

Section 3: Curriculum support documents

Curriculum support documents have been developed for those secondary KLAs which use chemicals extensively for teaching and learning purposes.

Advice is provided on teaching strategies, procedures and practical activities related to the use of chemicals. In some cases, the information in CSIS replaces advice previously issued to principals by the department

3.1: Creative arts

3.1.1: Introduction

3.1.1.1: Rationale

The information in [Section 3.1](#) has been developed to supplement [Sections 1](#) and [2](#) of the CSIS package. It is intended to assist teachers of visual arts, music, dance and drama to:

- identify chemicals which may present significant risks to people in visual and performing arts spaces
- better manage the risks associated with chemical usage in visual and performing arts spaces
- identify and manage risks associated with equipment used in visual and performing arts spaces.

3.1.2: Organising chemicals

3.1.2.1: Labelling

In addition to being stored in the correct container, all hazardous chemicals must be appropriately labelled. This is achieved either by leaving the substance in its original packaging (which must be labelled correctly by law), or by producing a label using the ChemWatch online system available with this package([Section 2](#)) and attaching the correct label to the container. In addition, colour-coded labels must be applied to identify the categories of chemical usage (see [Section 1.4](#)).

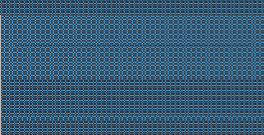

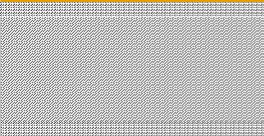
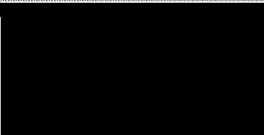
Chemicals are often purchased in bulk to save on costs. It is common for these substances to be decanted into smaller containers ready for use. This presents a problem with labelling. Purchasing a number of smaller quantities of the particular chemical in commercially labelled containers is recommended. Subsequent bulk purchases can be decanted into the correctly labelled container. This also avoids the problem of using unsuitable containers, such as food containers, to store chemicals (e.g. PVA in sauce bottles).

3.1.2.2: Storage

As outlined in **Section 1.3**, hazardous chemicals must be stored according to the requirements of the legislation. Within storage areas, separation may be required between classifications of chemicals (see Section 1.3). Creative arts teachers should recognise the dangers associated with chemical substances in use in creative arts classes. The risk can be increased by poor storage methods, especially when chemicals are left in or near the teaching area. Even small quantities can present a significant risk. Chemicals should be stored according to the advice provided in

The chemical risk assessments provide guidance on the storage controls required for hazardous chemicals. As a general principle, the below table provides guidance on the separation and segregation requirements for chemical classification types.

Class	2.1	2.2	3	4.1	4.2	4.3	5.1	5.2	6	8
2.1										
2.2										
3										
4.1										
4.2										
4.3										
5.1										
5.2										
6										
8										

Segregation key	Segregation type
	COMPATIBLE: Chemicals with similar hazards are usually compatible. However chemicals may have more than one hazard and you should still check the SDS.
	REFER TO SDS: Separation of these chemicals may be necessary. Consult the SDS for further guidance.
	MINIMUM THREE METRE SEPERATION: These chemicals may react dangerously if stored together and should be kept at least three metres apart.
	MINIMUM FIVE METRE SEPERATION: Storing these chemicals together will significantly increase the likelihood or severity of an incident. They should be kept at least five metres apart or in separate storage areas.
	ISOLATE: Dedicated storage areas or storage cabinets are recommended for self-reactive chemicals and organic peroxides, as is separation from other buildings and property boundaries.

Source: SafeWork Australia - Managing risks of storing chemicals in the workplace : Guidance Material

Creative arts staff should ensure the following.



- chemicals, such as cleaning agents and glazes, should be stored well away from food, food storage and preparation areas.
- chemicals, such as dyes and textile testing agents, should be labelled and stored in a locked cupboard.
- any utensils used for preparing and storing chemicals, such as dyes, should never be used for any other purpose, e.g. food preparation.
- small quantities of paints, lacquers, solvents and thinners should be stored in a lockable cabinet when not in use. Larger quantities should not be stored in the work space areas.

3.1.2.3: Signs

Teachers need to ensure that there is clear and consistent communication about potential hazards in all creative arts work spaces and storage areas. This can be achieved through the use of signs which comply with Australian Standards. These signs use coloured pictograms to communicate the existence of hazards to everybody in the vicinity.

GHS hazard statements and pictograms are used to identify hazards related to chemical substances. This signage should already be a part of any commercially produced container.

GHS compliant label

Flammosol		Product identifier
Contains: Aliphatic hydrocarbons 95% Toxicole 5%		Identity and proportion of each chemical ingredient
500ml		
DANGER		Signal word
		Pictograms
Highly flammable liquid and vapour Toxic if swallowed Causes skin irritation		Hazard statements
<p>Keep away from sparks and open flames. – No smoking. Wear protective gloves and eye and face protection.</p> <p>Wash hands thoroughly after handling.</p> <p>Do not eat, drink or smoke when using this product.</p> <p>Store locked up in well ventilated place. Keep cool.</p> <p>Dispose of contents / container in accordance with local regulations.</p> <p>Refer to the Safety Data Sheet before use.</p>		Precautionary statements
<p>IF SWALLOWED: Immediately call a POISON CENTRE or doctor/physician. Rinse mouth.</p> <p>IF ON SKIN (or hair): Take off contaminated clothing and wash before re-use.</p> <p>If skin irritation occurs: Get medical advice/attention. Rinse skin using plenty of soap and water.</p> <p>In case of fire: Use powder for extinction</p>		
Other useful information		
Madeup Chemical Company, 999 Chemical Street, Chemical Town, My State. Telephone: 1300 000 000		Name, address and telephone number of the Australian manufacturer or importer.

Foster a safety conscious learning environment by taking appropriate opportunities to educate students about the significance of safety warning signs and symbols.

3.1.3: Safe practice for creative arts learning environment

3.1.3.1: Lesson planning

Lessons that involve the use of chemical substances require thorough planning.

This includes:

- identifying if the substances to be used or produced are hazardous
- completing an assessment of the risks
- following department advice given in *Appendix D* about the use of the chemical
- implementing appropriate control measures
- obtaining appropriate chemicals and equipment for use during the lesson
- ensuring that all materials and equipment are available when required
- ensuring that students are wearing appropriate clothing, footwear and any other personal protection equipment required by a risk assessment
- planning for sufficient time to clear away equipment and clean up.

3.1.3.2: Preparation and maintenance of learning spaces

All creative arts learning spaces should be kept clean and the equipment and resources maintained ready for use. This includes:

- storing all tools and equipment safely
- storing all chemicals appropriately
- keeping fixed and portable machinery, tools and equipment in good order
- optimising room layout to reduce hazards
- keeping locked any storerooms used to hold chemicals. Storerooms should be kept tidy and well ventilated. The bulk of flammable liquids should be stored in a flammable liquids storage cabinet.
- seeking professional advice for the extermination of pests.

3.1.3.3: Classroom management strategies

- Students need to be aware of the safety procedures required when using chemicals. In addition to specific safety lessons or demonstrations, students should be reminded frequently about safety procedures when using chemicals.
- Eating and drinking must not be permitted during lessons where chemicals are being used.
- All students and staff should wear personal protective equipment where required by the risk assessment. Teachers should always model safe practice when working with chemical substances.
- Students' bags should not be allowed to remain in walkways. They should be left outside or locked away.
- The distribution of materials and equipment should be organised to minimise congestion.

3.1.3.4: Contingency planning

Before each lesson involving the use of chemicals, teachers should be aware of:

- the degree of sensitivity to chemicals of the students in their classes. This information can be obtained from student records or by asking the students themselves
- the correct emergency care procedures to apply in the event of a student reacting adversely to a chemical substance
- the location of fire extinguishers, fire blankets, and first aid equipment.

3.1.3.5: Emergency evacuation procedures

Emergency evacuation procedures for each learning space should be known by all staff and students. The evacuation plan for each room must be displayed clearly.

3.1.3.6: Using chemicals

(a) Containers

Containers must be appropriate for the chemical being used and have the correct labelling.

(b) Preparation of chemicals

Prepare chemicals before the lesson, wherever possible. Chemicals should be checked for condition before use.

Do not use substances that:

- have obviously deteriorated, e.g. "cracked" or oxidised. The "appearance" section of the SDS will tell you what the chemical should look like if you are not sure
- are in damaged containers or have damaged or illegible labels
- are beyond their use-by date if the chemical has one.

(c) Heating chemicals

Heating of chemicals occurs in numerous activities. Teachers must ensure that the correct technique is used for the activity, and that all safety equipment required is readily available.

Students should remain standing when carrying out heating processes, as this enables quicker escape in the case of accidents.

Flammable liquids should generally not be heated, nor should they be allowed near heating devices.

A recommended spill kit is described in Appendix E.

(d) Fumes

The generation of fumes may occur in creative arts activities. Whilst appearing to be insignificant, they can cause serious injury in the form of poisoning. This can occur via inhalation, ingestion or absorption through the skin, depending upon the type of fumes. Whenever fumes are generated, teachers need to ensure that:

- the amount of fumes developed is kept to a minimum
- the work area is well ventilated
- exhaust fans are in place and used where appropriate
- respiratory equipment is used when required.

(e) Spills and cleaning up

Spills should be cleared up immediately. Some spills can be simply cleaned up with a damp cloth, whilst others require the use of protective equipment or specific procedures, e.g. gloves and neutralising chemicals.

Flammable chemicals should not be absorbed using paper towels, as these can easily ignite.

Cat litter (clay-based not paper-based cat litter), expanded perlite or vermiculite are good absorbents for spilled chemicals, especially those which are flammable or corrosive.

Students should be encouraged to report all spills to the teacher to ensure immediate clean-up.

Ensure that facilities for washing and drying hands are readily available.

3.1.3.7: Using electric power tools

As a general principle, only teachers and students with a sound knowledge of the operating principles and appropriate training should use electric power tools. These include hand-held power planes, drills, saws and angle grinders.

Leads on power tools should always be inspected prior to use to ensure that connections and the cable itself are sound and that the protective insulation is not cracked or frayed. Only heavy-duty leads should be used outside.

Keep electrical equipment away from sources of water such as taps, sinks, glaze buckets, etc. Be particularly vigilant if hair dryers are being used to dry art works. Students must not use electrical appliances at power points near sources of water.

Use eye protection which is resistant to impact and heat to reduce the risk of eye damage from fragments of metal or other materials being worked on.

When using the tools, hold them in a way that minimises the chance of injury to yourself and others.

A standard 240 V power outlet should not have more than 10 A (Amperes) of current passing through it. If the total power of electrical appliances operating from the outlet is limited to 2 400 W (Watts) i.e. 2.4 kilowatts, the current should not exceed 10 A. Leads coming from a power outlet should have a rating of 10 A. If a lead feels warm after use, check that it is at least 10 A rating and has not been connected to more than 2 400 W load of appliances.

3.1.4: Handling chemicals in visual arts

Information on chemicals for use in visual arts is available from:

- labels and manufacturer's information sheets
- SDS
- Appendix D

3.1.4.1: General advice for chemicals commonly used in visual arts

The information in this section includes some product specific advice which is intended to supplement, but not replace, the information found on the label and SDS for the product. It may help teachers make decisions when completing risk assessments. The department risk assessment advice must be implemented or a site-specific risk assessment completed, before these chemicals are used.

(a): Carving stones

A dust mask or respirator that meets Australian Standards (AS1715:2009) must be worn when using carving stones such as:

- creastone (carves like soap, hardens like stone)

- hebel blocks (autoclaved aerated concrete)
- limestone (calcium carbonate)
- pottery plaster mixes.

Soapstone should not be used and should be substituted with another product. Soapstone may be hazardous to health due to the potential exposure to silica. Dust control and effective wet clean-up measures must be implemented to minimise exposure of later classes to dust generated by earlier classes. The wet clean-up cloths or mops must be washed with clean water for each clean-up. Do not just reuse a cloth or mop that always sits in a bucket of dirty water.

(b): Ceramics

When purchasing ceramic materials, obtain an SDS from the supplier, or check the ChemWatch database so that hazards can be identified and risks assessed.

Controlling dust

The major risk from pottery activities is from the inhalation of dust. Clay and glaze dust contain fine silica particles which cannot normally be seen floating in the air. These particles can penetrate deep into the lungs causing silicosis which can lead to emphysema with impairment of respiratory function.

