as a preservative for biological specimens. A solution of concentration between 0.07 M (0.2%) and 0.3 M (1%) was used in the past for extracting earthworms from soil but there are safer alternatives which are also less damaging to the worms.
Dilute methanal solution (formalin) *If less than 0.07 M (0.2%) but more than 0.03 M (0.1%)*	HEALTH HAZARD	DANGER: may cause cancer.
Very dilute methanal *If less than 0.03 M (0.1%)*	**Currently not classified as hazardous**	–

Typical control measures to reduce risk

- Wear appropriate eye protection (depending on the concentration) and wear protective gloves (preferably nitrile).
- Open bottles of all except dilute solutions of methanal in a fume cupboard.
- **Do *not* use near naked flames; if heating is necessary, use an electrically heated water bath or hot water from a kettle.**

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Keep them warm. Call 999/111 if breathing is difficult.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do **not** induce vomiting. Call 999/111.
• Spilt on the skin/clothing	Remove contaminated clothing. Wash the affected area and clothing with plenty of water.
• Spilt on the floor, bench, etc	Put out all Bunsen flames. Wipe up small amounts with a cloth and rinse well. For larger amounts, open windows, if fumes are not too strong cover with mineral absorbent (eg, cat litter), scoop into a bucket and add water.

Ethanal *and* higher aldehydes

including **propanal, butanal** *and* **hexamine**

Substance	Hazard	Comment
Ethanal (acetaldehyde) *Liquid with boiling point close to room temperature (21 °C)*	FLAMMABLE IRRITANT HEALTH HAZARD	DANGER: extremely flammable liquid and vapour; causes serious eye irritation; may cause respiratory irritation; suspected of causing genetic effects; may cause cancer. For a 15-minute exposure, the concentration in the atmosphere should not exceed 92 mg m^{-3}. The flash point is -39°C, ie the liquid gives off sufficient vapour at -39°C to ignite if a flame or spark is applied. May boil spontaneously during storage or on opening. May spurt out of the bottle as the pressure is released when it is opened. Tiny traces of impurity can cause spontaneous boiling. Cool in an ice bath before opening in a fume cupboard.
Propanal (propionaldehyde) *Liquid*	FLAMMABLE HARMFUL	DANGER: highly flammable liquid and vapour; causes skin and serious eye irritation; may cause respiratory irritation. The flash point is -30°C, ie the liquid gives off sufficient vapour at -30°C to ignite if a flame or spark is applied. Because of its higher boiling point (48°C), it is much safer to use than ethanal.
Butanal (butyraldehyde) *Liquid*	FLAMMABLE	DANGER: highly flammable liquid and vapour. The flash point is -22°C, ie the liquid gives off sufficient vapour at -22°C to ignite if a flame or spark is applied. Because of its higher boiling (75°C), it is much safer to use than ethanal.
Hexamine (hexamethylene tetramine) *Solid*	FLAMMABLE HARMFUL	WARNING: flammable solid, may cause an allergic skin reaction. Flash point and melting point is 250°C. Hygroscopic – keep dry. Do **not** use tablets if they have become damp, even wax coated tablets.

Typical control measures to reduce risk

- Wear eye protection and protective gloves (preferably nitrile).
- Open ethanal bottles very cautiously in a fume cupboard, after cooling in an ice bath.
- Avoid using ethanal if at all possible; use propanal or butanal instead.
- **Do *not* use near naked flames; if heating is necessary, use an electrically heated water bath or hot water from a kettle.**

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Keep them warm. Consult a medic if breathing is difficult.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
• Spilt on the skin/clothing	Remove contaminated clothing. Wash the affected area and clothing with plenty of water.
• Spilt on the floor, bench, etc	Put out all Bunsen flames. Wipe up small amounts with a cloth and rinse well. For larger amounts, open windows, if fumes are not too strong cover with mineral absorbent (eg, cat litter), scoop into a bucket and add water.

Ethanoic anhydride

Substance	Hazard	Comment
Concentrated ethanoic anhydride (acetic anhydride) *Liquid*	**FLAMMABLE** **IRRITANT** **CORROSIVE**	DANGER: flammable liquid and vapour; harmful if swallowed or if inhaled; causes severe skin burns and eye damage; may cause respiratory irritation. For 15-minute exposure, the concentration in the atmosphere should not exceed 10 mg m^{-3}. The flash point is 49°C, ie the liquid gives off sufficient vapour at 49°C to ignite if a flame or spark is applied.
Moderately concentrated ethanoic anhydride (acetic anhydride) *(if less than 25% (w/w) but 5% (w/w) or more)*	**CORROSIVE**	DANGER: causes severe skin burns; irritant to the skin; may cause respiratory irritation.
Moderately dilute ethanoic anhydride (acetic anhydride) *(if less than 5% (w/w) but 1% (w/w) or more)*	**IRRITANT**	WARNING: irritant to the skin.

Typical control measures to reduce risk

- Wear splash-proof goggles.
- Dispense in a fume cupboard. Avoid inhaling the vapour. Ensure the laboratory is well ventilated.
- Take particular care to avoid skin contact.
- Use the lowest concentration and smallest volume possible
- Do not use the concentrated ethanoic anhydride near naked flames; if heating is necessary, use an electrically-heated water bath or hot water from a kettle.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg choking fumes if concentrated ethanoic anhydride is over-heated.
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Keep them warm. Call 999/111 if breathing is difficult.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
• Spilt on the skin/clothing	Remove contaminated clothing. Quickly use a dry cloth or paper towel to wipe as much liquid off the skin as possible. Irrigate the affected skin area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111.
• Spilt on the floor, bench, etc	Wipe up small amounts with a damp cloth and rinse it well. For larger amounts and if safe to deal with, especially for concentrated ethanoic anhydride, ventilate the area as much as possible. Cover the spill with absorbent material (eg cat litter). Scoop this into a **dry** bucket and take to a fume cupboard. Treat with a large excess of water (eg 4 L per 100 cm^3 of spill). Leave to hydrolyse for at least 12 hours. Thoroughly mop the spill area. After 12 hours, decant the liquid down a foul-water drain and rinse away with more water. Place the rinsed absorbent in the waste.

Dyes, stains *and* indicators

Substance	Hazard	Comment
Dyes, **stains** *and* **indicators** *including*: **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** *Solid*	**TOXIC** **HEALTH HAZ.** **CORROSIVE** **IRRITANT** **ENVIRON. HAZARD**	DANGER: May include one or more of the following statements: fatal/toxic if swallowed/in contact with skin/if inhaled; causes severe skin burns & eye damage/ serious eye damage; may cause allergy or asthma symptoms or breathing difficulties if inhaled; may cause genetic defects/ cancer/damage fertility or the unborn child; causes damages to organs/through prolonged or repeated exposure.
Dyes, **stains** *and* **indicators** *including*: **Alizarin** (1,2-dihydroxyanthraquinone), **Alizarin Red S**, **Aluminon** (tri-ammonium aurine tricarboxylate), **Aniline Blue** (cotton / spirit blue), **Brilliant Yellow**, **Cresol Red**, **DCPIP** (2,6-dichlorophenolindophenol, phenolindo-2,6-dichlorophenol, PIDCP), **Direct Red 23**, **Disperse Yellow 7**, **Dithizone** (diphenylthiocarbazone), **Eosin** (Eosin Y), **Eriochrome Black T** (Solochrome black), **Fluorescein** (and 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, Sudan II, Sudan IV**, **Sudan Black** (Solvent Black 3), **Thymol Blue**, **Xylene Cyanol FF** *Solid*	**HEALTH HAZARD** **HARMFUL** **ENVIRON. HAZARD**	WARNING: May include one or more of the following statements: harmful if swallowed/in contact with skin/if inhaled; causes skin/serious eye irritation; may cause allergic skin reaction; suspected of causing genetic defects/cancer/damaging fertility or the unborn child; may cause damage to organs/respiratory irritation/drowsiness or dizziness/damage to organs through prolonged or repeated exposure.
Dyes, **stains** *and* **indicators** *including*: **Acid Blue 40**, **Blue Dextran**, **Bromocresol Green**, **Bromophenol 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**, **Sudan III**, **Thymolphthalein**, **Toluidine Blue**, **Xylenol Orange** *Solid*	**Currently not classified as hazardous**	Some dyes may contain hazardous impurities and many have not been well researched. Suppliers often vary in the hazard classifications they use. So, although the substances listed here are not usually classified as hazardous, they should be used with caution. Skin contamination should be avoided.
Dyes, **stains** *and* **indicators** *Dilute solutions (usually less than 1% in water or non-aqueous solvents).*	**Dependent on solvent**	Aqueous solutions are low risk but with non-aqueous solvents risks are greater, eg ethanol [FLAMMABLE if more than 25% (v/v)] or ethanoic acid [CORROSIVE].

Typical control measures to reduce risk

- Use the lowest concentration possible and wear eye protection for all but the most-dilute solutions.
- Reduce the risk of skin contact by wearing disposable gloves.
- Avoid powdered dyes and indicators escaping into the air; use a fume cupboard when transferring/dispensing more hazardous ones.
- Avoid naked flames if using flammable solvents.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
• Dust breathed	Remove the casualty to fresh air. Call 999/111 if breathing is difficult.
• Spilt on the skin or clothing	Remove contaminated clothing. Wash off the skin with soap and plenty of water. Rinse contaminated clothing.
• Spilt on the floor, bench, etc	Scoop up solids (take care not to raise dust). Wipe up solution spills or any traces of solid with a damp cloth and rinse it well.

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Sharps

including **scalpels, knives, syringe needles, seekers** *etc*

Substance	Hazard	Comment
Scalpels, knives and other blades	⚠ **DANGER**	Cuts and puncture wounds can lead to infection, especially if the blade or point is contaminated by contact with living or once-living material. Careless use and handling of scalpels, syringes with needles, seekers and other sharps can lead to cuts and puncture wounds. Sharp scalpels are safer to use than blunt ones because there is less risk of them slipping as less force needs to be used. Carrying scalpels, syringes with needles, seekers and other sharps especially in crowded rooms, can present a hazard to the user and others. Sharps that have been disposed of carelessly can present a hazard to waste handlers and others.
Syringe needles		
Seekers and other sharps		

Typical control measures to reduce risk

- Find out from a reliable source if there any health amd safety issues relating to the material being dissected.
- Cut in a direction away from yourself and where possible cut using a cutting board, dissection tray, a pad or similar.
- Wear eye protection when changing scalpel blades or cutting material likely to "flick" (eg cartilage or bone).
- Cooperate with any requirement to count sharps out at the beginning and in at the end of a lesson.
- Carry sharps with the blade or point protected, eg in a shallow tray, and do not carry them at all if you are likely to be jostled.
- Dispose of used sharps in a proper, safe container, eg a sturdy box, that is clearly labelled, sealed and wrapped before disposal.
- Take steps to prevent theft.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could the user or somebody else be cut or stabbed by accident?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Minor cuts	Wash the wound. Get the casualty to apply a small, sterile dressing.
• Severe cuts	Lower the casualty to the floor. Raise the wound as high as possible. If feasible, ask the casualty to apply pressure on or as close to the cut as possible, using fingers, a pad of cloth or, better, a sterile dressing (adding further layers as necessary). If the casualty is unable to do so, apply pressure yourself, protecting your skin and clothes from contamination by blood if possible. Leave any embedded large bodies and press around them. Consult a medic.

Animals (dead) *and* animal parts

See also CLEAPSS Student Safety Sheet 71: Sharps

Substance	Hazard	Comment
Animals (whole) *such as* **whole rats, mice, fish** *Fresh or recently defrosted from frozen* **Organs** *such as* **eyes, hearts, kidneys, lungs, and chicken's feet/legs** **Bones**	**BIOHAZARD**	Whole animals obtained from a reputable biological supplier should be safe to use; but road kill, for example, might be infected. Items intended for human consumption, available from butchers, abattoirs and fishmongers, should also be safe. Because of the risk of BSE it would only be legal to supply cattle eyes (or brain tissue) from animals slaughtered at less than 12 months or eyes of sheep and goats from animals slaughtered at less than 12 months or with at least one erupted incisor. If only bones are to be studied, and especially if they are to be kept, use a knife to remove as much flesh as possible. Place the bones in a saucepan of water to which sodium carbonate is added and simmer until the remaining flesh can easily be removed, using an old brush. Return to the pan for more simmering until the bones are cleaned. Some people have cultural or religious objections to handling particular species. Some people object to killing animals, whether for food, medical research or dissection in schools. Fewer people object to the use of material intended for human consumption available from butchers, abattoirs and fishmongers.
Animal parts *Preserved*	**HEALTH HAZARD** **HARMFUL**	In the past, specimens were preserved in 1.3 M (4%) methanal solution (formalin) (see CLEAPSS *Student Safety Sheet 67*). Formalin-free preservatives are mostly used now, but formalin will still have been used professionally as a fixing agent. Sometimes 70% ethanol or propanol solutions are used (see CLEAPSS *Student Safety Sheets 60* and *66*). Preservative should always be rinsed off before use, preferably soaking for an hour in water. However, preservative may still remain in body cavities, which must be rinsed as soon as they are exposed.
Dissection	**HARMFUL**	See CLEAPSS *Student Safety Sheet 71: Sharps*.

Typical control measures to reduce risk

- Use material from reliable sources.
- Wash preserved material prior to dissection and rinse it if body cavities are exposed during dissection.
- Wear eye protection when cutting bone or cartilage, using preserved material or changing scalpel blades.
- Count sharps out at the beginning and in at the end of the lesson.
- Carry sharps around in a safe manner.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Animal material in the eye	Flood the eye with gently running tap water for 10 minutes. If discomfort persists, consult a medic.
• Spilt on the floor, bench, etc	Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth. Wipe up solution spills with a cloth and rinse it well.

Animals (living)

See also CLEAPSS *Student Safety Sheet 75: Fieldwork*

Substance	Hazard	Comment
Vertebrates *including* **small mammals**, **fish**, **birds**, **reptiles**, **amphibia**	☣ BIOHAZARD	It is illegal to treat vertebrates in a manner causing pain, suffering, distress or lasting harm. Such cruelty might result from some experiments, poor handling, unsuitable housing or inadequate feeding. Some animals may bite and some people may be allergic to hairs, skin, scales, feathers, droppings etc. Some animals can present a health hazard, although the risk of diseases being passed to humans is usually low, but may be higher for farm animals. Wild animals can harbour diseases and parasites, especially if injured. Obtaining animals from reputable sources, preventing contact with wild species and adopting good hygiene practices will usually make the risk insignificant. A few species present higher risks and should be avoided. Bees and farm animals need special facilities and specialist knowledge. Some native species are protected and must not be brought in from the wild. It is illegal to release any non-native species into the wild.
Invertebrates *including* **insects**, **snails**, **worms**, **brine shrimps**, **water fleas, etc.**	☣ BIOHAZARD	Although cruelty to invertebrates is not an offence, they should still be treated humanely, handled carefully, housed and fed in a suitable manner. Any garden 'minibeasts' brought into school for study should be returned to the environment from which they came as quickly as possible. It is illegal to release any non-native species into the wild. Some animals may sting and some people may be allergic to hairs, skin, scales, droppings, etc.
After use, healthy animals taken from the wild should be returned to the place from which they were taken.		

Typical control measures to reduce risk

- Check detailed guidance on suitability, handling, housing and feeding of individual species.
- Use material from reliable sources; avoid species presenting higher risks; check that mammals are docile.
- Ensure laboratory mammals cannot come into contact with wild rodents.
- Before handling animals, cover cuts and abrasions on exposed hands and arms. Gauntlets may be necessary when handling some animals. If animals of any sort are to be handled regularly, it is a good idea to have up-to-date anti-tetanus vaccination.
- Wash hands in warm soapy water before and soon after handling animals, or coming into contact with their bedding, water, droppings or housing.
- Wear gloves when cleaning cages or handling soiled bedding; dispose of such bedding by incineration or in a sealed plastic sack with normal non-recycling waste.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Animal material in the eye	Flood the eye with gently running tap water for 10 minutes. Do not attempt to remove any embedded object. If discomfort persists, consult a medic.
• Animal bites	Wash the wound with warm soapy water; raise and support the wound, cover with a sterile dressing. Consult a medic.

Plants, fungi *and* seeds

See also CLEAPSS *Student Safety Sheet 75: Fieldwork*

Substance	Hazard	Comment
Plants and fungi	☠ TOXIC ✖ IRRITANT	Some plants, eg cacti, have spines which can cause deep puncture wounds and other spines may cause skin irritation. Other plants, eg Euphorbia have irritant or poisonous sap. Nettles are well known but hyacinth bulbs can also cause dermatitis (skin rash), as can bulbs of other members of the liliaceae family such as daffodils, tulips and primulas. Many common garden and hedgerow plants are poisonous or have toxic parts. Some Umbellifers, eg giant hogweed, can cause photosensitisation after skin contact, resulting in blisters on exposure to light. Some plants used as common food sources may have poisonous parts, eg rhubarb leaves and the green parts of the potato (including the tuber) and tomato. Some fungi are very poisonous and easily mistaken for the common (field) mushroom. Pollen from some plants can produce an allergic reaction in susceptible individuals, commonly known as hay fever. Plant material collected from farming areas may have been contaminated with pesticides, although most rapidly break down after spraying. Wild plants are protected by law. It is illegal to uproot, pick or destroy certain highly protected plants and it is illegal to uproot any plant without the landowner's permission.
Seeds	❗ **IRRITANT**	Some seeds are very poisonous, eg castor oil, laburnum. French beans or red kidney beans are poisonous unless cooked. Seeds bought from commercial suppliers are often treated with a pesticide to prevent attack by insects or fungi. Seeds from health food stores will not have been treated. The effects of radiation on plant growth are often investigated using seeds that have been exposed to gamma-radiation. Such seeds are NOT radioactive.