Managing the risks of exposure to silica can be achieved by selecting and implementing more than one of the controls;

Eliminate or Substitution	Sourcing materials with no silica or a much lower percentage of silica
Isolation	Designate areas for tasks that generate dust.
Engineering	Local exhaust ventilation, water suppression (wet cutting) or using tools with dust collection attachments
Administrative controls	Good housekeeping policies, rotations and modifying cutting sequences
Personal Protective Equipment	Respiratory equipment (generally a minimum of a P2 efficiency half face respirator) and work clothing that does not collect dust. Correctly fit RPE, instruction on use and regular maintenance of RPE is also critical.

The best control measure is to work on low silica materials, only with moist clay and to work on moist surfaces to limit the production of dust. in an outdoor environment or with the use of appropriate extraction.

Further guidance on working with silica can be found in the below general and technical fact sheets (current at the time of update, May 2021).

<https://www.safework.nsw.gov.au/resource-library/hazardous-chemicals/crystalline-silica/crystalline-silica-general-fact-sheet>

<https://www.safework.nsw.gov.au/resource-library/hazardous-chemicals/crystalline-silica-technical-fact-sheet>

At times, there may be a need to use an abrasive material, such as sandpaper, a scouring pad or a fine file, on dry clay. If so, the activity should be conducted outdoors in a well-ventilated area. If it is carried out indoors, a dust mask or respirator must be worn and the area cleaned using a wet vacuum cleaner (e.g. *aqua vac*) or "wet wiped". The risk to other students working nearby should also be considered and controlled. Do not brush or sweep up dry clay powder either on benches or floors. Exhaust fans should be operated at a level that does not draw dust up off the floor.

If dry material (e.g. glaze, ball-clay) must be handled, a dust mask or respirator complying with AS 1715:2009 should be worn. Suitable dust masks should have two straps and an AS1715 marking on the rim. A suitable respirator will have AS1715 on the cartridge. Only one person should use each dust mask or respirator and when not in use the dust mask or respirator should be kept in a sealed plastic bag. Facial hair (beard, moustache or even day old stubble) makes correct fitting of the mask or respirator difficult.

Fine dust is generated when the seams of dry slip cast greenware are fettled by knives, pads or abrasive materials. This type of activity should never be carried out in a carpeted room. The carpet might hide the dust and this creates a hazard for all future users of that room. Before fettling dry greenware, spray the fettling area lightly with water, wait until the water is absorbed into the clay, then spray again with water so that the area becomes fairly wet. If the work is not completed on the moistened greenware by the end of the period, cover with plastic until the next work time. Students may need to wet the greenware again before continuing with fettling. An alternative approach is for all the greenware to be fettled by the teacher while wearing a dust mask or P1 respirator and away from students. The fettled greenware could be brushed with a soft brush over wet cloth to collect dust particles, then bisque fired before students get to apply underglazes or glazes.

Glazes

Some glazes contain toxic metals. Departmental policy restricts lead levels in glazes to less than 0.1% in primary and secondary schools. Glazes obtained must meet these specifications.

Cadmium-based glazes must not be used. There is too great a chance of contaminating the hands and then transferring glaze particles to the mouth.

Pottery objects, after firing, may be used to contain food or drink. If a lead or cadmium glaze has been used, significant amounts of a toxic metal may dissolve in food or drink and cause poisoning.

Washings from low lead glazes should not be collected with other glaze washings and reused. Other chemicals, such as copper compounds, added to low lead glazes can increase the solubility and hazard of lead significantly.

Air brushing of slips or oxides should be carried out in a well-ventilated area outside or under an extractor fan indoors. A P1 respirator must be used. Before commencing the air brushing, make sure that nobody else is down wind where they will be exposed to suspended droplets.

Good hygiene is essential, hands must be washed thoroughly after using glazes.

(c): Cleaning chemicals

Staff in practically-based subjects are involved in cleaning operations of all kinds. Some of the cleaning agents are much more powerful than those used in the home, or in other parts of the school. Some people are more sensitive to cleaning agents than others, and there are a number of cleaning agents which are highly corrosive.

Detergents

The skin-irritant properties of dishwashing and laundry detergents, and of specialised domestic cleaning mixtures, are described in [Appendix D](#).

Avoid skin contact with powerful detergents. Wear suitable gloves.

Staff in visual arts will sometimes use detergent mixtures which are much more powerful than those used for domestic cleaning. These detergents have been formulated for maximum effectiveness in removing chemical residues from glassware, grease residues from metal or for some other special purpose. They have NOT been formulated to be gentle to the hands! Treat these powerful detergents with respect. Wash any of the concentrated liquid off hands immediately with a large volume of water. The diluted solutions are less irritant, but avoid skin contact by wearing gloves and washing hands thoroughly if any cleaning liquid gets on them. Refer to [Section 1.9](#), [Figure 1.9-1](#) for the selection of gloves.

Acids

Strongly acidic solutions are often used for cleaning metals. Acids remove the surface coating of oxide from metals, making the surface shiny, chemically active and ready to receive coatings.

Never add water to acid. Always add acid to water, with stirring! wear eye protection when using concentrated acids.

When preparing an acid cleaning mixture, remember always to add acid to water, with stirring! If water is added to acid the mixture will generate excessive heat, possibly boiling and splashing hot acid out of the container. This is very hazardous.

Strongly acid solutions are highly irritant to the skin. Do not allow them to come in contact with hands. They are particularly hazardous. Consult the information in the relevant SDS and [Appendix D](#).

Fluxes, used for cleaning metal surfaces during soldering, silver soldering, and brazing are often strongly acid, and may contain highly toxic chemicals such as fluorides.

Alkalies

Alkaline cleaning mixtures are often used for cleaning metals such as aluminium, and for etching. Most of these are based on caustic soda (sodium hydroxide). This material dissolves fats and is used in the most powerful domestic cleaners (for clearing drains and removing oven grease).

Alkaline cleaning materials containing caustic soda are very corrosive to the eyes and skin.

Alkaline cleaning materials containing caustic soda (sodium hydroxide) are very corrosive to the eyes and skin. Wear eye protection and gloves.

If an alkaline solution splashes in the eye, it must be washed out INSTANTLY with water since it will damage the surface of the eye (cornea). Use any water that is nearby. The most important thing is speed. Seconds count!

If the sodium hydroxide solution is hot or concentrated, it may cause permanent damage to the surface of the eye before first aid is possible.

If using a strongly alkaline cleaning preparation, wear eye and face protection.

Solvents

Hydrocarbon solvents, such as white spirit, kerosene and mineral turpentine (turps), are used for removing grease. Methylated spirits or alcohol is used in many cleaning preparations. It is relatively non-toxic but can dissolve fat in the skin. Always wear gloves when using these materials since they dissolve the oils in the skin, making the skin dry and rough. Don't use petrol as a cleaning solvent, since it contains benzene and may contain lead compounds.

Most hydrocarbon solvents are highly flammable. Take care to store minimum quantities of flammable solvents outside flammable liquids cabinets and keep solvents away from any sources of ignition.

Note: Avoid inhalation of solvent fumes.

FIRE HAZARD !! Remember that the below are highly flammable.

- methylated spirits
- mineral turpentine
- white spirit
- kerosene

(d): Dusts

Sawdust

Sawdust particles from certain timbers are highly irritant to the lungs and can cause respiratory diseases and/or sensitisation. Some particle board products also release free formaldehyde when sawed or cut, therefore requiring exhaust ventilation for cutting operations. Before using or purchasing material or equipment, consider the health and safety implications by referring to the SDS for the wood product being used.

Standard dust extraction equipment is applicable for softwoods, but some hardwoods, particle boards, medium density fibre boards and treated timbers may require additional ventilation or dust extraction equipment (see [Section 3.3.4.1 \(j\)](#)). When safe conditions cannot be provided, the product should not be used.

Exposure to dusts can be minimised by ensuring:

- fixed equipment is connected to a dust extraction system
- protective equipment is provided when required by the risk assessment (disposable face mask, or respirator that complies with AS1715:2009)
- portable equipment has a dust collection attachment
- good natural ventilation is provided
- the collection of loose sawdust to prevent contamination of other areas, i.e. sweep or vacuum
- minimised use of abrasive papers.

Always wear eye protection when using cutting equipment.

Avoid inhalation of solvent fumes. FIRE HAZARD !

Remember that the below are highly flammable, try not to inhale fine particles of anything ! Wear safety glasses if there is a possibility of eye injury.

- methylated spirits
- mineral turpentine
- white spirit
- kerosene

Metal dusts and welding fumes

When metal dusts are formed, individual particles are usually heavy enough to settle immediately and do not pose the same problem as wood dusts. Some very fine particles of metals and abrasives used in cutting equipment can remain airborne for some time and may lodge in the lungs, causing injury. Take appropriate precautions, and use a respirator that complies with AS1715:2009. Always wear eye protection when

using equipment for cutting or grinding metals. Angle disc grinders produce abrasive dust as well as metal dust.

Welding produces a cloud of fine particles which can easily enter the lungs if inhaled. Fumes from stainless-steel welding are particularly harmful. Ensure that these activities are carried out in a well-ventilated area. A P2 respirator should be worn during welding operations.

See also [section 3.3.4.4 \(c\)](#)

Fibreglass and sanded resins

When fibreglass is sanded, small fibres of glass, dust particles of resin and resin fumes are released into the air. Many wood fillers also contain resins which can form irritant dusts during sanding. Dust fume extraction or the use of a respirator that complies with AS1715:2009 is essential, even during sanding operations of fibreglass.

For further information on fibreglass see [section 3.3.4.1 \(h\)](#)

Pottery glaze dusts

Pottery glazes are non-hazardous when applied as pastes. However, the dry glaze powder, whether purchased as a powder or generated as a dust, can be toxic if inhaled as it may contain heavy metals such as lead. Pottery glazes should only be used as pastes and spillages should be cleaned up using a wet mop or sponge.

Also see [section 3.1.4.1](#)

(e): Dyes

It is important to check labels, the relevant SDS and [Appendix D](#) for information and appropriate work practices before commencing work with dyes.

Some dyes are highly toxic and a few may be carcinogenic. Unlike food colourings, dyes were never intended for human consumption. Take care to avoid skin contact with dyes and wash them off as soon as possible if you should get them on your hands. An organic solvent such as methylated spirits or mineral turpentine (turps) may be necessary to remove the bulk of a dye from the skin. Follow this with careful scrubbing using soap and water.

Safe dyes should be chosen. Naphthol dyes should be used only by senior students wearing the appropriate protective clothing and gloves. Use the SDS as a source of information to help choose the most appropriate dye.

"LOOG" solution, a concentrated solution of sodium hydroxide (caustic soda), used for naphthol and diazo dyeing is extremely hazardous to the eyes and skin. Read the information on sodium hydroxide in [Appendix D](#) before considering preparing this solution. Always wear eye protection and protective clothing.

Try to use water-soluble dyes as far as possible since these, generally, are less toxic than those that are soluble in organic solvents.

(f): Etchants

The process of etching may be carried out in schools to prepare etchings and lithographic plates.

A range of etchant types are described in text books including pure substances, dilute solutions or mixtures, or commercial products. Many etchants are hazardous. Appropriate risk assessments are required prior to the use of any chemicals for etching and related processes.

The following etchant chemicals, or mixtures containing them, are banned in department schools:

- chromic acid
- nitric acid + potassium dichromate + water. (This could produce chromic acid)
- picric acid
- hydrofluoric acid.

Refer to Appendix H – Banned Substances for the current list of banned chemicals in department schools.

The following etchant preparations are not recommended for use in schools due to their high corrosive risk and potential fire hazard. These preparations require a full risk assessment by an approved teacher before they are used in schools:

- ammonium hydroxide + hydrogen peroxide
- nitric acid + methanol (Nital)
- glycerol + acetic acid + nitric acid
- concentrated sulfuric acid or solutions greater than 2M

The two commonly used etchants are ferric chloride and ammonium persulfate.

- Ferric chloride (iron (III) chloride) is a black-brown solid which is soluble in water and is corrosive to most metals and alloys.
- For etching, ferric chloride should be prepared as a 20-25 % solution.
- The risk of exposure for students may be reduced if the teacher prepares the required amount of ferric chloride solution prior to the lesson.
- Ferric chloride can be difficult to work with because of its dirty nature and its ability to produce persistent stains on most materials. Because of these qualities it is not recommended by, nor available from, some supply companies.

- Ammonium persulfate is used as an etchant for copper. It is not a true corrosive chemical but an oxidising agent. It is an odourless, white granular powder that is stable when dry and decomposes slowly, evolving oxygen and some ozone.
- For etching, ammonium persulfate should be prepared as a 20-25% solution with the temperature kept at approximately 80°C.
- Pure ammonium persulfate is classified by department as a TCH-category chemical and can only be used for teacher demonstration, while a 20% solution can be used by students. Therefore, teachers will need to prepare the required quantity of ferric chloride solution for their students. It is recommended that this is done prior to their lesson so the risk of exposure for students is minimised.