Typical control measures to reduce risk

- Check reliable sources to find if there are hazards in any plants in your garden, in the neighbourhood or in school.
- Where possible, use seeds known to be pesticide free or rinse the seeds in running water for several hours.
- Treat unknown plants with caution; never taste or eat a plant unless it is definitely known to be non-poisonous.
- Wash hands in warm soapy water after handling seeds and other plant material.
- Wear gloves when handling plants likely to cause irritation or seeds treated with pesticides.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Skin rash from irritant plants	Cool the affected area with cold water (if available) and cover with a sterile dressing. You might self-medicate using a traditional remedy by rubbing a nettle sting (acidic) with a dock leaf (alkaline).
• Poisonous seeds swallowed	Do no more than wash out the mouth with drinking water. Do **not** induce vomiting. Consult a medic.

Fieldwork

including **any science work outside the laboratory**
see also CLEAPSS *Student Safety Sheets 73* and *74*

Substance	Hazard	Comment
Site-specific hazards	DANGER BIOHAZARD	Schools will normally have identified any significant hazards in school grounds, as will other sites which regularly welcome schools for fieldwork. Be aware that broken glass and animal faeces are always possible. Working outdoors, eg at the seaside, in the countryside or near water, will introduce hazards specific to the location, eg drowning, trapping by tides, falls from a height, slips and trips, plants with poisonous parts, pesticides, animal bites/stings and animal-borne infections, eg toxocariasis from soil contaminated with cat or dog faeces, Weil's disease from water contaminated with rat urine, and Lyme disease from ticks. Working outdoors can lead to exposure to weather conditions which present hazards, eg strong sunlight (near ultraviolet, see CLEAPSS *Student Safety Sheet 12*), freezing cold, rain.
Transport hazards	DANGER	Walking to the site may result in exposure to traffic hazards. Public transport, hired coaches, the school minibus or private cars introduce a variety of different hazards.
Child abuse and / or disappearance	DANGER	Children in unfamiliar settings may wander off. If children are in contact with members of the public, there is a small possibility of child abuse.

Typical control measures to reduce risk

- As far as possible only visits sites you know to be safe and follow the Code of Practice for that type of fieldwork.
- Ensure that others know where you are and make sure you use safe equipment and transport arrangements.
- When working in shoreline ecologies, check tide tables and beware of the risk of slipping on seaweed.
- Ensure shoes and clothing are suitable for the terrain and for varying weather conditions. For example, avoid bare legs and arms in areas known to be infested with ticks, or in sunny conditions wear sun hats and use sun cream.
- Wear gloves when handling plants likely to cause irritation or seeds treated with pesticides.
- Wear hard hats when working in quarries and eye protection when hammering rocks.
- Avoid contact with water with growths of blue-green algae on the surface.
- Cover cuts and abrasions with water-proof dressings when working in and around water which may be contaminated by rat urine.
- Treat unknown plants with caution; never taste or eat a plant unless it is definitely known to be non-poisonous.
- Approach vertebrates with caution, especially those with young.
- Ensure easy access to hand-washing facilities before eating/drinking; if soap/water is unavailable use alcohol gel.
- Beware of the possibility of hay fever etc. Carry a first-aid kit and ensure at least one person is trained to use it.
- Ensure there is a workable emergency contact system. Be aware that there may be no mobile phone signal in some areas.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Insect bites & stings	If sting is visible and can be displaced easily, brush off sideways with the edge of a credit card or finger nail, avoiding further damage. Raise affected body part and, if possible, apply cold compress for 10+ minutes.
• Tick bites	Remove the tick with forceps by grasping as close to the skin as possible and pulling gently without twisting or jerking. Keep the tick for identification and consult a medic.
• Animal bites	Wash the wound with warm soapy water or, if unavailable, alcohol-free cleansing wipes. Raise and support the wound, cover with a sterile dressing. Consult a medic.
• Minor cuts	Wash the wound or, if water is unavailable, use cleansing wipes. Get the casualty to apply a small, sterile dressing.

Bioreactors *and* fermenters

see also CLEAPSS *Student Safety Sheet 1: Microorganisms*

Substance	Hazard	Comment
Micro-organisms	BIOHAZARD	Bioreactors and fermenters present greater risks than agar plates because of the much greater volume of medium involved and the possibility of liquid spills and aerosol formation. Schools should restrict work to yeasts or bacteria with unusual growing conditions, eg low pH, high salt concentration or specialist media. Generation of biogas from silage or pond mud is acceptable but the use of animal manure as an inoculum should be avoided because it may introduce pathogens and/or medication administered to animals.
Electrical equipment	ELECTRIC SHOCK/BURN	The proximity of large volumes of liquid and mains electrical equipment (eg from heaters, aerators, sensors, etc) presents a hazard. Commercially designed equipment from a reliable source should prevent access to live conductors (check the integrity before each use) but DIY equipment should not exceed 30V.
Gases	EXPLOSIVE HIGHLY FLAMMABLE	Depending on the reactions taking place, large volumes of gas may be produced, usually carbon dioxide or methane (biogas). The vessel **must** be vented to avoid the build-up of pressure. It is also important to prevent the entry of external microorganisms or the release of aerosols. Care must be taken to ensure no naked flames are near the bioreactor if a highly flammable gas such as methane is being produced.
Sterilisation	DANGER	Steam sterilisation may be impossible if the bioreactor is too large to fit into an autoclave, so chemical disinfection will be necessary. Some possible disinfectants are hazardous. *Virkon* is the preferred disinfectant.

Typical control measures to reduce risk

- Use only safe microorganisms from safe sources.
- Do not seal bioreactors but prevent the entry of external microorganisms and the release of aerosols.
- Sterilise all equipment before and after use and sterilise the culture before disposal.
- When withdrawing samples, take care to avoid aerosol production and place a pad of tissues moistened with disinfectant underneath to catch drips.
- Keep electrical leads tidy and site mains equipment as far away from the reactor as possible.
- Always wash hands after using cultures.
- Wear a clean laboratory coat or overall to protect cultures from microbes on the skin, clothing, etc.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could a culture become contaminated? Could microorganisms escape?
- How serious would it be if something did go wrong?
  eg could there be an explosion resulting from a pressure build-up or ignition of a flammable product?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Spilt on the floor, bench, etc	For spills of cultures, place paper towels over the spill, pour disinfectant (eg, *Virkon*) on top and leave for at least 15 minutes.

Working with DNA

See also CLEAPSS *Student Safety Sheet 78: Genetic modification*

Substance	Hazard	Comment
'Naked' DNA (ie DNA not incorporated into a living cell)	**Currently not classified as hazardous**	DNA only functions when it is inserted into a living cell. Therefore, work with DNA itself is generally low hazard, although there may be other hazards associated with the process. For example chemical, microbiological or electrical hazards (electrophoresis).
Extraction of DNA from human tissue	☣ **BIOHAZARD**	Extraction of DNA from human tissue, eg cheek cells, prior to amplification by the polymerase chain reaction (PCR), could result in the transfer of infective material between participants. See CLEAPSS *Student Safety Sheet 3.*
DNA from laboratory suppliers	☣ **BIOHAZARD**	DNA from sources such as bacteriophage lambda and salmon sperm is generally safe. However, DNA from mammalian sources may be contaminated with viruses.
Gel electrophoresis	⚡ **ELECTRIC SHOCK**	Electrophoresis can be very slow unless moderately high voltages are used, giving a risk of electric shock, especially because of the high conductivity of the buffer solutions. If voltages more than 30V AC or DC are used, it must be impossible to touch a live conductor accidentally or to open the tank if a current is flowing. Some commercial tanks, especially if imported from the USA, may not satisfy this requirement.
Chemicals used	☠ **TOXIC**	Polyacrylamide gels are too toxic to make or cast in schools. Some stains, eg ethidium bromide, are also unsuitable. Others may be used with care. See CLEAPSS *Student Safety Sheet 70: Dyes, stains and indicators.*

Typical control measures to reduce risk

- If extracting DNA from human tissue, you should only use your own.
- Avoid using DNA obtained by laboratory suppliers from mammalian sources.
- Carry out electrophoresis at voltages below 30V AC or DC unless the design of tank is such that it is impossible to open the tank when a current is flowing or accidentally touch a live conductor.
- Use agarose gels. If polyacrylamide gels are used, buy ready-made ones.
- Use safe stains such as methylene blue, Azure A or B or Nile blue sulfate. Avoid using ethidium bromide as a stain.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could a culture become contaminated? Could microorganisms escape?
- How serious would it be if something did go wrong?
  eg could somebody receive an electric shock from damaged or unsuitable equipment?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Spilt on the floor, bench, etc	For spills of DNA extracts, place paper towels over the spill, pour disinfectant (eg Virkon) on top and leave for at least 15 minutes.

Genetic modification

See also CLEAPSS *Student Safety Sheets 1: Microbiology* and *77: Working with DNA*

Substance	Hazard	Comment
Genetic modification	⚠ **DANGER**	In law, genetic modification is the alteration of genetic material (DNA or RNA) by means that could not occur naturally by mating and/or recombination. Throughout most of the world, the use of genetically modified organisms (GMOs) is controlled by law. In the UK, separate regulations control work with GMOs in the laboratory and their deliberate release into the environment. Before genetic modification (other than 'self-cloning') is undertaken, the premises must be registered and approved by the HSE and other procedures put in place. Some procedures used in schools in the USA, or found on the internet, would be illegal in the UK.
'Self-cloning' (plasmid transfer) (Plasmids are small rings of DNA, comprising just a few genes)	⚠ **DANGER**	Returning genetic material to a species in which it could occur naturally is called self-cloning; cloning here means making copies of plasmid DNA within an organism, even if the DNA has been modified by enzymes, chemicals, etc. Providing the resulting organism is unlikely to cause disease in humans, other animals or plants no HSE registration is needed. It is still illegal to release the GMO into the environment without approval and so it must be contained. The law requires GMOs to be inactivated after use by validated means, ie by steam sterilisation.
Incubation	☣ **BIOHAZARD**	Although schools normally avoid incubating at 37°C because of the risk of promoting the growth of pathogens, the particular strains of E. coli used for cloning work will not grow quickly or reliably at other temperatures. Hence very strict adherence to good microbiological practice is essential.

Typical control measures to reduce risk

- Do not seal cultures completely before incubation (otherwise hazardous anaerobic bacteria may be encouraged) but make sure they cannot be opened accidentally.
- Use sterile equipment and aseptic technique (eg by flaming loops and mouths of bottles, etc).
- Avoid draughts (from open windows and doors) which could contaminate cultures.
- Work near Bunsen burner flames so that the updraught helps to prevent contamination of cultures.
- After work is complete, treat surfaces using a suitable disinfectant for a sufficient length of time, for example 1% Virkon for at least 15 minutes.
- Dispose of cultures by sterilisation in an autoclave (pressure cooker).
- Always wash hands after using cultures.
- Wear a clean lab coat or overall to protect cultures from microbes on the skin, clothing, etc.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could a culture become contaminated? Could microorganisms escape?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• Spilt on the floor, bench, etc	For spills of cultures, place paper towels over the spill, pour disinfectant (eg 1% Virkon) on top and leave for at least 15 minutes.

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Alkali metals

lithium, sodium *and* potassium

Substance	Hazard		Comment
Lithium (metal) *solid*	**FLAMMABLE**	**CORROSIVE**	DANGER: It causes severe skin burns and eye damage; in contact with water releases flammable gases which may ignite spontaneously; reacts violently with water. With water produces hydrogen, an extremely flammable gas (see CLEAPSS *Student Safety Sheet 50*). Although difficult to ignite, once lit, it burns readily in air and is difficult to extinguish. It reacts violently with many substances.
Sodium (metal) *solid*	**FLAMMABLE**	**CORROSIVE**	DANGER: It causes severe skin burns and eye damage; in contact with water releases flammable gases which may ignite spontaneously; reacts violently with water. With water produces hydrogen, an extremely flammable gas (see CLEAPSS Student Safety Sheet 50). It burns vigorously and is difficult to extinguish. Contact with moisture produces sodium hydroxide which is corrosive (see CLEAPSS Student Safety Sheet 31). It reacts violently with many substances.
Potassium (metal) *solid*	**FLAMMABLE**	**CORROSIVE**	DANGER: It causes severe skin burns and eye damage; in contact with water releases flammable gases which may ignite spontaneously; reacts violently with water. With water produces hydrogen, an extremely flammable gas (see CLEAPSS Student Safety Sheet 50). It burns vigorously and is difficult to extinguish. Contact with moisture produces potassium hydroxide which is corrosive (see CLEAPSS Student Safety Sheet 31). It reacts violently with many substances. Over a period of years, it may develop a coating of yellow superoxide. Under slight pressure, eg, from a knife blade, this may explode.

Typical control measures to reduce risk

- Store alkali metals under liquid paraffin (mineral oil) and check there is sufficient liquid.
- Check potassium samples regularly for signs of custard yellow coating; if found dispose of the sample safely.
- Handle sample using forceps, wear eye protection and use safety screens.
- Conduct all investigations on a small scale - generally use a rice grain sized piece.
- Make sure everybody involved (eg technicians clearing away) understands the hazards.
- Take steps to prevent theft.
- Ensure a container of **dry** sand is available at all times for smothering metal fires.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could molten, corrosive metal spit out of a container?
- How serious would it be if something did go wrong?
  Note: There are occasional reports of pupils being taken to hospital following explosion of apparatus during practicals involving sodium. Injuries include cuts and/or chemical splashes.
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111. If it is necessary to go to hospital, continue washing the eye during the journey in the ambulance.
• In the mouth/ swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
• Spilt on the skin or clothing	Remove any pieces of solid with forceps. Irrigate the affected skin area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111.
• Metal catches fire	Smother with clean, dry sand. Have a container of this sand to hand.
• Spilt on the floor, bench, etc	Scoop up as much metal as possible into a dry container. Cover the area with dry sand or anhydrous sodium carbonate and scoop into a dry bucket for further treatment. Rinse the area with plenty of water and mop.

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Group 2 metals

magnesium and **calcium**

Substance	Hazard	Comment
Magnesium (metal) *Solid (powder, turnings, ribbon)*	**FLAMMABLE**	DANGER: (*powder*, *turnings*) flammable solid, self-heating in large (kilogram) quantities; may catch fire; contact with water releases flammable gases. *Ribbon* – classification varies – may be as *powder/turnings* or may be *Currently not classified as hazardous.* It is moderately difficult to ignite but, once burning, it does so very vigorously and is difficult to extinguish. Ordinary fire-fighting methods are not suitable, but dry sand may be used. The flame is very bright and may damage eyesight. View through shade 9 welding filter **only**. It reacts readily with acids to produce hydrogen, an extremely flammable gas (see CLEAPSS *Student Safety Sheet 50*).
Calcium (metal) *solid*	**HIGHLY FLAMMABLE**	DANGER: In contact with water releases flammable gases. It reacts readily with water (or acids) to produce hydrogen, an extremely flammable gas (see CLEAPSS *Student Safety Sheet 50*). Contact with moisture forms calcium oxide or hydroxide which are CORROSIVE to eyes IRRITANT to skin (see CLEAPSS *Student Safety Sheet 32*). It is difficult to ignite but, once burning, does so vigorously.

Typical control measures to reduce risk

- Conduct all experiments on a small scale.
- Keep careful control of stocks to prevent theft.
- Wear eye protection.
- NEVER look directly at magnesium when it is burning: view through a passive welding filter lens, shade 9

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg is there the possibility of theft or foolish behaviour?
- How serious would it be if something did go wrong?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	If magnesium powder or calcium contaminates the eyes, irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• In the mouth/swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
• Skin burnt by burning metal or by moist calcium	Remove any pieces of solid with forceps. Irrigate the affected skin area with gently-running tap water for at least 20 minutes. If a large area is affected or symptoms occur, call 999/111.
• Metal catches fire	Smother with clean, dry sand. Have a container of this sand to hand.
• Spilt on the floor, bench, etc	Scoop up as much metal as possible into a dry container. Wipe the area with a damp cloth which (for calcium) should then be placed in a bucket of water.

Sulfur and **phosphorous**

Substance	Hazard	Comment
Sulfur *Solid*	**IRRITANT**	WARNING: Causes skin irritation. Some suppliers may also classify it as a flammable solid. Under the Explosives Regulations it is illegal to make mixtures with potassium chlorate(V) or other chlorates, without the prior approval of the Health & Safety Executive. Yellow crystals of sulfur occur in volcanic regions. In Victorian times, children were fed a mixture of brimstone (sulfur) and treacle, to do them good! Sulfur burns to form sulfur dioxide gas (TOXIC) (see CLEAPSS *Student Safety Sheet 52)*. Asthmatics are particularly vulnerable. When melting sulfur or heating it, for example with iron, insert a plug of mineral wool in the mouth of the test tube to prevent sulfur vapour escaping and igniting.
Phosphorus (red) *solid*	**FLAMMABLE**	DANGER: Flammable solid; harmful to aquatic life with long-lasting effects. Under the Explosives Regulations it is illegal to make mixtures with potassium chlorate(V) or other chlorates, without the prior approval of the Health & Safety Executive. May be explosive when mixed with oxidising substances. It has been used in the heads of some matches.
Phosphorus (yellow/white) *solid*	**FLAMMABLE** **TOXIC** **CORROSIVE** **ENVIRON. HAZARD**	DANGER: catches fire spontaneously if exposed to air; fatal if swallowed or inhaled; causes severe skin burns and eye damage; very toxic to aquatic life. For a 15 minute exposure, the concentration in the atmosphere should not exceed 0.3 mg m^{-3}. Under the Explosives Regulations it is illegal to make mixtures with potassium chlorate(V) or other chlorates, without the prior approval of the Health & Safety Executive. It has a long history of causing poisoning, for example amongst workers using phosphorus to make matches. When handling it, have copper(II) sulfate(VI) solution (0.2 M to 0.5 M) available to remove specks on clothing, bench etc. It is used in incendiary bombs. When it burns, corrosive fumes are formed. Phosphorus fires are difficult to extinguish; smother with dry sand. It must be stored under water (or under an inert gas). When cutting phosphorus, do this under water, otherwise friction ignites it. It is hard to cut; do this in a strong container, for example a mortar or plastic bowl – not glass, which is too fragile.