Staff must assess the risks of using any etchants and determine usage restrictions either:

- following the DETRA protocol. Staff should refer in *Appendix D* and refer to the information provided on the label and the SDS; or
- conducting a site-specific risk assessment (SSRA) where the use of the DETRA protocol is inappropriate.

For the first time use of a manufactured product, always assess the risks using information on the product label, the SDS and Appendix D to determine the required control measures and any usage restrictions. Whenever the product is used, do so in accordance with the directions for use on the label and manufactures instructions and the initial risk assessment.

If any chemical used in etching activities is hazardous and is not listed in Appendix D, a site specific risk assessment must be carried out using label information, the suppliers instructions and SDS. All staff using the chemical must ensure that any controls determined by the risk assessment are applied whenever the chemical is used.

Be aware that using etchants on metals will most likely involve the following type of hazards:

- damage to the skin and eyes
- toxic or corrosive dust or fumes which can damage mouth, lungs and digestive tract.

The etchants listed in the figure below can be used safely in schools provided appropriate measures are implemented to control the risks.

(g): Fixatives

Fixatives used on drawings, pastels or fabric to prevent smudging are usually acrylic or vinyl resins dissolved in alcohol or hydrocarbons.

The labels on a spray can and the information on the SDS should be thoroughly read before use. Use strictly according to the manufacturer's instructions.

Solvent based fixatives must be used in well ventilated areas. It is recommended that fixatives are applied outdoors to reduce risks to others.

Ensure appropriate masks are available to students, especially those who may suffer from minor respiratory ailments that may be aggravated by spray fumes. In such cases, it may be prudent for those students to either wear a full respiratory mask or avoid that particular activity.

Spraying against a work hung vertically can dislodge the particles of colorant and increases exposure of the sprayer to fixative. It is a good idea to test the spray device on scrap paper.

Make sure no naked flames or sources of electrostatic charges which could cause ignition of the spray are nearby.

Minimise exposure to the xylenes and n-hexane used in many spray fixatives by choosing less toxic alternatives.

(h): Glues and adhesives

Glues and adhesives may emit vapours once exposed to air while they set. Check the appropriate SDS and [Appendix D](#) for advice on appropriate work practices.

Liquid glues should be stored in a cool place. Hot weather can cause a pressure build-up in the container.

Epoxy resin glues may irritate the skin on contact. In some cases, contact may sensitise the skin or cause an allergic reaction. Gloves should be worn when using this or similar adhesives and glues. The amount of vapour released is not great, but some people may find it irritates their nasal passages.

Contact adhesives containing hydrocarbons, products containing hexane or n-hexane and formaldehyde-based glues should not be used at all with students.

Great caution must be exercised with solvents used to join plastics, as many of these solvents give off toxic fumes.

Spray glues have similar problems to those of spray paints, and similar measures should be employed to minimise exposure. Do not use spray glues near naked flames, as the propellants are usually highly flammable. Never use spray glues containing hexane or n-hexane.

Use water-based PVA glues or "Clag" where possible.

(i): Paints

Paints are suspensions of fine particles in a base of either water or another liquid.

Pigments provide the colour in paints and glazes and they usually contain metals.

Some pigments are highly toxic, and care should be taken to avoid ingestion or absorption into the body through the skin, irrespective of whether the paint is acrylic or oil-based.

Pigments of significant toxicity are those containing:

antimony

- e.g. Naples yellow, antimony white, antimony black.
- All antimony compounds are highly toxic, cumulative poisons.

arsenic

- e.g. copper acetoarsenite (green 21, emerald green or Paris green), copper arsenite (Scheele's green), cobalt arsenite, arsenic trisulfide (yellow 39).
- All arsenic compounds are extremely toxic and carcinogenic. All arsenic compounds are banned in NSW government schools.

barium

- e.g. barium carbonate (White 10), barium chromate (yellow 31), barium sulfate (white 21).
- Barium chromate is extremely toxic and carcinogenic.

cadmium

- e.g. cadmium sulfate (cadmium yellow, yellow 37) cadmium sulfide (cadmium orange, orange 20, cadmium vermilion red), cadmium sulfo-selenide (cadmium red, red 108).
- All cadmium salts are banned in NSW government schools.

chromium

- The red, orange or yellow pigments contain the highly toxic, carcinogenic Cr(VI) whilst the green pigments contain the much less toxic Cr(III). e.g. lead chromate (yellow 34), chromium (III) oxide (green 17).
- Chromium (VI) oxide is banned in NSW government schools.

cobalt

- e.g. cobaltous aluminate (cobalt blue), cobalt magnesium borate (cobalt violet, violet 48), cobaltous oxide (cobalt green).

copper

- e.g. copper acetoarsenite (emerald green or Paris green), copper arsenite (Scheele's green).

lead

- e.g. lead monoxide (yellow 46), lead tetroxide (red 105), lead chromate (Naples yellow) and also pigments white 1, white 2, white 16, mixed white, chrome yellow, chrome green and chrome orange.
- All lead salts are highly toxic cumulative poisons.

manganese

- e.g. Mars brown, burnt umber, raw umber, manganese blue, manganese violet, black 14.

mercury

- e.g. mercury (II) sulfide (vermilion, cadmium vermilion red, red 106).
- All mercury (II) compounds are highly toxic cumulative poisons.

nickel

- e.g. nickel oxide, nickel carbonate and nickel chloride.
- Most nickel compounds are sensitisers, may cause severe skin allergies and are possible carcinogens.

Pigment powders should be avoided as they are often very fine, hang in the air and can be inhaled if mishandled. Even if the pigment is non-toxic, always avoid inhaling the dust and wear a suitable dust mask. Once a pigment is dispersed in a liquid medium, its hazardous nature is markedly reduced. However, use or abuse will determine future hazards. Graphite (also called black lead or plumbago) dust is highly toxic by inhalation. Lamp black, carbon black and ivory black are less hazardous alternatives.

Where water is the solvent base for the pigment e.g. in acrylic paints, the vapours from the drying paints are usually less hazardous than hydrocarbon-based ("thinners-based" or "turps-based" or "oil-based") solvents.

Consult the appropriate SDS and use [Appendix D](#) to evaluate the risks associated with different types of hydrocarbon-based solvents and for information about safe work practices and possible effects on health.

Oil-based paints contain flammable solvents. Products containing flammable solvents should be stored in a secure place away from any sources of ignition.

Note, most solvent based paints are manufactured product flammable liquids (formerly Class 3), and should not require special storage (such as FLC) in the quantities used by schools.

The vapours from solvent-based products can contain toxic chemicals and inhalation of the vapours should be avoided. There is a general trend to substitute water-based

products for solvent-based ones. As far as possible, use water-based products. Solvent based paints should only be used in well ventilated areas.

As a general rule, teachers should ensure that ventilation is adequate. In some situations, mechanical ventilation using ceiling fans or portable fans may be needed to achieve acceptable air quality indoors. Users should, as much as possible, have the source of fresh air behind them, while the source of fumes is between the users and the open window or door.

Products containing isocyanates may only be used if the necessary controls to minimise the risk as specified in the SDS are implemented.

It is important to remove paint and its solvent from skin as quickly as possible to minimise the risk of a sensitisation, allergic reaction, burns from corrosive action or toxic effects. Wash the skin thoroughly with a suitable soap and water.

If accidentally ingested, the paint may also be toxic. It is important that you know the appropriate first aid procedures for dealing with the ingestion of different kinds of paints. Consider keeping this information prominently displayed in the room. Where in doubt contact the Poisons Information Centre immediately.

Prevention is better than cure. Wear gloves and use the least toxic products appropriate to the task.

Paint-applying implements such as brushes must never be put to the lips or in the mouth. Students should be shown how to "point" a watercolour brush against a tissue.

Spray painting

Spray painting is used as a means of finishing projects in some art classes and involves the use of aerosol spray cans, airless spray guns and the use of hand guns and air compressor equipment.

School programs should not include spray painting as an activity unless adequate measures are implemented to control the risks to staff and students.

For small spraying jobs using aerosol spray cans, the following controls should be implemented.

- Spray painting should be carried out in an open area where exposure to fumes can be minimised.
- Students should wear safety equipment including an approved filtered respirator.
- Paints and solvents should not come into contact with the skin. Students should wear appropriate protective clothing at all times.
- The number of people in the area where fumes might travel should be minimised.

- Oil, grease, paint and other spills should be cleaned up immediately to avoid slippery floors and/or the build-up of fumes.
- Dirty rags and paper should be disposed of at the conclusion of work.
- Disposal of spray cans must be carried out by the teacher.

Larger spray-painting jobs should only be carried out in an approved air extraction and filtering device, e.g. a spray booth which complies with Australian Standards.

In addition to the advice regarding paints, and manufacturers' specific recommendations, a number of safety issues arise when finishes are applied using spraying devices in a spray booth. The following precautions must also be taken.

- Respiratory equipment with the appropriate filters must be worn by all those working in the vicinity. **THIS IS A MANDATORY REQUIREMENT.** Spray painting produces very fine droplets of paint, not all of which reach the object being coated. Fumes in the form of vapour are also generated by solvents evaporating from the paint. Do not use dust masks for protection against fumes. The correct respirators are available on contract. For health reasons students should have their own mask or, where applicable, their own filter cartridge. Where a replaceable cartridge respirator is used it must be sterilised before and after each use by a student.
- The area where spraying is to be carried out should be clean and tidy. It should be free of obstructions on the floor and around the project where the operator will be working.
- Dirty rags and paper should be removed from the area and stored in a covered container. These materials usually contain significant amounts of flammable substances which could lead to spontaneous combustion. They must be properly disposed of at the conclusion of work.
- First aid equipment and fire extinguishers should be readily available.
- Possible sources of ignition, such as static electricity, electrical appliances, naked flames or welding equipment should not be used in the vicinity of the spray-painting area.

A risk assessment should be undertaken prior to spray painting – refer to the SafeWork NSW Code of Practice – Spray Painting and Powder Coating (August 2019) for further information.

(j): Photographic chemicals

The chemicals most commonly used in photography are:

- developers, e.g. hydroquinone or p-aminophenol or metol (4-methyl aminophenol sulfate) or diethanolamine bisulfite or diethylene glycol or diethanolamine or sodium polysulfide or phenidone
- developer replenishers, e.g. sodium hydroxide

- stop bath, e.g. acetic acid
- fixer, e.g. sodium thiosulfate or ammonium thiosulfate
- film cleaner, e.g. naphtha (TCH teacher use only)
- reversal solutions, e.g. potassium dichromate
- brown (sepia) toner: sodium polysulfide (Caution: this produces a toxic gas, hydrogen sulfide when mixed with acids such as stop bath).

Photographic chemicals have been associated with skin diseases and respiratory allergies. Avoid skin contact with developers and other photographic solutions.

The use of protective clothing, tongs for handling wet photographic paper and gloves to prevent skin contact are also essential. Check the SDS and [Appendix D](#) for the appropriate safe work practices or to find a less hazardous alternative.

Appropriate ventilation is essential. School darkrooms should be fitted with an exhaust fan. An exhaust system operating to remove air at a velocity not less than 0.5 ms^{-1} is a minimum requirement. The inlet hood should be as close as possible to the chemicals being used.

Concentrated powdered photochemicals are more hazardous and could be replaced with premixed solutions. When powdered photochemicals are used, do so in a well-ventilated area with eye and skin protection and a dust mask. Aprons can be worn to protect clothing.

Clean up and wash off all spills and splashes immediately. Do not allow splashes on clothing to dry. Wash these with copious quantities of water.

A photographic solution can contain five or six different chemicals and there are hundreds of different chemicals used in the solutions available for photography. Always read the label and follow any safety instructions given. Generally, the solutions used in colour photography contain more chemicals, and should be used with greater caution, than the chemicals used in black and white photography.

Eye protection should be worn when mixing these chemicals from powders or liquid concentrate.

The unique smell in photographic darkrooms is largely the result of acetic acid and ammonium thiosulfate (or sodium thiosulfate). If acetic acid is allowed to dry, a strong odour of vinegar results. When acetic acid is permitted to mix with sodium thiosulfate, sulfur dioxide gas is produced.

Where ammonium thiosulfate is used ammonia is also released. It is therefore very important that darkroom bench surfaces, containers and trays be kept clean of chemical residues. It is important that extraction fans for darkrooms be switched on prior to entry.

To prevent the build-up of vapours from spills, all surfaces (including the floor) should be impervious to the chemicals being used. As the solutions age, chemical baths emit vapours such as sulfur dioxide and hydrogen sulfide. This reinforces the need for ventilation as described above.