Typical control measures to reduce risk

- Wear eye protection when handling phosphorus or when heating or burning sulfur. Use small amounts.
- Avoid breathing fumes of sulfur dioxide, for example use a fume cupboard or prevent sulfur vapour from igniting by using a mineral wool plug in the mouth of a test tube.
- Wear protective gloves if handling yellow/white phosphorus; store and handle it in the absence of air.

Assessing the risks

- What are the details of the activity to be undertaken? What are the hazards?
- What is the chance of something going wrong?
  eg could sulfur vapour form? Could it ignite?
- How serious would it be if something did go wrong?
  eg could people be exposed to sulfur dioxide gas?
- How can the risk(s) be controlled for this activity?
  eg can it be done safely? Does the procedure need to be altered? Should goggles or safety spectacles be worn?

Emergency action

In all emergency situations, alert the responsible adult immediately. Be aware that actions may include the following:

• In the eye	Irrigate the eye with gently-running tap water for at least 20 minutes. Call 999/111.
• Vapour breathed in	Remove the casualty to fresh air. Call 999/111 if breathing is even slightly affected.
• In the mouth/ swallowed	Do no more than rinse and spit with drinking water. Do not induce vomiting. Call 999/111.
• Spilt on the floor, bench, etc	For sulfur or red phosphorus, brush up. For yellow/white phosphorus, cover with sand to prevent ignition. Soak in copper(II) sulfate(VI) solution until there is no further reaction, then brush up.

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Vocabulary

aerosol	Very tiny droplets of liquid floating in a gas (usually air). Diseases are often spread by coughing and sneezing, which results in an aerosol containing microorganisms.
allergy	Some people are allergic to particular substances. Their bodies' immune system reacts to these substances to an unusual extent, resulting in skin rashes, runny noses, wheezing or even shock.
asthma	A common lung condition that causes occasional breathing difficulties.
auto-ignition point	The temperature at or above which vapour from a liquid will inflame spontaneously in the presence of air.
biohazard	May cause disease or harm in humans.
carcinogen	A substance which may cause cancer, if breathed in, swallowed or absorbed via the skin.
corrosive	A substance which may destroy living tissue, causing burns.
COSHH	Control of Substances Hazardous to Health Regulations which aim to limit the exposure of employees and others in the workplace to hazardous substances which may damage their health.
EHT	Extra High Tension. See HT.
explosive	Substances that may explode because of heat, fire, friction or shock.
eye protection	This includes safety spectacles, goggles and face shields. Goggles (or face shields) give better protection against chemical splashes and should always be used for anything which is CORROSIVE or TOXIC.
flammables	Substances which burn easily.
flash point	The lowest temperature at which a liquid gives off vapour at the surface in sufficient quantity to ignite with air when a spark or flame is applied.
GHS	Globally Harmonised System (of hazard symbols and safety information). See CLEAPSS *Student Safety Sheet 91*.
harmful	Similar to the effects of toxic substances, but larger quantities are needed to produce an effect.
HT	High Tension (high voltage); power packs used in schools may deliver more than 30 V at a current of more than 5 mA. These are less safe than EHT power packs, which have an output of up to 5 or 6 kV but the current is limited to 5 mA or less.
ionising radiation	Radiation which, when absorbed by a substance, including living tissue, causes some of the molecules to turn into ions.
irritant	A substance (including a dust) which behaves in a similar way to corrosives but, instead of destroying living tissue, causes significant inflammation (reddening) through immediate, prolonged or repeated contact with the skin or a mucous membrane (eg eyes, lungs, etc).
M	Molarity – a way of measuring concentration. More correctly written as mol dm^{-3} or moles per litre. An ammonia solution which is 2 M has twice as many molecules of ammonia dissolved in the water as a solution which is 1 M.
mg m^{-3}	Concentrations of pollutant gases in air are sometimes measured as x milligrams of pollutant per cubic metre of air. An alternative unit is ppm, parts per million.
mineral absorbent	When clearing up spills of chemicals it is often useful to soak them up on something inert (unreactive). Sand can be used, but other substances soak up more, eg clay in the form of some types of grey 'cat litter' (familiar to those who keep cats as pets).
mutagen	A substance which may cause genetic defects.
oxidising agent	A substance which helps other substances to burn or explode.
pathogen	An organism which causes disease.
sensitising	A further exposure to a sensitising substance will produce an unusually severe reaction, even when the dose or the exposure time is less than the first exposure.
toxic	A substance which, in very small quantities, may cause death or damage to health when breathed in, swallowed or absorbed via the skin.
teratogen	A teratogen is any medication, chemical, infectious disease or environmental agent that might interfere with the normal development of a fetus and result in the loss of a pregnancy, a birth defect or a pregnancy complication.
v/v	A crude measure of concentration. A 10% v/v methanol solution contains 10 cm^3 of methanol in 100 cm^3 of the solution.
w/v	A crude measure of concentration. A 10% w/v sodium chlorate(I) solution contains 10 grams of sodium chlorate(I) in 100 cm^3 of the solution.

91a
Chemical safety symbols

Containers of hazardous chemicals must be labelled according to the ‘globally harmonized system’ (GHS). The diamond-shaped symbol will be accompanied by:

- a signal word (DANGER, WARNING or nothing),
- up to 6 hazard statements (H-statements, explaining the nature of the hazard) and
- a number of precautionary statements (giving advice on transferring/dispensing the chemical).

Symbol	Official name	Meaning	Some examples you might find in school
	GHS01	**EXPLOSIVE**	Tollen’s Reagent (ammoniacal silver nitrate) if allowed to stand.
	GHS02	**FLAMMABLE**	Zinc and aluminium dust, hydrogen, ethanol, methanol, propanone, sodium.
	GHS03	**OXIDISING**	Potassium manganate(VII) solid, ammonium nitrate solid, oxygen gas, nitrogen monoxide, nitrogen dioxide, chlorine.
	GHS04	**GAS UNDER PRESSURE**	Hydrogen, oxygen.
	GHS05	**CORROSIVE**	Concentrated acids, some dilute acids (depending on concentration), concentrated alkalis, some dilute alkalis (depending on the concentration), sulfur dioxide gas, nitrogen monoxide, nitrogen dioxide, sodium.
	GHS06	**(ACUTELY) TOXIC**	Solid barium chloride, most mercury compounds, sulfur dioxide gas, nitrogen monoxide, nitrogen dioxide, chlorine, methanol.
	GHS07	**MODERATE HAZARD** **(eg harmful if inhaled or in contact with the skin, causes eye irritation)**	Some dilute acids or alkalis (depending on concentration), iodine solid and concentrated solutions, propanone.
	GHS08	**HEALTH HAZARD** **(eg sensitisers, carcinogens)**	Most lead compounds and their solutions, most chromates and dichromates, dichloromethane, methanol.
	GHS09	**ENVIRONMENTAL HAZARD**	Most copper, mercury and lead compounds, and chromates and dichromates.

The chemical hazard symbols below (known as CHIP 4) are no longer used but may still be found on some old containers.

CORROSIVE

TOXIC

HARMFUL or **IRRITANT**

EXPLOSIVE

EXTREMELY or **HIGHLY FLAMMABLE**

OXIDISING

ENVIRONMENTAL HAZARD

Note: some of these symbols (eg TOXIC) displayed inside a yellow triangle can be found where chemical containers are not involved. See CLEAPSS *Students Safety Sheets 91b*.

Student safety sheets 91b

Non-chemical safety signs and symbols

The *Health and Safety* (*Safety Signs and Signals*) *Regulations* define what the law requires. There is some additional information in the British/International Standard, BS ISO 7010:2011, *Graphical symbols – Safety colours and safety signs – Registered Safety Signs*.

Safety signs which are circular are **mandatory** (you **MUST**) or **prohibitory** (you **MUST NOT**).

- **Mandatory** signs have a white pictogram on a *blue* background
- **Prohibitory** signs have a black pictogram on a *white* background, with red edging and diagonal line.

	**You MUST wear eye protection.**		**You MUST NOT have naked flames.**
	**You MUST wear protective gloves.**		**You MUST NOT drink water from this tap.**
	**You MUST wash your hands**		**You MUST NOT put water on a fire**

If there is no standard sign available you can design your own but it must conform to the general principles and must have a sign board that explains it in words.

	**You MUST do this…**		**You MUST NOT do this…**

Other signs give advice or information.