Disposal of wastes

The alkaline developer solution and the acid stop bath should be disposed of down the sink with running water.

The fixer salt solution contains silver which should be recycled. Enquire about this with local minilab operators. Schools are not allowed to put solutions such as fixer containing more than 5 mg per litre of silver down sinks.

Some proprietary developers contain other chemicals such as amines or phenols. Since these are used in limited quantities and as dilute aqueous solutions they do not create additional disposal concerns.

When cleaning up minor spills from normal work practices ensure that clean up materials (mops, wash clothes) are washed regularly and any residue in basins or sinks is completely flushed.

When collecting waste or surplus photographic chemicals always collect each substance in a separate container i.e. don't mix acetic acid with 'hypo'. Fixer wastes will have a higher silver content, with the developer and wash water wastes having a relatively low silver content.

If the 'developer' and 'fixer' wastes are collected on site they will rapidly exhaust available storage. The storage of chemical waste can be significantly reduced by undertaking the following treatment, so that only a small amount of waste material (silver chloride) need be stored prior to collection.

The treatment of photographic 'fixer' wastes involves three separate steps.

Step 1: Precipitation of silver as insoluble silver chloride.

1. Add table salt (sodium chloride) to each waste container (2-5 litre) to make a 2% salt solution, i.e. add 20 g of salt per litre of waste solution.
2. Leave until the salt dissolves (a few days) - any silver will be precipitated as silver chloride, a fine white solid.
3. Pour off (decant) or filter the solution.
4. Either collect the solid silver chloride for recycling or leave it as residue in the container for pick up by a waste contractor.
5. Treat the solution further by following Step 2.

Step 2: Addition of mineral acid (typically 5 M hydrochloric acid) to react with thiosulfate.

Undertake this task in a fume cupboard or out of doors with a breeze behind you.

1. Add all previously treated chemicals together in a larger container e.g. 10 litre plastic bucket.
2. Add 4-6 M mineral acid (typically hydrochloric acid) until sufficiently acidic to react with thiosulfate.
3. Leave for 1 hour to react.

Step 3: Addition of alkali (typically, 2 M sodium hydroxide) to make the final solution slightly basic (pH 8-10) for discharge to the sewer.

1. Add indicator (phenolphthalein, litmus) which allow you to determine when the solution is sufficiently basic.
2. Add sufficient alkali (typically, 2 M sodium hydroxide) until the indicator is just basic.
3. Add a further 20 mL - this will be in the range pH 8-10.
4. You may now discharge the basic mixture of common salts directly to the sewer. This solution is free from silver and ions that can release noxious gases in the sewer.

Note: Fixer wastes contain significant amounts of silver in solution which can be recycled.

Rather than carrying out the process detailed in Step 1 you may be able to sell or dispose of the waste to your local photographic mini labs or professional photographer, or arrange collection by a chemical recycler.

"PURE" is Photographic Uniform Regulations for the Environment.

School visual arts departments may find it useful to obtain a copy of PURE (Photographic and Imaging Industry) *Code of Practice for Liquid Waste Management and Disposal (Photographic, Graphic Arts and X-ray)*.

(k): Plastics

There are two different types of plastics, thermoplastics and thermoset plastics.

Thermoplastics are made of long thin molecules which form tangled chains. There are weaker forces between the chains than along the chains and so the chains can slide past each other easily. Thermoplastics can bend and can be softened or melted reversibly with heat.

Thermoplastics include:

- celluloid and other cellulose plastics
- lucite (perspex or plexiglas)
- nylon
- polythene
- polyethylene
- styrene polymers
- vinyl polymers
- poly-formaldehyde
- polycarbonates.

Working with thermoplastics may involve cutting, shaping, polishing and joining using an adhesive or joining agent.

Possible hazards include:

- airborne particles resulting from various shaping processes
- vapour arising from adhesives, resins, solvents and joining agents
- fumes generated by plastics being heated, welded or accidentally burnt.

In all situations involving thermoplastics, staff should follow risk assessment procedures and ensure appropriate controls are in place. This will usually involve ensuring that there is adequate ventilation. Appropriate respiratory devices must be worn where indicated by the risk assessment.

Thermoset plastics are made of long chains of molecules with strong bonds between the chains. They are made when simpler molecules are converted with heat and pressure and, for some, by addition of a hardener. Thermoset plastics are much harder and less flexible than thermoplastics and cannot be remoulded. They don't melt when heated, but rather they char as the bonds between the long chains are broken down.

Examples of thermoset plastics include:

- epoxy resins
- phenol resins like bakelite
- polyesters
- silicones
- urea-formaldehyde and melamine-formaldehyde resins
- some polyurethanes.

Thermosetting resins are used for casting and fillers.

Thermoset resins are used in conjunction with a catalyst, usually methyl ethyl ketone peroxide (MEKP). They can generate significant amounts of heat when mixed with the catalyst. They are especially hazardous if too much catalyst is used. This can lead to burns from contact with the hot material, or possibly the resin may ignite or explode.

MEKP is not overly toxic, but it is highly flammable. Over time, MEKP can become concentrated and unstable, and should be disposed of in an appropriate manner. Use MEKP only from its original container, and do not mix batches. Because of its instability, MEKP should not be stored in the flammable liquids cabinet. It should be stored in a refrigerator or cool place.

Thermosetting resins are also used with fibre reinforcing to create fibreglass reinforced plastics (FRP).

The following are the main hazards associated with the production and use of FRP. The hazards are mostly due to particles and fumes.

- Contact with glass fibres can irritate the skin. Some chemicals in resins and hardeners are sensitisers and can cause a more serious form of dermatitis.
- Many chemicals used are flammable. These include most resins, acetone and MEKP. Rags soaked in MEKP can self-ignite. MEKP and promoter can explode when combined.
- If MEKP splashes in the eyes it can cause blindness.
- Styrene, found in most polyester resins, is a solvent which can enter the body through the lungs and skin. Styrene can cause headaches, nausea and drowsiness as well as long term neurotoxic effects.
- Dust from cutting or sanding can irritate the eyes, nose, throat and skin. The glass fibres currently available for purchase are not thin enough to pass deep into the lungs and so are not suspected of causing cancer.

Schools generally do not have the facilities for the use of FRP due to the difficulties of controlling hazards and disposing of waste.

School programs should not include the production of fibre reinforced plastics unless SafeWork NSW approved control measures are implemented.

(I): Printing chemicals

It is important to know what is in the inks used in printing. Always read the label of the original container thoroughly before using an ink with students. Employ the work practices advised in the SDS and [Appendix D](#). Some ink solvents may sensitise the skin, thus contact should be avoided.

Fumes from drying inks and ink solvents in felt-tip pens may be an irritant for nasal surfaces. Read precautionary labels before use. Ensure that adequate ventilation is available to reduce vapour build-up.

Correcting fluids and the solvents used to reconstitute them should be used with care. Choose the least toxic alternatives.

The solvents used in oil-based block printing inks and screen-printing inks require careful handling as they emit toxic fumes and are absorbed into the body through the skin. These oil-based solvents are particularly harmful and require adequate ventilation and protective gloves to be worn. It is NOT recommended that students use these products, as comparable results can be achieved with water-based inks.

"Lascaux" is an example of a water-based screen-printing ink with results comparable to oil-based inks.

Photographic emulsions for water-based screen printing are readily available.

If an ultraviolet (UV) lamp is used with photosensitive emulsions, the process must be carried out using extreme caution and strict supervision of students. UV light sources can cause permanent eye damage. UV equipment sometimes comes with specific guidelines on its use (e.g. wait two minutes for maximum power, wait two minutes after turning off equipment before turning on again), but little guidance on avoiding eye damage. The UV light should shine down onto a dull, dark background surface to minimise reflection.

Any technique that uses ultraviolet (UV) light sources must be carried out using extreme caution and strict supervision of students. Using direct sunlight or a 500-Watt light bulb with suitable emulsions, whilst still potentially hazardous, are safer alternatives.

Never dilute UV products with solvents. UV inks and varnishes tend to strip the skin of its protective fats. This makes it easier for the solvent to penetrate the skin.

(m): Solvents

Petrol and ethers should never be used as "thinners".

Shellac is dissolved in methylated spirits (metho), which is a highly flammable, ethanol-based solvent. The fumes from this may irritate nasal surfaces.

Mineral turpentine (turps) is the cheapest and most commonly used solvent for cleaning up oil-based paints and inks. Turps is a mixture of hydrocarbons from petroleum. Use should be minimised and carried out in well-ventilated areas as the fumes are toxic. Avoid breathing vapours and contact with eyes and skin.

Turpentines such as "Turpenoid" or Turpentine Odourless Thinner, which have had the strong-smelling hydrocarbons removed, may be less toxic and less likely to cause allergic reactions. However, students and teachers may be unaware that they are being exposed to high concentrations because of the lack of odour.

Gum turpentine, normally an extract from pine trees, has a more pleasant odour than mineral turpentine but the vapour may irritate the skin of some individuals.

An alternative oil-based solvent to mineral turps is the product "Turpenoid Natural", which is non-toxic and non-flammable and is rated by the American Society for Testing and Materials (ASTM). (ASTM D4236 *Standard Practice for Labelling Art Materials for*

Chronic Health Hazards and the more recent ASTM D4236-93 *Standard Practice for Labelling Art Materials for Chronic Health Hazards* are often quoted for American products. Note that an ASTM rating does not protect you or your students unless you read the full label, understand the instructions and fully implement them. A product conforming to the standard ASTM-D4236 could be very toxic and potentially hazardous.

(n): Wax

Candle wax must not be melted over direct heat. Most waxes melt at about 60°C. The wax is best melted in a heat resistant container sitting in gently boiling water in an electric frypan. Provided the frypan is not allowed to boil dry it is very unlikely that the wax will catch alight.

If a flame is used to heat a pan containing water and a container of molten wax the chances of fire are much greater. Treat burning wax the way you would treat burning fat or oil smoother the fire with a suitable lid, fire blanket, baking soda or moist towel. Do not use water the water can rapidly change to steam causing an explosion of molten, burning wax.

(o): Wood

Exposure to wood dust, especially from craft board or Medium Density Fibreboard (MDF), may cause skin irritation, dermatitis, sensitive reactions, breathing difficulties and, in the extreme, nasal cancers.

Woodworking machines should have dust-collecting systems. Dust masks for use when working on the machines should conform to AS 1715, Respiratory Protective Devices. Those masks should be maintained and stored to meet AS 1716, selection, use and maintenance of respiratory protective devices.

Wood burning using pyrographic instruments should be carried out in a well-ventilated area.

The following products commonly used when working with wood are irritants and should be used cautiously:

- urea formaldehyde resin glues
- polyurethane adhesive or surface coatings such as hexamethyl diisocyanate (HMDI)
- curing agents for epoxy resin adhesives or surface coatings such as:
 - DTA (diethylene triamine)
 - TET (triethylenetetramine) and
 - EAPA (diethylaminopropylene)
- products using solvents such as MEK (methylethylketone), xylene, toluene, acetone.

See [Section 3.3.4.1\(j\)](#) Timber products and preservatives for more detailed advice.

3.1.4.2: Heat sources

Electric fry pans are good for controlled heating of things like wax. A water bath can also be used. Apart from the risk of burns, heat sources may induce chemical reactions that produce toxic vapours. The application of heat to some substances can cause them to emit toxic vapours.

(a): Kilns

All kilns should be secured from unsupervised access by students. Kilns should be used only where they can be vented to the outside or when rooms or areas are unoccupied. This will reduce or prevent exposure to vapours containing heavy metals which are released from glazes as their constituents react with each other and the clay minerals during firing (see NSW government schools Memorandum 95/086: Lead Levels in Pottery Glazes).

Modern kilns use pyrometers and electrical meters to display internal temperature.

Cones should not be used to confirm firing temperature, as eye damage can result from lengthy exposure to high temperature heat rays. The bung hole at the front should be used for ventilation in early bisque firings and not for observing the contents of the kiln.

A fired kiln should not be opened until the internal temperature has dropped to less than 100°C.

Kilns containing asbestos, such as old enamelling kilns, should not be in a school.

Older ceramic kilns usually contain firebrick. Modern ceramic kilns use ceramic board and fibre. Students must not be allowed to touch or pick at the ceramic board and fibre as this releases fibres into the air. If the fibres are very fine (less than 3 microns, i.e. 0.000003 of a metre, in diameter) the fibres may cause cancer.

(b): Pyrography

Woodburning using pyrographic instruments should be carried out in a well-ventilated area.

(c): Soldering

When soldering, make sure the soldering iron is maintained at the appropriate temperature to work the solder. Excessive heat can lead to the production of excessive toxic lead vapour.

Ensure there is adequate ventilation (Australian Standard AS1668). Consider using a small personal fan to waft fumes away from the face.

Different fluxes are used to assist the soldering process. Fumes from these fluxes may be an irritant, cause a sensitive reaction to chemicals or can be toxic if inhaled. Contact with the skin should also be avoided because of corrosive or possible toxic effects. Lead flux (but not rosin-based flux) can cause permanent kidney and brain damage as well as harm a developing foetus.

If fluxes which contain fluoride contact damaged skin the healing process will be slower. Fluoride fluxes should be avoided.

Check the SDS to identify the hazard associated with the chemicals in the flux vapours.

(d): Welding

If electric welding is being done, local exhaust ventilation with a capture velocity of 0.5 ms⁻¹ should be in place and an appropriate respirator giving protection against metal fumes must be used as well as the appropriate eye shielding. Heat-proof protective gloves and clothing should also be worn. Similar measures apply when using oxyacetylene equipment to cut or join metal.

Wear eye protection, gloves and protective clothing when preparing metal with a degreasing solvent such as trichloroethylene, with caustic paint strippers or with acid paint strippers.

3.1.4.3: Personal protective equipment

Whenever required by a risk assessment, teachers must ensure that students use appropriate personal safety equipment. Teachers and support staff must use personal protective items whenever indicated by a risk assessment.

Note: See [Section 1.9](#)

(a): Eye protection

Eye protection devices are made in a range of styles to suit different purposes and the needs of the individual. A variety of eye and face protection equipment should be purchased and maintained. These include glasses, goggles and face shields.

(b): Gloves

Protective gloves are made from a variety of materials to cater for contact with the range of chemicals used in schools. A range of sizes should be purchased and maintained for ready access when any type of chemical is being used.

(c): Respirators

Respirators are designed to protect employees from airborne particles, gases and vapours. A wide variety is now available in both maintenance-free and reusable models. Only respirators that meet Australian Standards should be used. Because each type of respirator is designed for specific applications and has specific limitations on its use, it is important to systematically select the respirator indicated by the risk assessment for the task.

(d): Footwear

Substantial footwear appropriate to a practical activity should be worn. Footwear such as thongs, open weave type shoes, or shoes with openings at toes or heels, platform or high-heel shoes should not be worn in areas which present hazardous situations. Where indicated by a risk assessment, the wearing of safety footwear is mandatory.

(e): Aprons and protective clothing

Aprons or other protective clothing should be worn by all participants in practical activities to avoid splashes and spills when indicated by a risk assessment.

In some circumstances, garments such as overalls may be more appropriate. Disposable overalls are readily available from safety equipment suppliers and are particularly useful for activities like painting and pottery work.

See [Section 1.9](#)

3.1.4.5: Equipment in contact with chemicals

All equipment which comes into contact with chemicals should be thoroughly cleaned or disposed of at the conclusion of the activity. This should be carried out using the appropriate cleaning agent and technique, or the correct disposal technique.

3.1.4.6: Disposal of chemicals

[Appendix E](#), Volume 2 provides a comprehensive description of disposal methods for chemicals. Visual Arts staff are advised to consult this and the SDS for the chemical before proceeding with a planned activity.

The Guidance Notes in [Appendix D](#) direct the user to the appropriate disposal methods for each chemical.

3.1.4.7: Immediate emergency procedures

The following generic advice is provided as an indication of the actions which may be required in response to an emergency situation. Specific advice for particular chemicals is given in SDS and [Appendix D](#) and should be followed where possible.

(a): Chemical splashes in the eye

Immediately wash the eye under running water from a tap or eye-wash bottle for at least 15 minutes. The flow should be slow and eyelids should be held back. During the first minute of washing ask if the casualty is wearing contact lenses. If so the contact lenses should be removed quickly to improve contact between water and eye. Always seek medical advice whenever chemicals (even the most seemingly harmless) get into the eyes.

(b): Chemical splashes on the skin

Wash the skin for 5 minutes or until all traces of the chemical have disappeared. Remove clothing as necessary. If chemical adheres to the skin, wash gently with soap.

(c): Chemicals in the mouth, perhaps swallowed

Do no more than wash out the casualty's mouth. If there is a possibility of poisoning contact the Poisons Information Centre by phoning **131 126**.

DO NOT INDUCE VOMITING.

(d): Burns

The [e-Emergency Care](#) module (updated October 2020) advises the following actions for emergency care procedures involving burns.

DO

- cool burns under cold, gently running water for at least 10 minutes
- remove jewellery
- cover burn with sterile non-stick dressing
- treat for shock

DO NOT

- break blisters
- apply lotions, ointments or creams
- apply ice
- remove clothing that sticks to burned area

(e): Inhalation of a toxic gas

Sit the casualty down indoors in an area free from fumes. Keep the casualty warm and calm. If the casualty has been overcome, e.g. short of breath, dizzy, medical advice should be sought. In the interim the casualty should be constantly monitored by someone who is capable of providing CPR and offer first aid.

(f): Hair on fire

Smother by surrounding burning hair with non-flammable cloth (or fire blanket, if close by).

(g): Clothing on fire

Push the casualty to the ground with the flames on top. Smother flames by covering with a thick cloth/non-flammable garment/ fire blanket.

(h): Electric shock

Take care of your own safety if a person appears to have been electrocuted. Break contact by switching off the power or pulling out the plug. If it is necessary to move the casualty clear of the source of the electricity use a wooden broom handle or wear thick rubber gloves.

If the casualty is unconscious, check that the airways are clear.

If the patient is unconscious but breathing normally: lay patient on side, head to one side, mouth open, with head unsupported. To leave an unconscious person lying on his or her back may cause death. Never give anything by mouth to an unconscious person.

If breathing has stopped or is feeble: Start mouth-to-mouth resuscitation, continue until help arrives.

If breathing has stopped and no pulse can be detected: Start CPR immediately.

(i): Severe cuts or wounds

The immediate priority is to stop excessive blood loss by applying pressure to the wound e.g. by using a pad of cloth. Do not attempt to remove imbedded bodies. Raise the wound as high as possible and, if the blood loss continues or the casualty feels faint, lower the patient to the floor. Protect yourself and others from contamination by blood.

Figure 3.11: Commonly used etchants

Etchant	Concentration	Uses
ammonium persulfate solution	20 % solution (w/v) (20 g per 100 mL water)	etching of copper plates
ferric chloride solution (iron III chloride)	20% solution (w/v) (20 g per 100 mL water)	etching of aluminium, zinc and copper plates
nitric acid	25 % solution (approx 4 M)	etching of copper plates

Results similar to etching can be achieved by employing techniques such as:

- drypoint on plastic or acetate sheet
- photographic etching plates
- solar etching plates
- drypoint on plastic coated cardboard.

Any etching technique that uses ultraviolet (UV) light sources must be carried out using extreme caution and strict supervision of students. UV light sources can cause permanent eye damage. Using direct sunlight or a 500-Watt light bulb, while still potentially dangerous, are safer alternatives.

Never dilute UV products with solvents. UV inks and varnishes tend to strip the skin of its protective fats. This makes it easier for the solvent to penetrate the skin.

Oil based etching inks are superior to water-based inks, but care should be taken with handling the ink and cleaning up with turps [[refer to Section 3.1.4.1 \(m\) Solvents](#), for guidance on the use of turps].

Any solutions to be used to remove dried ink or backing paint from zinc etching plates, such as sodium hydroxide (caustic soda) solution, should also be risk assessed prior to any etching activity.

Teachers should be aware that some substances previously used are no longer permitted for use with students. Many formulations may result in violent, unpredictable reactions. Before using any etchant or etchant formulation for the first time, refer to [Appendix D](#) and SDS to determine any restrictions on its use and the

measures needed to control risks. If generic advice is not provided in [Appendix D](#) a site specific risk assessment must be carried out.

3.1.5: Safe practice for the performing arts

The following information relates to safety for classroom activities, student practice activities and major performances. However, most issues relating to chemical safety for performing arts subject areas potentially relate to the staging of major student performances such as a school play or musical.

Any space where students are performing for an audience is considered to be a performance area. These may include classrooms, halls, verandas or external areas. When using any performance area consider all possible hazards and develop a plan to address the hazards.

Hazards to consider when organising a performance are:

- overcrowding
- handling and carrying equipment
- special effects
- electrocution
- fire
- excessive noise.

3.1.5.1: Performance space organisation

Accidents can occur if insufficient space is available for performers and audience. Performance spaces should be free from unnecessary obstructions such as electrical cords and equipment. Ensure adequate off-stage storage and space to allow support crew to do their job in safety and comfort. There should also be sufficient room for the safe storage of sets and props. Stage crew should know the location of fire extinguishers and where to gain access to a telephone in an emergency.

Consideration should be given to the placement of equipment so that the risk of injury to audience is minimised. There should be adequate separation between performers, their equipment and the audience.

3.1.5.2: Equipment organisation and handling

Ensure that the risk of injury from lifting and carrying equipment are minimised. The weight of the equipment is only one factor that can make lifting a load dangerous. The size and shape of the load must also be considered.

Assess the load. Can it be lifted safely by one person?

To safely lift and carry a load the person doing the lifting should:

- face the load squarely and take a firm grip
- get close to the load, by bending the knees not the back
- lift in a smooth and balanced way
- hold the load close to the body
- when carrying the load, turn by moving the feet, not by twisting the body.

If a load is too heavy or awkward, one person should not attempt to lift it. Heavy or awkward loads should be moved by two or more people using safe lifting practices, or by using an appropriate mechanical lifting device.



Image: image of how to safely lift a load

3.1.5.3: Special effects

The use of special effects should generally be limited to major school performances.

A risk assessment must be conducted before a decision is made to use potentially dangerous props such as matches, lighters, candles, sparklers, theatrical flash-pots, starting guns or open flames (such as flaming torches or real fireplaces).

Cigarettes, firearms and any kind of fireworks must not be used for school performances.

If special effects are planned for performances at venues other than at the school, seek permission for their use from the management of the host venue.

Pyrotechnic displays, laser shows and other dangerous special effects should be contracted to specialists who already have the required skills and permits.

(a): Stage pyrotechnics

To be authorised to use stage pyrotechnics, personnel must have current training in the safe use and storage procedures for stage pyrotechnics and must hold a current licence.

(b): Lasers

Schools should never use science lasers during a performance. Where lasers are used in school performances, they should be used in accordance with the National Health and Medical Research Council (NHMRC) *Code of practice for safe use of lasers in the entertainment industry (1995)*.

(c): Smoke machines and fog machines

Schools hiring smoke or fog machines must assess the risk to staff, students and the audience. Hire companies must be able to supply Safety Data Sheets (SDS) for the chemicals used in the machines. The SDS must be used to carry out the risk assessment. The results of the assessment, including what to do in case a person is affected by the chemicals, must be available during the performance.

Small amounts of carbon dioxide mist can be created by placing some dry ice into a metal bucket of water. Use thick gloves when handling the dry ice blocks as it can seriously damage unprotected skin. Although carbon dioxide is not toxic, avoid breathing the mist as it can cause asphyxiation in large volumes.

In carrying out the risk assessment, staff should be aware that some students, particularly those with asthma and respiratory disorders, may be affected by the use of smoke or fog machines.

Check that the fog created:

- is not flammable, combustible or explosive in the presence of sparks, flames or hot lights
- does not leave walking and performing surfaces greasy and slippery

- will not obscure an actor's vision.

(d): Costumes

All costumes and material props should be made from fire resistant fabrics.

(e): Theatrical cosmetics

Before using any props, always carefully assess the risks.

Some students may develop allergies to chemicals in cosmetics. Always use makeup which is hypoallergenic. Be aware and warn students that some theatrical cosmetics cause acne. Theatrical cosmetics must be of a type which are approved for placing on the body. Use only ingredient labelled products. Check for risks by referring to SDS. Use only fresh cosmetics to avoid the possibility of bacterial contamination. Use cosmetics sparingly. Never use paints, textures or other inappropriate substances such as boot polish. Always use a suitable skin cleanser, such as cold cream, to clean up after a performance rather than solvents such as methylated spirits or acetone.

Any special effects makeup should be taken off carefully. Use as little solvent as necessary to remove any makeup. Wash excess solvent off with mild soap immediately.

(f): Set painting

Paint used for set production should be acrylic based rather than solvent based.

3.1.5.4: Electrical equipment

Performances may involve setting up sound and lighting equipment. Make sure an adult who understands the safe use of electrical equipment supervises the setup.