- **Hazard information** signs are triangular and have a *yellow* background
- **Emergency** and **first aid** signs have a white pictogram on a *green* rectangle
- **Firefighting** signs have a white pictogram on a *red* rectangle

	**RISK OF ELECTRIC SHOCK**		**DANGER** (needs a signboard to spell out the type of danger)
	**RADIOACTIVE**		**BIOHAZARD**
	**COLD**		**TOXIC** (not on a chemical container, eg seeds)
	**LASER BEAM**		**STRONG MAGNETIC FIELD**
	**FIRST AID**		**FIRE EXIT ROUTE**
	**EYE WASH STATION**		**ELECTRICAL CUTOFF**
	**FIRE EXTINGUISHER**		**FIRE BLANKET**

Using a Bunsen burner

For heating non-flammable liquids and solids, see CLEAPSS *Student Safety Sheet 93*
For heating flammable liquids and solids, see CLEAPSS *Student Safety Sheet 94*
For handling hot liquids in beakers, see CLEAPSS *Student Safety Sheet 95*

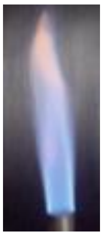
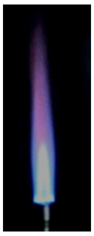
Using a Bunsen burner

- Tie any long hair back to avoid it catching fire.
- Make sure your clothing does not get in the way of the flame and don’t lean over a flame to reach other apparatus.
- Wear eye protection.
- Place the Bunsen burner on a heat resistant mat 30 to 40 cm from the edge of the bench.
- Make sure the air hole is closed (unless you are lighting the gas with a piezo-electric lighter, in which case air hole should be half open).
- Attach the gas tubing to the gas tap.
- Light a match or a wooden splint from a central flame. (Do not walk around the laboratory with wooden splint alight.)
- Turn on the gas tap.
- Keeping your head well away from the Bunsen burner, use the match or lighted splint to light the gas coming up the Bunsen burner chimney.
- Do not allow solids to drop into the Bunsen burner as these will clog the gas jet or the collar at the top of the chimney.

When you have finished:

- Make sure the air hole is closed and the flame is yellow.
- Switch the gas off.
- Remove the tubing by putting your fingers on the tubing around the gas tap nozzle and pulling. Don’t pull the tubing off by stretching it.

Types of flame

Type of flame	Gas tap	Air hole	Appearance	Hazards	When used
Yellow flame	Fully (or partly) open	Closed		This flame is still hot if you put your hand into it.	To light the burner and when it is not being used to heat anything because is easy to see and will not readily set fire to clothing etc. This flame is unsuitable for heating as it coats surfaces with soot (carbon).
Gentle flame *Yellow just disappears; pale lilac, almost invisible.*	Half open	Partly closed		It is difficult to see the flame in bright sunlight. Some risk of blowing out.	For general heating. Start with the gentle flame and then open the gas tap fully to give the medium flame.
Medium flame *Yellow just disappears; pale lilac, almost invisible.*	Fully open				
Roaring flame *Inner cone blue, outer cone lilac.*	Fully open	Fully open		It is difficult to see the flame in bright sunlight. Some risk of blowing out. Do not partly close the gas tap if the air hole is fully open as this will extinguish the flame.	For very strong heating (which is not very often needed). The hottest section of the flame is just above the blue cone of unburnt gas.

Heating non-flammable liquids and solids in test tubes

For using Bunsen burners and especially use of different flames, see CLEAPSS *Student Safety Sheet 92*
For heating flammable liquids and solids, see CLEAPSS *Student Safety Sheet 94*
For handling hot liquids in beakers, see CLEAPSS *Student Safety Sheet 95*

Test tube holders

- Test tube holders (metal wire design shown on the right) must have the O-ring in the correct place, so that the clamping ends cannot slip apart.
- Wooden peg-type test tube holders are also suitable if they are not badly burnt.
- Tongs should not be used for holding test tubes. Tongs are intended for crucibles.

The test tube holder shown does not have the O-ring in the correct position (circled) and should not be used.

Heating non-flammable solids in test tubes

- Wear eye protection.
- Do not have the test tube more than one-fifth full of solid.
- If the solid is a powder, agitate it so that it is sloped in the test tube.
- Using a suitable holder, which is in good condition, keep the test tube pointing just up from the horizontal.
- Take care that the test tube is not pointing directly at yourself or anybody else.
- Hold the test tube so that the bottom is just in the tip of the flame and the top is well clear of the flame.
- Start with a gentle flame (see CLEAPSS *Student Safety Sheet 92*), increase to a medium flame and then a roaring flame, if necessary.

Heating non-flammable liquids in test tubes

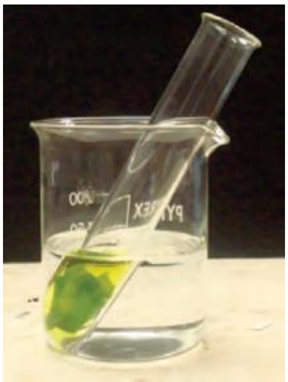
- Wear eye protection.
- If possible, use a wide-diameter test tube (usually called a boiling tube).
- Do not have the test tube more than one-tenth full (it is much less likely to boil over).
- Add an anti-bumping granule (‘boiling chip’) before starting to heat (but never add one when it is already warm, which might result in it frothing up).
- Using a suitable holder, which is in good condition, keep the test tube at an angle.
- Take care that the test tube is not pointing directly at yourself or anybody else.
- Hold the test tube so that the bottom is just at the tip of the flame and the top is well clear of the flame.
- Start with a gentle flame (see CLEAPSS *Student Safety Sheet 92*) and increase to medium flame only if necessary.
- Flick your wrist continuously but gently so that the liquid is agitated all of the time that it is being heated.

Heating flammable liquids and solids in test tubes

For using Bunsen burners and especially use of different flames, see CLEAPSS *Student Safety Sheet 92*
For heating non-flammable liquids and solids, see CLEAPSS *Student Safety Sheet 93*
For handling hot liquids in beakers, see CLEAPSS *Student Safety Sheet 95*

Heating flammable liquids

For example, when extracting chlorophyll from leaves.



- Wear eye protection.
- If possible, use a wide-diameter test tube (boiling tube).
- Add an anti-bumping granule ('boiling chip') before starting to heat.
- **Do not heat directly over a naked flame**. Instead, stand the test tube in a beaker half filled with freshly boiled water from a kettle.
- (If necessary, boil the water in the beaker using a roaring flame; then extinguish the flame before the flammable liquid is put into the hot water. Also, see below.)
- It is always better to allow the apparatus to cool down before removing the test tube but this can take a long time.
- If necessary, take hold of the test tube with a holder or a piece of folded paper carefully placed around the top of the test tube. Slowly and carefully lift the test tube out of the hot water into a test tube rack.

Heating flammable (organic) solids

For example, heating wax or salol for cooling curves.

Do not heat the wax or salol directly over a naked flame. The tube will be heated quickly and locally to a very high temperature. If a 'spirit' thermometer is used, the spirit vaporises and the glass explodes under the increase in pressure. In addition, the boiling tube may break and the contents catch fire.

- Wear eye protection.
- Use a test tube or boiling tube. Test tubes contain less solid and so take a shorter time for the contents to melt and cool. (It took 6 -7 minutes for the wax to melt in the boiling tube on the right.)
- Do not have the test tube more than half full of wax or salol.
- Fill a 250 cm^3 beaker half full with hot water from a kettle.
- (If necessary, boil the water in the beaker using a roaring flame; then extinguish the flame before the flammable solid is put into the hot water. Also see below.)
- After the activity is completed allow the equipment to cool as much as possible.
- If necessary, take hold of the test tube with a holder or a piece of folded paper carefully placed around the top of the test tube. Slowly and carefully lift the test tube out of the hot water into a test tube rack.

If you have to heat the water with a Bunsen burner (ie not a kettle)

- At the end of the activity, first get the beaker onto the heat-resistant mat – see CLEAPSS *Student Safety Sheet 95.*
- Then remove the boiling tube using a good test tube holder, as described above.
- This method of heating takes about the same time to melt the wax as using water boiled in a kettle and so offers no real advantage.

Note that a thermometer standing in a beaker on a tripod has a high likelihood of being knocked over.

Handling hot liquids in beakers

For using Bunsen burners and especially use of different flames, see CLEAPSS *Student Safety Sheet 92*
For heating non-flammable liquids and solids, see CLEAPSS *Student Safety Sheet 93*
For heating flammable liquids and solids, see CLEAPSS *Student Safety Sheet 94*

Heating liquids in beakers

- Wear eye protection.
- Set up the apparatus 30-40 cm back from the edge of the bench.
- Do not fill the beaker more than half full.
- If available, add an anti-bumping granule ('boiling chip') to the liquid before heating. Do **not** add an anti-bumping granule once the liquid is boiling.
- Place a tripod and gauze on a heat resistant mat.
- Place the beaker of liquid on the gauze.
- Place the Bunsen burner on the mat to the side of the tripod and attach the Bunsen burner to the gas.
- Light the Bunsen burner and open the air hole.
- Holding the hose, move the Bunsen burner under the beaker.
- If the air hole needs adjusting, move the Bunsen burner out from under the beaker, make the adjustment and return the Bunsen burner to position. Do **not** place hands underneath hot equipment in case of unexpected breakages or spills.
- Once the liquid begins to boil, close the air hole to half open and turn the gas tap down.
- At the end, it is always better to allow the apparatus to cool down naturally. However, this can take a long time. If time is short use one of the procedures described below.
- The tripod will be very hot – only hold at the bottom of the legs, never the triangle at the top. Take care.