It is good practice to ensure that the basic operating principles of the equipment to be used are known to students and that students are aware of electrical hazards and good practices needed to avoid injury.

Some good practices include:

- using heavy duty extension leads when connecting to equipment outside
- minimising the risk of tripping by careful placement of cables
- taping temporary cables to the floor
- ensuring that appropriate earth connections are made
- using connectors that are secure and safe
- keeping cables and connectors dry
- ensuring that heavy equipment is properly fastened so that it cannot fall
- using portable safety switches with equipment where safety switches are not installed on the electrical distribution board.

A standard 240 V power outlet should not have more than 10 A (Amperes) of current passing through it. If the total power of electrical appliances operating from the outlet is limited to 2400 W (Watts), i.e. 2.4 kilowatts, the current should not exceed 10 A. Leads coming from a power outlet should have a rating of 10 A. If a lead feels warm after use check that it is at least 10 A rating and has not been connected to more than 2400 W load of appliances.

3.1.5.5: Fire

The risks from fire must be considered when organising performance spaces and audience seating.

Think carefully about evacuation plans for the performance. Even a small fire can cause panic.

Exits should be clearly signposted and exit pathways kept clear.

The location of fire extinguishers and other fire control measures or alarms should be known to the staff involved.

Curtains in a school hall must be fire rated.

Any special effects used with a performance should be carefully planned, trialled and tightly controlled. The safety of all participants must be the prime consideration.

3.1.5.6: Noise

Sustained exposure to excessive noise over a long period can cause permanent damage to hearing. A potentially harmful noise problem may exist when it is necessary to use a raised voice in order to communicate with a person about one metre distant. Ways of minimising exposure to excessive noise levels should be considered at all times.

The risk of permanent hearing loss is related to both the loudness of noise and the length of time a person is exposed to it. Noise is measured in decibels (dB). Over an eight-hour period 85 dB is the total allowable amount of noise exposure.

For every increase of 3dB the noise energy is doubled and so the exposure time should be halved.

Figure 3.1-4: Recommended exposure thresholds

Noise level (dB)	Time (hours)
85	8
88	4
91	2
94	1
97	0.5
100	0.2

No person should ever be exposed to a noise of 140 dB or above. This is an extremely loud noise at the threshold of pain. Any exposure to noise of 140 dB or over can cause hearing loss.

Control measures may include:

- setting appropriate limits on the loudness of noise and the duration of exposure

- ensuring that groups practise in adequate spaces
- using sound-absorbent materials on walls and barriers
- providing hearing protection devices, such as ear plugs and ear muffs, in extreme cases
- having a person equipped with a decibel meter in charge of amplification equipment (small, portable and cheap decibel-meters may be purchased from some electronic stores)
- installing a proprietary noise level switch to disable the local electrical supply when the noise or music exceeds a predetermined level.

3.2: Science

3.2.1: Introduction

3.2.1.1 Rationale

The information in this section has been developed to supplement Volume 1 of the Chemical Safety in Schools package. The document contains safety advice related to equipment, devices and practices commonly encountered in science work spaces.

The package updates and replaces information found in Safe practices and levels of usage of chemicals in secondary schools 1983. Information in this Section also replaces a number of memoranda issued in previous years. Where the advice replaces a previous memorandum, e.g. for ionising radiation and model rocketry, a specific reference is made to that fact. Where additional information is available in a current memorandum, reference is made to that memorandum.

This Section also provides new advice and information in response to changed circumstance and work practices in science.

3.2.2: Safety procedures and equipment

3.2.2.1: Emergency management procedures

All staff should know:

- the school emergency evacuation procedure and what to do in case of fire, earthquake or bomb threat. Specific information on these is available via the Emergency Management Intranet Page, available [here](#). This is inclusive of the Emergency Management Procedures and the supporting overview and key steps document.
- who the designated first aid personnel are within the school
- the telephone numbers for emergency help:
 - **EMERGENCY** (fire, police, ambulance): **000**
 - **The POISONS INFORMATION CENTRE: 131 126**

For science laboratories there are additional considerations. Staff should assess the escape routes for any laboratory in which classes are being taught. Staff should ensure that:

- the door is always unlocked when a class is present
- doors to preparation rooms are never unlocked when the laboratory is occupied
- exit through ground floor windows is possible in an emergency evacuation
- students with disabilities are assisted during evacuation.

3.2.2.2: Fire safety equipment

A faculty floor plan located near the faculty entrance should show the location of all fire-fighting extinguishers and hydrant heads. This will assist staff in the event of a fire emergency.

Fire safety equipment should not be kept in areas where it is susceptible to vandalism and consequent high maintenance costs.

An approved fire blanket must be in each science room and placed in a prominent position and easily accessible where it is visible to students and staff. It is useful for personal fire protection and for smothering small fires in containers.

Metal fire buckets containing dry sand can be useful in some circumstances. Sand will reduce the spread of fire by absorbing burning liquid. Sand can also be used to extinguish small combustible metal fires.

It is recommended that sand buckets be kept in a preparation room and be made available where a risk assessment indicates it should be used. Make sure sand is not contaminated with waste such as paper or glass. The combined weight of sand and bucket should be limited to 10 kg.

Each science room and bulk chemical store should contain a 3.4 kg carbon dioxide (CO₂) fire extinguisher (red with a black band). One such fire extinguisher should be located near, but not in, any electrical distribution or switchboard room.

Yellow BCF fire extinguishers are no longer allowed, owing to the ozone-depleting properties of halon, BCF. Any halon fire extinguishers found in schools are to be disposed of by contacting your local Fire and Rescue NSW station to arrange drop-off. Find your local station [using this link](#).

Using fire extinguishers

Examine the fire extinguishers used in your work area. Take one off its rack, familiarise yourself with the instructions on the label and physically rehearse the procedure. You may be surprised to find out just how heavy it is. Check that it is fully charged and that the metal tag that shows its maintenance record is up to date. Report any problems to your supervisor.

Staff should be aware of the types, location and appropriate use of fire fighting equipment in the school.

Choosing and using the right piece of equipment:

1. In the event of a person's clothing or hair catching on fire, use the fire blanket, NEVER the sand.
2. In a school, a fire extinguisher should only be used where it is needed to assist personnel to escape a fire or where the fire is small and containable. If in doubt it is safer to raise the alarm and evacuate the area.

3. Carbon dioxide extinguishers in laboratories are good for extinguishing burning liquids and electrical fires but poor for cooling to below ignition temperature.

Carbon dioxide extinguishers are the most commonly installed extinguishers in science work areas.

To use a carbon dioxide extinguisher to extinguish a fire:

1. remove the safety pin
2. hold the insulated part of the hose
3. aim at the base of the flames while staying one to two metres from the fire
4. squeeze the handle
5. direct the jet of carbon dioxide to the base of the flames, using a sweeping motion.

For comprehensive advice on fire safety issues in schools, see the following Safety Bulletins:

- Location of fire fighting equipment in schools, (Safety Bulletin: No 23) November 1993
- Fire safety, (Safety Bulletin: No 7) November, 1989
- Fire precautions in schools, (Safety Bulletin: No 2) June, 1989
- Fire precautions in schools: actions in the event of a fire, (Safety Bulletin: No 3) March 1983.

3.2.2.3: Personal protection

Personal protective equipment includes such things as spectacles and goggles, gloves, laboratory coats and enclosed footwear made of non-porous material.

Teachers and SASS must use personal protective equipment to protect their health when this is required by the risk assessment.

(a): Eyes

Personal protective equipment for eyes includes safety glasses, goggles and face shields. Staff and students must wear eye protection when a risk assessment indicates that it be used or whenever it is considered that eyesight is at risk. Eye protection should also be used whenever activities such as the following are conducted: heating solids, heating rocks or minerals, breaking rocks, cutting, bending or heating glass tubing, cutting glass, stretching wires or cords, or filling burettes when the open end of the burette is near or above eye level.

Goggles should be used when greater protection is needed than provided by safety glasses. However, goggles mist up. The elastic straps tend to perish rapidly and there is the possibility of the goggles spreading eye infections such as conjunctivitis.

Safety glasses are generally more practical for student use. These provide important protection for situations where there is insufficient time for normal blink response to protect your eyes. With safety glasses there is less chance of spread of eye infection and less misting. There are usually more fashionable designs than with goggles, making it easier to achieve student compliance.

A face shield should be used by:

- SASS handling large volumes of concentrated acid or alkalis or opening containers that could be under pressure (e.g. concentrated ammonia solution or hydrochloric acid)
- students who have eyesight problems or other problems which require them to work in closer proximity to chemicals than normal
- students with limited body motor control, particularly of the head.

The use of eye protection is not advised when using school type lasers. There is a possibility that the eye wear will concentrate the beam and increase the likelihood of eye damage.

Ultra-violet lamps should be arranged so that UV rays cannot reach the eye.

Note: Students who refuse to comply with the requirement to wear PPE should be directed to an alternate activity.

(b): Hair

Experience in schools and industry has shown that hair can be a hazard unless adequately restrained. Long hair should be securely fixed and confined to minimise chance of catching alight or getting caught in moving equipment.

While it is not possible to specify any one type of hair restraint as the most suitable, industrial hairnets, snoods, beanies, medical theatre (paper) caps or similar hair wear could be used to confine long hair.

(c): Gloves

Disposable plastic (polythene) gloves are unsuitable for any work involving chemicals. [Section 1.9.1.3](#) and SDS provide advice on the most appropriate glove type to be used.

Barrier creams may provide an extra layer of protection, but must never be used as a glove substitute.

Try to make a range of glove sizes available for student use. Many disposable gloves are too large for effective use by small students' hands.

Disposable plastic gloves protect the skin from contamination by radioactive substances (but not from radiation itself) and biological material.

Note: See [Section 1.9.1.3](#) for information on selecting suitable gloves.

(d): Clothing

Low flammability clothing such as wool or cotton is most suitable. Synthetic layers, such as rainwear, should be removed before entering the laboratory. Ties and scarves should not hang free as they could be a fire hazard or get caught in moving equipment.

Ideally, laboratory coats should be used by staff and students when conducting practical activities with hazardous substances. Laboratory coats can stop ties and scarves from getting into flames or being caught in moving equipment. They provide most protection when fully buttoned up. Normally they protect only clothes but can provide some protection for the body if removed immediately after working with radioactive or microbiological materials.

Flammable liquids or acid/base solutions spilt on a laboratory coat are more quickly and easily removed than if spilt on other clothing.

(e): Footwear

Substantial footwear appropriate to the practical activity should be worn at all times. Footwear such as thongs, open weave type shoes, or shoes with openings at toes or heels, platform or high-heel shoes should not be worn in areas which present hazardous situations. Where indicated by a risk assessment, the wearing of safety footwear is mandatory.

Footwear with a stout sole and firm leather uppers provides best protection to students and staff in science. Because hot liquid can enter and be retained by footwear, the footwear chosen should be capable of quick removal. Thongs, open type sandals or shoes, canvas type shoes and/or gym boots must not be worn in practical classes where there is the possibility of injury through spillage of hot or corrosive liquids.

If a student whose shoes do not meet footwear safety standards is excluded from participating in a particular aspect of practical work, an alternate activity with the same expected outcome should be provided.

Note: See [Section 1.9.1.6](#) for information on footwear.

3.2.2.4: First aid equipment

A first aid cabinet should be located in each science preparation room. The cabinet must be clearly marked FIRST AID and should not contain anything other than first aid supplies.

Basic first aid supplies that should be in all science first aid cabinets include:

- disposable gloves
- cotton wool swabs
- scissors

- adhesive dressing strips
- splinter forceps or tweezers
- adhesive dressing tape
- safety pins
- gauze bandages
- eyebath
- elastic bandage
- eye pads, sterile
- sterile non-stick dressing pads
- triangular bandage
- antiseptic solution e.g. 3% cetrimide BP plus 0.3% w/v chlorhexidine in water
- antiseptic ointment e.g. 0.5% cetrimide BP plus 0.1% w/v in vanishing cream base

3.2.2.5: Immediate emergency measures in the science laboratory

The following generic advice is provided as an indication of the actions which may be required in response to an emergency situation. Specific advice for particular chemicals is given in SDS and should be followed where possible.

(a): Chemical splashes in the eye

Immediately wash the eye under running water from a tap or eye-wash bottle for at least 15 minutes. The flow should be slow and eyelids should be held back. During the first minute of washing ask if the casualty is wearing contact lens. If so, the contact lens should be removed quickly to improve contact between water and eye. Always seek medical advice whenever chemicals (even the most seemingly harmless) get in the eyes.

(b): Chemical splashes on the skin

Wash the skin for five minutes or until all traces of the chemical have disappeared. Remove clothing as necessary. If the chemical adheres to the skin, wash gently with soap.