Removing hot beakers

- To remove very hot beakers of liquid from a tripod, the teacher/technician should wear thermal protection gloves and go around the laboratory moving the beakers for each group of students.
- If this is not possible, beakers are best left where they are until cooler.

For less hot beakers, *skilled* students can use the procedure illustrated below

- Switch off the gas.
- Place a commercial 'J-cloth' loosely around the hot beaker.
- Carefully tighten the cloth.
- Lift the beaker onto the heat resistant mat.

96a

Risk assessment

What is risk assessment?

A risk assessment is a judgment of how likely it is that someone (anyone) might come to harm if a planned action is carried out. The law requires the likelihood of harm to be reduced to as low as is reasonably practicable. Risk assessments, although an excellent idea for all of us, are only legally required for actions which take place at work. The significant findings of risk assessment must be recorded. (You must show the answer, you don't have to show your workings).

You carry out risk assessments all the time, for example when riding a bike or crossing the road. When riding a bike in the UK you can choose whether you wear a cycling helmet. However, because risk assessments are required at work, paid cycling couriers will wear helmets. The risk of them being knocked off their bike is quite high but a helmet reduces the likelihood of head injury.

Who is responsible for risk assessment?

In law, risk assessment is the responsibility of the employer. The employer can ask employees to assess risks, if they have been trained. However, the employer must then check from time to time that it is being carried out correctly. Students can be asked to draw up a risk assessment as part of their education, but it must always be checked by teachers before being put into effect. By law, everybody in a work situation must take care of their own safety and that of other people, and employees must do what their employer requires on health and safety matters.

Model risk assessments

In schools and colleges, the employer usually makes use of model (or general) risk assessments written for them by national organisations (such as CLEAPSS). Model risk assessments give sufficient details of a procedure to enable it to be carried out safely – equipment, amounts, safety precautions, etc. However, teachers (or other employees) must consider whether the model assessment needs to be adapted slightly to the particular circumstances of their own situation, eg the nature of the building or equipment used, the proximity of other students, etc. An activity considered suitable in the model risk assessment being carried out in the open laboratory might not be suitable in a laboratory with poor ventilation.

How do you 'do' a risk assessment?

To make a risk assessment you need to know the **hazards** and the **risk** of them causing harm in the planned activity.

A **hazard** is anything which could cause harm. For example, some chemicals, electricity at high enough currents, glass (if it breaks) and even you running in the corridor are all hazards because they can all cause harm. Although sometimes you can use your common sense to identify a hazard, often you will need specialist information, eg as provided on CLEAPSS Student Safety Sheets or on chemical suppliers' Safety Data Sheets.

The **risk** is the likelihood that a hazard would cause significant harm. It is a matter of judgment and depends on:

- how likely it is that something would go wrong with this hazard;
- how serious any resulting injuries would be; and
- how many people would be affected.

To reduce the risks to an acceptable level, we put in place relevant control measures. These are the safety precautions used to reduce the risk of harm. In science we often wear safety spectacles or use fume cupboards. We also minimise the quantities of materials used and the concentration of hazardous solutions.

What should you do when making a risk assessment?

When making a risk assessment, go through the following process.

1. Consider what materials you are working with and what procedures you are you following. You could list them on the CLEAPSS *Student Form for Assessing Risk*. Think about microorganisms, heavy weights, electricity, chemicals (how much of each, what concentration of solutions), hot objects. You should also try to find out if there are any hazardous materials produced by your procedure - you may need to ask your teacher!
2. For each of the materials and procedures, ask what are the hazards? Add them to your list. What could possibly go wrong? Look up the materials and procedures in reliable and relevant sources, eg CLEAPSS *Student Safety Sheets*.
3. How many people could be affected if it went wrong? Who would they be?
4. What control measures (safety precautions) would you adopt? Check relevant CLEAPSS *Student Safety Sheets*.
5. Make sure you record anything important and especially the control measures.
6. Have the result of the risk assessment checked by your teacher before you carry on.

Science Safety Certificate

Name ………………………………………………………………… **Form/Tutor Group** ………………………………………………

I can carry out the following with due regard to safety.

Task/Skill	**Teacher's signature**	**Date**
Behave sensibly during practical sessions		
Wear safety spectacles or goggles when appropriate		
Recognise and understand the hazard symbols		
Control a Bunsen burner		
Heat a liquid in a boiling tube		
Heat a liquid in a beaker using a tripod and gauze		
Locate the position of the eye wash in the laboratory		
Measure and pour dilute acids		
Deal with an acid spill		
Check that mains plugs have the correct fuse & are correctly wired		
Explain why each of the Lab Safety Rules is needed		

Student form for assessing risk

Proposed practical activity	
Name(s) of student(s) completing form	
Class/set	
Date	

Hazardous chemical or microorganism being used or made, or hazardous procedure or equipment	**Nature of the hazard(s)**	**Sources(s) of information**	**Control measures to reduce risk**

Checked by:	**Date:**

Student safety sheets

Student form for assessing risk

Proposed practical activity	Making copper sulfate crystals from copper oxide or copper carbonate
Name(s) of student(s) completing form	
Class/set	
Date	

Hazardous chemical or microorganism being used or made, or hazardous procedure or equipment	**Nature of the hazard(s)**	**Sources(s) of information**	**Control measures to reduce risk**
1) Sulfuric acid	(1) Acid is corrosive if 1.5 M or more; irritant if 0.5 M or more.	(1) Bottle label; CLEAPSS Student Safety Sheets.	(1) Use lowest possible concentration, 0.5 M; wear eye protection.
2) Copper carbonate	(2) (a) The solid is harmful if swallowed and dust irritates lungs and eyes. (b) When the reaction takes place, tiny bubbles of carbon dioxide are formed which may produce a spray of sulfuric acid as they burst.	(2) (a) Bottle label; CLEAPSS Student Safety Sheets. (b) Text book; teacher.	(2) (a) Avoid raising dust; wear eye protection. (b) Keep face well away from reaction; wear eye protection.
3) Copper oxide	(3) (a) The solid is harmful if swallowed and dust irritates lungs and causes serious damage to eyes. (b) Unlike copper carbonate, copper oxide needs to be heated so mixture may boil over, spill hot acid, etc. (c) Hot tripods, etc.	(3) (a) Bottle label, CLEAPSS Student Safety Sheets. (b) Teacher; text book. (c) Teacher; past experience.	(3) (a) Wear eye protection, (b) Control Bunsen-burner flame; stir to speed dissolving; stand up throughout process. (c) Pay attention.
4) Copper sulfate	(4) Solid and solutions more concentrated than 1 M are irritant and cause serious eye damage. The solid is harmful if swallowed.	(4) CLEAPSS Student Safety Sheets.	(4) Wash hands after activity; when solution is standing to crystallise label it carefully.
5) Evaporating solution to form saturated solution	(5) (a) Solution may boil over, or start spitting when nearly saturated. (b) Hot tripods, etc. (c) Process is slow, leading to rushing at end of lesson and accidents.	(5) (a) Teacher; past experience. (b) Teacher; past experience. (c) Teacher; past experience.	5) (a) Keep careful watch over Bunsen burner. Do not evaporate too much - allow to crystallise slowly. Wear eye protection. (b) Pay attention. (c) Use small volume, so it is quicker

Checked by:	**Date:**

Student form for assessing risk

Proposed practical activity	
Name(s) of student(s) completing form	
Class/set	
Date	

A **hazard** is anything which could cause harm, eg, a hot tripod, a cluttered floor.

A **risk** is the likelihood of harm actually being caused.

Use the CLEAPSS *Student Safety Sheets*, the practical instructions and the labels on the bottles to fill in this form.

Hazardous chemical or procedure	**Type of hazard**	**Control measures to reduce the risk**

Checked by:	**Date:**

Student form for assessing risk

Proposed practical activity			
Name(s) of student(s) completing form			
Class/set		**Date**	

Hazardous chemical or microorganism being used or made, or hazardous procedure or equipment	**Nature of the hazard(s)**	**Source(s) of information**	**Control measures to reduce the risks**	**Emergency procedure**

Checked by:	**Date:**

96b
Emergency actions

Emergencies

Emergencies are incidents that need to be dealt with immediately to minimise damage occurring. In all emergency situations, alert the responsible adult immediately (usually the teacher). They will assess, respond to and manage the situation. This will include using Immediate Response Measures (IRMs). Being aware of how emergencies are dealt with can help to reduce the risk of your practical activities, and support the responsible adult in dealing with emergencies.

1. Make sure that you are prepared in case an emergency arises

- Know what might go wrong, and ensure your risk assessment has reduced the risks.
- Know how to call for help if something goes wrong (alert the teacher).
- Know how to recognise danger and how to keep safe.
- Know who can deal with emergencies (the teacher or technician).

2. Dealing with an incident (general strategy)

Alert the teacher and they will carry out the following steps:

- Assess – is it safe to proceed? If not, evacuate.
- Prioritise – is anyone injured? Can further damage be avoided?
- Act quickly – make sure casualties are taken care of, and do what you can to reduce further damage. Clear up any spills.
- Continue to monitor and assess – watch out in case the situation changes.
- If unsafe at any time, evacuate and call for help.
- Report the incident – say what happened, what was done, and what you would do to avoid a repeat in future.