(c): Chemicals in the mouth

Do no more than wash out the casualty's mouth. If there is a possibility of poisoning contact the Poisons Information Centre by phoning **131 126**.

(d): Burns

The [e-Emergency Care](#) module (updated October 2020) advises the following actions for emergency care procedures involving burns.

DO:

- cool burns under cold, gently running water for at least 10 minutes
- remove jewellery
- cover burn with sterile non-stick dressing
- treat for shock

DO NOT:

- break blisters
- apply lotions, ointments or creams
- apply ice
- remove clothing that sticks to burned area

N.B. Large burns must be left uncovered and medical help sought urgently.

(e): Inhalation of a toxic gas

Sit the casualty down in an area free from fumes. Monitor the patient closely in case CPR is suddenly required.

(f): Hair on fire

Smother by surrounding burning hair with fire blanket (or non-flammable cloth if close fire blanket not close by).

(g): Clothing on fire

Push the casualty to the ground with the flames on top. Smother flames by covering with a thick cloth, non-flammable garment or fire blanket.

(h): Electric shock

Take care of your own safety if a person appears to have been electrocuted. Break contact by switching off or pulling out the plug. If it is necessary to move the casualty clear of the source of the electricity use a wooden broom handle or wear thick rubber gloves.

If the casualty is unconscious, check that the airways are clear.

If unconscious but breathing normally, lay patient on side, head to one side, mouth open, with head unsupported. To leave an unconscious person lying on his or her back may cause death. Never give anything by mouth to an unconscious person.

If breathing has stopped or is feeble, start mouth-to-mouth resuscitation, continue until help arrives.

If breathing has stopped and no pulse can be detected, start CPR immediately.

(i): Severe cuts or wounds

The immediate priority is to stop excessive blood loss by applying pressure to the wound e.g. using a pad of cloth. Do not attempt to remove imbedded bodies. Raise the

wound as high as possible and, if blood loss continues or the casualty feels at all faint, lower the patient to the floor. Protect yourself and others from possible contamination by blood.

3.2.3: Good practices in chemical safety in science

3.2.3.1: Bulk storage

(a): General storerooms

All storerooms must be lockable with keys held by the head teacher and delegated staff. The entrance door must be able to be opened from the inside without the use of a key.

Teachers should periodically look through the storerooms to review the range of equipment and resources available for teaching.

Students are not permitted in storerooms unless helping with the movement of equipment, under the direct supervision of a teacher or SASS.

(b): Chemical stores

The bulk of chemicals and reserve stocks should be stored in a secure chemicals store. A chemical storeroom must have a lockable door which can be opened from inside the room without the use of a key.

The chemical store should be labelled as a chemical store (in case of fire) and no access should ever be allowed to students.

Chemical storerooms must have adequate cross ventilation to the outside. This can be achieved by the use of:

- fixed louvre ventilation
- exhaust fans if ventilation is not adequate.

Where there is a chemical store provided with mechanical ventilation, this should be used as the depot to store the greater quantity of your chemical stocks.

Storage shelving must be permanently fixed to the walls. The use of compactus storage systems where shelves are moved together and apart is inappropriate for chemical storage.

For a list of X-category chemicals, chemicals which are banned from use in government schools see Appendix H of the CSIS package. If you have any of these chemicals, they must be safely stored until collected by a waste collection service.

All chemical containers should be correctly labelled to comply with NSW WHS Regulations 2017 and the GHS. Adding the date of supply helps with stock management. Use the older stock first.

Under no circumstances should food or drink containers be used to store chemicals, even if original labels have been removed.

A stocktake of chemicals should be carried out at least once per year and containers and their labels checked for signs of deterioration. Because the chemical storeroom

can be a corrosive environment, the labels of chemical store stock should be protected. This is best achieved by covering the label and colour code dots with contact adhesive.

Unidentified chemicals (i.e. unlabelled containers) must be disposed of. They should be marked "CAUTION. DO NOT USE. UNKNOWN SUBSTANCE" and stored securely until collection by a licensed waste contractor can be arranged. Any available information about the substance should also be included on the label e.g. organic acid, heavy metal salts. This will assist with the disposal.

Note: See [Section 1.3](#) for storage requirements for the bulk chemical store.

(c): Storage containers and their transport at school

Winchester (2.5 L glass) bottles

Winchester bottles should be lifted with two hands, one under the base. Never carry these bottles by one hand around the neck. Never wash out these bottles by adding hot water suddenly because the bottom of the bottle can expand and crack away from the cooler top. When used for waste storage ensure that no waste is added that could react with existing waste. An exothermic reaction could crack the bottom off the bottle which may not fall off until you move or are carrying the bottle somewhere.

If Winchester bottles need to be carried some distance use a carrier (wire basket carriers may be purchased) or a plastic bucket. If carrying more than one of these bottles do not allow them to clink together.

Plastic containers

The suitability of a plastic container will depend on the type of plastic, thickness of plastic, contents, chemical exposure and age. Be particularly careful when handling old plastic containers of corrosive liquids. These are sometimes very brittle and can shatter easily.

3.2.3.2: Understanding and preparing chemicals

(a): Preparation rooms

Preparation rooms should be organised to achieve the optimum safe working environment.

Each preparation room should have an unlocked door leading to the laboratory(s). The external doors should have locks to provide security.

Because the preparation room is often a storage area for chemicals, preparation room doors and or the perimeter doors should be locked when not in use, so that access through adjoining laboratories is not possible to unauthorised people.

Ensure that doorways are uncluttered. It should be possible for trolleys to be moved through doorways with ease between preparation rooms and laboratories. Uncluttered and safe access between storage areas, other preparation rooms and laboratories is important. Ensure that chemical containers are secure on a trolley. Place containers in a tray if necessary.

Keep sinks, benches and services in the preparation room well maintained.

SASS should have keys and access to all parts of the science department. The school science assistant frequently works in the preparation room but must be provided with opportunities to use a separate work desk and eating area away from the preparation rooms and laboratories.

No eating, drinking or preparation of food should occur in a preparation room or laboratory, unless adequate precautions are taken to ensure no contamination is possible.

(b): Chemicals kept in preparation rooms

The chemicals in preparation rooms should be accessible to teachers and SASS but not to unauthorised people, including students. Where chemicals are stored in preparation rooms, any adjoining laboratories or other rooms must be lockable.

Compared to bulk chemical stores, storage requirements do not need to be as stringent for science preparation rooms. However, only minimal quantities of flammable liquids should be kept in these areas. For more details refer to [Section 1.3.2](#).

Care should be taken not to store Oxidising Liquids and Oxidising Solids next to strong reducing agents such as carbon, carbon compounds (including wood, paper, cotton, sugar, starch, organic solvents), metals, phosphorus, sulfur, sulfites, thiosulfates, chlorides, bromides, iodides.

Chemicals should be stored out of direct sunlight and away from heat sources.

Chemicals are best stored in areas of low humidity away from sinks.

The chemical risk assessments provide guidance on the storage controls required for hazardous chemicals. As a general principle, the below table provides guidance on the separation and segregation requirements for chemical classification types.

Class	2.1	2.2	3	4.1	4.2	4.3	5.1	5.2	6	8
2.1										
2.2										
3										
4.1										
4.2										
4.3										
5.1										
5.2										
6										
8										

Segregation key	Segregation type
	COMPATIBLE: Chemicals with similar hazards are usually compatible. However chemicals may have more than one hazard and you should still check the SDS.
	REFER TO SDS: Separation of these chemicals may be necessary. Consult the SDS for further guidance.
	MINIMUM THREE METRE SEPERATION: These chemicals may react dangerously if stored together and should be kept at least three metres apart.
	MINIMUM FIVE METRE SEPERATION: Storing these chemicals together will significantly increase the likelihood or severity of an incident. They should be kept at least five metres apart or in separate storage areas.
	ISOLATE: Dedicated storage areas or storage cabinets are recommended for self-reactive chemicals and organic peroxides, as is separation from other buildings and property boundaries.

Source: SafeWork Australia - Managing risks of storing chemicals in the workplace: Guidance Material

(c): Techniques

Learn as much as you can about the chemicals you handle and make.

Read chemical labels very carefully to ensure that you:

- have the chemical you want, e.g. that you haven't confused mercury (II) chloride, which is highly toxic, with mercury (I) chloride, which has low toxicity
- are aware of hazards associated with the chemical, e.g. contact with mercury vapour is much more toxic than contact with mercury liquid
- are aware of any potentially hazardous additives in mixtures, e.g. formalin contains 10-15% methanol; commercially prepared volumetric solutions of hydrochloric acid can contain toxic mercury (II) chloride preservative.

If you have never used a particular chemical before, read about it before you physically handle its container or carry out a reaction to make it. Refer to the department risk assessment protocol (see [Section 1.5](#))

Mentally prepare yourself and physically prepare the handling site before removing the chemical from storage.

Assess if you should:

- be away from heat sources
- use a fume cupboard
- be near or away from water
- use a spatula or particular glassware
- be handling this chemical alone or with other people present.

Appendix D provides useful information about these issues.

All reagent bottles should be properly sealed.

If chemicals are repackaged into reagent bottles:

- solids go into wide-necked bottles (for easier spatula access)
- liquids go into narrow-necked bottles (for easier pouring).

Bottles should be picked up by the body of the bottle, not by the neck or lid.

Remove non-screw stoppers by holding the bottle, then simultaneously turning and lifting the stopper upwards.

When pouring liquid ensure that the label is at the top (i.e. label faces palm), so the liquid does not run down the label. Wipe the exterior to remove spilt liquid after use.

Solids should not be touched by hand. Use a spatula or spoon.

Tighten screw tops after use to minimise exposure to oxygen, water or carbon dioxide.

Unless a chemical is being heated, keep chemicals away from heating devices such as Bunsen burners, hot plates or gas rings.

(d): Labelling of decanted substances

Labelling hazardous substances

All chemicals used in schools for curriculum purposes must be labelled. The department requires chemicals in schools to be labelled with coloured dots. These dots are a key to the department restrictions on the use of the chemical in teaching and learning settings. Hazardous chemicals must be labelled to comply with the legislative requirements.

There are labelling requirements for containers of decanted substances which are particularly relevant to secondary schools. There are three levels of labelling required for use with decanted hazardous substances in schools.

- If the decanted substance is for **immediate use**, no labelling is required.
- Substances decanted for **current use** (on the day of preparation) must be labelled with the product identifier and a hazard pictogram or hazard statement

consistent with the correct classification of the chemical. Substances to be used over two or three days must also have the concentration, date and the name of the person preparing the substance included on the label.

- If a chemical is decanted for **long term use** (i.e. longer than three consecutive school days), the labelling must comply with the legislative requirements for containers of that capacity.
- Where the container to be labelled is too small for the required information to fit on the label, the small container should be labelled with the name, and placed in a larger container which has a label complying with the short or long-term use requirements.

Note: Existing stocks of chemicals and containers of previously decanted substances may need to have their labels upgraded to meet these requirements.

Preserved biological specimens

In the past formalin (40% formaldehyde) has been used to preserve biological specimens in jars.

Where this is still the case, these jars need to be labelled in accordance with the NSW Work Health and Safety Regulation 2017 and GHS requirements. The following sample label indicates the recommended detail. An appropriate label should be attached.

It is recommended that a 50% solution of ethanol or methylated spirits and water be used in place of formaldehyde solution. In such cases the label needs to clearly identify the preservative.

If formaldehyde solutions are replaced the procedure should be carried out in a fume cupboard. See Appendix D for disposal advice.

(e): Transporting chemicals

Science staff with laboratories on two or more sites are advised to plan carefully to reduce the need to transport chemicals between the sites.

Only non-hazardous chemicals should be transported by staff in private vehicles. Potentially reactive or incompatible chemicals should never be transported in this way. No chemical (hazardous or non-hazardous) should be transported in the cabin of a motor vehicle.

The following strategies will help schools manage the transportation of chemicals to, from, or in the school site.

- Hazardous chemicals purchased from local suppliers should be delivered to the school by the supplier.
- When ordering chemicals, request that chemicals are packaged separately and are delivered by the supplier to the relevant sites around the school.

- If multiple distribution is not possible, hazardous chemicals should be left in the packaging/outer packaging in which they were delivered to the school and transported to various school sites in this condition. (This will ensure that the chemicals are transported with the appropriate labelling, including the relevant signal words, hazard statements and pictograms. People involved in the transport will be able to apply the appropriate measures to ensure their safety therefore complying with legislative requirements.)
- If these strategies cannot be applied, it will be necessary to contract a qualified transporter of hazardous chemicals to move the chemicals.