3. Immediate response measures (IRMs)

In the event of emergencies, teachers/technicians will use immediate response measures. The individual Students Safety Sheets include specific IRMs. General IRMs include:

- Irrigation – flooding the affected area with **gently-running** water. Using plenty of water will minimise any damaging effects.
- Hair and/or clothes on fire – get the person to stop, drop and roll.
- Burns – cool burn for at least 20 minutes with gently-running water and until pain is relieved and heat is no longer felt.
- Severe cuts – control bleeding with pressure and by raising the wound.
- Asthma attack / anaphylactic shock – support and protect the person and follow school’s agreed procedures.
- Fainting/epileptic fit/loss of consciousness – support and protect the person.
- Electric shock – isolate the person from the supply and call 999.

4. Fires

- Alert the teacher who will assess the situation.
- If unsafe, evacuate and isolate the area.
- If safe to do so, switch off ignition/fuel sources, and extinguish the flames.

5. Spills

- Alert the teacher who will assess the situation.
- If unsafe, isolate and secure the area.
- If safe to do so, the teacher/technician will assess, contain, collect, treat and dispose of the spill.

Transferring (handling) solid chemicals

Why 'transferring' and not 'handling'?

It is better to use the word 'transferring' as opposed to 'handling' because 'handling', if taken literally, means 'using your hands' (or fingers). Many chemicals are toxic, corrosive or irritant to the skin so directly 'handling' such chemicals is never a good idea.

Should I wear gloves?

The use of chemically resistant gloves should always be considered. However, wearing gloves reduces manual dexterity, gives rise to an environmental issue (because they do not degrade very quickly in the waste) and are expensive for the school.

More importantly, if a chemical is on the gloves, wearers may not realise it is there and so may wipe that chemical on other parts of the body (eg by rubbing their eyes).

However, if there are cuts which cannot be covered, or other skin issues on the hand, then gloves should be worn.

For a small number of chemicals which are corrosive but do not immediately produce a sensation of burning, for example phenol, they should also be worn.

Transferring solids

When transferring solid chemicals, the main risk is of spilling a hazardous solid.

A spatula is the correct tool for transferring solids from one container to another. Always check that the spatula is clean and do not use the same spatula for different solids, unless cleaned in water and dried. Spatulas come in various shapes and sizes so beware of instructions that simply say "use a spatula-full".

Nuffield spatula

This is the most common spatula used by students in schools, about 14 cm long. But with either end available for use, care must be taken in using the same end. The spatula must be cleaned and dried before changing to another chemical. The 'curved' end is the most suitable to use.

Chattaway spatula

This is available in different sizes. Students should use the small size version, about 10 cm long; teachers and technicians may use larger versions, about 20 cm long, in the preparation of solutions. There are also micro-sized versions.

Spoon Spatula and Trulla spatula (trowel spatula)

This is usually only used by technicians or teachers for transferring larger quantities of solids.

DIY spatula

A wooden splint can be used to transfer solid chemicals. The end can then be cut off with scissors and another chemical can be transferred with the same splint. The splint can be cut to a point to transfer tiny amounts of solids.

Mixing solids

The solids to be mixed should each be placed on separate pieces of paper (or in plastic weighing boats) and the solids then poured gently from one onto the other, back and forth. Repeat the pouring action about 10 times so that there is thorough mixing. This is the only safe way of preparing explosive mixtures (which might explode if stirred with a metal spatula) and is good practice for all solid mixtures.

Transferring (handling) liquid chemicals

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However, if there are cuts which cannot be covered, or other skin issues on the hand, then gloves should be worn.

For a small number of chemicals which are corrosive but do not immediately produce a sensation of burning, for example phenol, they should also be worn.

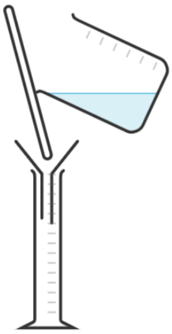
Transferring liquids

When transferring chemicals which are liquid, the main risk is of spilling or splashing a hazardous liquid or a hazardous aqueous solution.

Spills occur when people attempt to pour liquids from a large container (bottle) into a small container such as a test tube. There is a risk of liquids dribbling down the side of the bottle or measuring cylinders, possibly damaging labels, making the bottle unsafe to pick up for the unwary, or producing fumes in the store as the liquid evaporates. It is better to pour from large bottles into (labelled) beakers first.

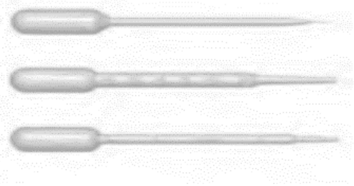
Pouring from bottles, measuring cylinders and beakers

One way of avoiding dribbles is to pour down a glass rod into a container via a funnel.



Small volumes of liquid (up to 3 cm^3)

Use plastic teat pipettes or dropping bottles.



Using automatic or volumetric pipettes

More sophisticated pipettes are available for other purposes.

Mixing liquids

Spatulas should not be used for stirring. Stirring rods made of glass or plastic should be used. Over enthusiastic stirring can cause a glass stirrer or container to break or the liquid to splash out. Some laboratories have magnetic stirrers.

Filling a test tube

If using a test tube, do not fill it more than one-fifth full. To mix the contents, hold the tube close to the open end and agitate (waggle) the test tube from side to side. Do not shake it up and down, especially not with a thumb over the end.

Waste disposal

Avoid waste	If you carry out a practical activity in a school or college you may end up with waste. Waste is anything you don't want. The best way of dealing with waste is not to create it in the first place. Take care not to contaminate a large stock bottle, for example, by putting a dirty spatula or teat pipette into it. Plan the activity so as to minimise the amount of waste you need to deal with. If there are two alternative methods, which one generates the least waste? Microscale chemistry uses much smaller quantities than traditional methods, so generates much less waste.
Waste disposal in general	Waste disposal is tightly, and expensively, regulated. Legislation distinguishes between many different categories of waste. This sheet refers mainly to the waste that might be generated in student practical work.
Recycle or re-use	Before disposing of waste, consider whether it can be recycled or re-used. Can the product you have made in this chemical reaction, eg copper sulfate, be used for some further purpose? Can an impure solvent be safely re-distilled to purify it?
Solids, including solid non-hazardous chemicals	Solids which are not hazardous and not separately classified, including non-hazardous solid chemicals, eg calcium carbonate, can be placed in the solid non-recycling waste. You have a duty of care to those handling the waste later on. For example, broken glass (if there is no separate glass collection) should be wrapped and labelled to minimise the risk of injury.
Water-soluble chemicals	If a chemical dissolves in water and is not classed as hazardous, eg sodium chloride, it can be dissolved in water and poured down the drain as effluent. Small amounts of some hazardous chemicals can be disposed of in the same way, providing the concentration is below a threshold – the limit depends on the nature of the hazard. For some chemicals, eg copper sulfate, a 10% solution is acceptable (ie not more than 10 g of the chemical in 100 cm^3 of the solution). For other chemicals, eg potassium dichromate, the maximum concentration is 0.1%. For some, eg mercury compounds, this method of disposal is completely prohibited. It is prudent to react acids or alkalis so that the effluent is roughly neutral. Similarly, react oxidising agents with reducing agents before them flushing away.
Hazardous solid chemicals	Hazardous chemicals which do not dissolve in water, eg lead oxide, or which do dissolve but are too hazardous to dispose of in this way, eg many pesticides, must be collected by a Licensed Waste Carrier for safe processing.
Non-aqueous liquid chemicals	Chemicals that are liquids that do not mix with water, eg paraffin or solvents for cleaning paint brushes, must be collected by a Licensed Waste Carrier for safe processing. Cooking oil, even although it is not regarded as hazardous, must not go down the drain because it can result in blockages in the sewers (fatbergs).
Biological waste	Much biological waste (ie plant materials) can be treated as solid waste, although ideally it should be composted. Left overs from dissections must NOT enter the food waste system. It should be wrapped in newspaper and placed in the main non-recyclable waste.
Microbiological waste	Microbiological waste needs to be steam sterilised with a pressure vessel (autoclave or pressure cooker) before disposal.
Gases	Discharging gases to the atmosphere is regarded as pollution. However, small amounts of most gases can be discharged from fume cupboards to the atmosphere. Ensure that the quantities released would not be a risk or a nuisance (eg causing an unpleasant smell) to neighbours.
Cells and batteries	Discharged cells and batteries of all types must not be disposed of as solid waste. Collection points can be found at civic amenity sites and at shops selling batteries. May cells and batteries have the 'do not discard' symbol (right).
Waste electrical and electronic equipment	No electrical and electronic equipment - from vacuum cleaners to light bulbs, from mobile phones to ammeters - can be disposed of as solid waste. These must be collected separately, either by licensed waste carriers (for businesses, including schools) or taken to a civic amenity site (usually only domestic users). Modern items should have the 'do not discard' symbol (right).
Radioactive substances	Some low-level radioactive materials can be disposed of as solid waste or effluent, as above. However, legislation is very detailed and a licensed waste carrier is usually needed.

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