(f): Glassware

Check glassware before use and discard any chipped or cracked glassware. Broken glassware must go into a dedicated and well labelled glass waste container.

Inserting glass tubing or thermometers into corks or stoppers is a very dangerous activity for teachers, SASS and students. Junior students should not carry out this activity. Complete equipment should be provided for junior students. Some injuries resulting from these activities have involved cut arteries and permanent nerve damage.

Lubrication of the glass with water or glycerine may be needed. The borer used in bark cork should be slightly narrower than the glass. The borer used in a rubber stopper should be slightly larger than the glassware. Make sure the glass is held close to the cork or stopper so as to minimise leverage and the force that could break the glass. Keeping the hands close together, rotate as well as lightly push the glass through the cork or stopper.

Dishwashers are a convenient way of cleaning glassware after a preliminary wash with cold water. Avoid putting chemicals into the dishwasher. Thermometers must NEVER be placed in a dishwasher.

Do not use hot water to wash glassware that has contained biological material. Hot water will denature (change structure of) soluble protein causing it to precipitate out and make cleaning difficult. Periodically check the waste trap of the dishwasher for chips of glass.

3.2.3.3: Laboratories

(a): A safe laboratory

Always work towards making the laboratory as safe as possible.

Make sure gas, electricity and water control devices are clearly labelled, readily accessible and well maintained.

Where electricity master controls exist, staff must have ready access to the keys for the switch, for use in an emergency.

The water control tap should be left on. When the water supply is interrupted, no experiments involving chemicals or heating are to be carried out.

In the event of an unplanned loss of power or water, teachers should cease any practical work which involves the use of chemicals, until the supply is restored.

Ensure that the principal, deputy principal or general assistant know to inform the science department when there is to be a planned shutdown of power or water. This should ensure that the following problems do not occur:

- fume cupboard or electric fan failing at a critical stage of an experiment.
- water not available for emergency washing of skin in the event of an acid spilt onto a student.
- water not available to clean-up chemical wastes at the end of a lesson.
- The main gas control must be turned off at the end of each day. If the control or its cabinet has a lock, the lock must be used to secure the control.

Make sure there is ready access to tap water in an emergency situation such as if there is a need to irrigate a student's eyes or exposed skin. Suitable devices include a hand-held shower head or a safety shower.

Timetable the classes which are most often using hazardous chemicals in laboratories which are fitted with fume cupboards. Consider class rotations into laboratories with fume cupboards while classes are doing topics involving chemicals.

Have separate waste receptacles for general rubbish and broken glass.

Ensure that there is always clear passageway to exit doors in case of an emergency evacuation. Exit doors may be closed but not locked whilst students are occupying a laboratory. Doors must be locked when the laboratory is not in use.

(b): Before a lesson

Lesson plan

Give SASS adequate notice of requirements. Last minute requisitions give neither the teacher nor the assistant time to complete a risk assessment. Allow time at the end of the lesson to clear away equipment, wipe down benches, unblock sinks, etc.

Contingency plan

If you plan to use chemicals, be aware of the degree of sensitivity to chemicals of the students in the class. This information can often be obtained from student records or by asking the students themselves.

Be aware of the correct emergency care procedures to apply in the event of a student reacting adversely to a chemical substance.

Be aware of the location and correct use of the fire extinguisher, fire blanket, sand bucket, a spill kit, the main controls for water, gas and electricity and location of

possible fire exits. Make sure the main water control is turned on or a safety shower or eye irrigation system is available.

Equipment distribution

Plan several points to minimise congestion. Stagger distribution to maximise supervision.

Distribution of chemicals

Consider if one or more containers should be used. If more than one container is used consider if there should be one or separated distribution points. Decide on how closely you need to supervise distribution for the class. Decide if the chemical is best distributed from the original container or from a beaker, a watch glass or Petri dish.

Check if the top layer of chemical needs to be removed and discarded first (e.g. if the top layer of green iron (II) salt has been oxidised to iron (III) salt; or if top layer of alkaline material has reacted with carbon dioxide in the air to form carbonate; or if sealing wax can be found in the top layer of a newly opened bottle).

Do not use substances that:

- have obviously deteriorated, e.g. "cracked" or oxidised - the "Appearance" section of the SDS will tell you what the chemical should look like if you are not sure
- are in damaged containers or have damaged or illegible labels
- are beyond their use-by date, should the chemical have one.

If the original container is used, check if the solid needs first to be broken up into finer pieces with a metal spatula.

Select the most appropriate instrument to transfer the solid i.e. a metal spatula, plastic spatula, plastic spoon or wooden "pop-stick"). To reduce the chances of contamination, excess chemical should not be put back into an original container.

Encourage students to only transfer the amounts needed. Give students clear instructions for disposal of excess quantities. Consider the use of a labelled secondary container for excess quantities so that the chemical can be used by others or kept for use when purity is not critical. Displaying of a sample of the quantity required may avoid the need to use weighing or volume measuring equipment.

Ensure students know how to remove a stopper, how to keep a stopper in one hand while pouring from the bottle; how to place the stopper, if it is a suitable shape, on the bench so that no contamination of the bench or the original bottle occurs.

Ensure students know to read the label and how to correctly and safely pour so that the chemical does not damage the label.

Personal protection

If the risk assessment indicates the need, make sure the appropriate personal protection equipment is used. Ensure other required control strategies are in place.

Note: Consider leaving some chemicals in full packaging to demonstrate the importance of safe transport to students, e.g. a 2 mL glass ampoule of bromine can come inside a small plastic tube sealed with cotton wool so the ampoule does not move. The plastic tube is then completely surrounded with absorbent perlite in a screw top plastic container with a volume many hundreds of times the volume of bromine.

(c): During a lesson

Bags

If allowed in the laboratory, bags should be placed so as not to impede student movement.

Class management

Encourage students to listen to instructions and to behave responsibly when carrying out practical activities. Raise the awareness of students to the need to be on task and mindful of the other activity in the room. Discuss how irresponsible or unthinking behaviour can lead to accidents.

Reminders

Frequently remind students of safe techniques, even when these should be familiar. This can be done by question, example and quick demonstrations.

Eating, drinking, chewing

Not permitted unless part of the experimental work. If an activity involving eating, drinking or chewing is carried out, stress the special nature and ensure no contamination occurs.

(d): Bunsen burners

When not in use Bunsen burners should be turned off to limit the production of carbon monoxide. When lit, but temporarily not in use, the air hole should be closed so the flame is yellow. When the air hole is open, the flame is difficult to see, especially in bright sunlight. Position burners away from wall fittings or blinds. Make sure that, with paired gas outlets, only the tap connected to the Bunsen is turned on. Periodically check the condition of supply hoses.

(e): Heating chemicals safely

The following skills need to be taught and frequently reinforced with students.

- Students usually remember to point test tubes away from their own face, but may need to be reminded to point them away from other students.
- Liquids are best heated in 150 x 25 mm boiling tubes. Anti-bumping granules (e.g. broken porous pot or broken unglazed earthenware pottery) may be useful and should be added to the liquid before heating.
- Heating should be gradual, with the mouth of the test tube well away from the flame.

- Students should always be standing when heating, boiling and pouring so that they can move away quickly if necessary.
- Flammable liquids must not be heated near or by a naked flame. Use hot water from a tap or a water bath heated by an electric hotplate.

(f): Smelling gases

Identifying gases by their odour is an important technique which students must learn to use safely.

- Fill the lungs with air by breathing in. Close the mouth then waft fumes by hand cautiously towards the nose whilst sniffing. Once the odour has been detected breathe out through the nose.
- Asthmatics should not be exposed to significant levels of sulfur dioxide or chlorine. Many gases dissolve in the moist tissues of the nose and lungs, forming acids or bases.

(g): Spills

Spills should always be cleaned up immediately.

Check [Section 3.2.7](#) and [Appendix E](#) and the SDS for advice on how to deal with a chemical involved.

Care should be taken if cloth or paper towel are used to absorb flammable liquids as they can be accidentally lit by hot objects. If the liquid is volatile enough, allow it to evaporate in a fume cupboard.

Cat litter, expanded perlite or vermiculite are good absorbents that can be used to cover and absorb spilt liquid.

Encourage students to report all spills and breakages so that immediate clean up minimises hazards.

(h): Cleaning up

Clean up after a practical lesson involving chemicals. Every teacher and class entering a laboratory is entitled to find the laboratory in good condition and free of chemical contamination of benches, seats and other working areas. Wise time management will ensure ample time to put away materials and clean up the laboratory after each practical session.

A good clean up demonstrates environmentally responsible behaviour.

It is good practice for the students who carried out a procedure with chemicals to also do the clean up under your supervision.

If you have handled the chemical then you are probably the person best qualified for cleaning up and disposing of any surplus chemical.

If you are not going to complete the cleaning up then at least do so to the stage where minimal risk exists for the person carrying out the remaining stages (e.g. other teacher or SASS). Advice from you on the best way to do the final clean-up will make it safer and easier for the person who completes the task.

If uncertain on how to dispose of a surplus chemical refer to [Appendix E Disposal of waste chemicals](#).

Make sure all students can and do wash their hands after practical work involving chemicals, soil or material of living origin. Provide disposable paper towelling. Liquid soap dispensers are convenient.

(i): Extended practicals

Experimental apparatus should be clearly labelled with a name, group, or class and date of setting up. If the apparatus contains any hazardous chemicals, an appropriate label in accordance with Section 3.2.3.2 d) should be attached. Consideration of the nature of other classes using the laboratory is crucial to deciding where the equipment should be placed.

3.2.3.4: Handling laboratory chemicals safely - a summary

1. Know your chemicals. Read the information in [Appendix D](#) and SDS. Consider how chemicals in mixtures could react. Consider the products of reactions.
2. Read each label carefully. Double check that the label is for the chemical you want. Does the chemical's appearance match the information you just read? Dispose of any unlabelled or suspect chemicals appropriately.
3. Do not create extra hazards by storing chemicals in a fume cupboard.
4. Don't smell chemicals directly. Gently waft the smell towards your nose until you get a faint odour.
5. Always use a pipette filler to fill a pipette. **NEVER PIPETTE BY MOUTH.**
6. Clean up spills immediately. If you made the spill, it is your responsibility. The SDS has information on appropriate procedures for dealing with the spill and about the personal protective equipment (PPE) which must be worn. If the required equipment or expertise is not available evacuate the area and call the fire brigade.
7. Be cautious. Try to avoid working alone. Don't leave experiments or active processes unattended. Don't use flame or sparking equipment (e.g. an electric motor) unless you are sure no flammable materials are present.
8. Laboratory chemicals belong in the laboratory. Do not remove them from the laboratory without permission.

3.2.3.5: Micro techniques in chemistry

Micro techniques are increasingly being used in chemistry, particularly as physical detection equipment becomes more sensitive e.g. drug analysis of an athlete's blood.

Micro and semi-micro equipment can be obtained from some suppliers. If you decide to reduce the scale of a laboratory activity it is wise for you to try the microtechnique yourself before asking students to do so. Special consideration needs to be given to:

1. measuring out chemicals

- If you are close to the limit of reading of a balance, the true proportions of chemicals reacting together will vary more than if you measured out larger amounts.
- If you are close to the limit of reading of a measuring cylinder, consider using a burette, or micro pipette or weighing the liquid(s).
- If a very small quantity of a chemical in solution is required, prepare a bulk solution of low concentration and then use a small volume, e.g. Avogadro's number determination involving measuring the area of a monolayer of molecules on water can require drops of a solution of 0.10 g stearic acid per one litre of petroleum ether.

2. narrowness of glassware used

- If ignition tubes are used as test tubes, surface tension effects become more important, e.g. some precipitates, although denser than the solution, will be trapped on the surface of the liquid; mixing immiscible layers will be more difficult.
- Vapour will condense to liquid more easily in cool spots of a condenser which could lead to spurting.

3. possible limitations

- Changes may appear to occur more quickly.
- Students' eyes may be closer to the equipment and things may go wrong.
- Temperature changes may be more difficult to measure by a liquid/glass thermometer.

If a demonstration is at too small a scale for the whole class to see, then use a video camera for all to see on the TV screen. Students might like to carry out demonstrations in small groups, videorecord what happens and possibly make a short teaching video.

Note: Using a microtechnique is practising conservation of resources.

3.2.3.6: Investigative science

Open-ended, practical investigations are carried out in many science courses. At times students are required or may wish to conduct investigations using hazardous chemicals. Such situations may occur within normal lesson time or they may occur

outside lesson time, e.g. at home or during a trip. (The situations for distance education students are considered in the next section.)

Teachers need to assume that students will not have sufficient understanding of the hazardous properties or the risks involved in using certain chemicals for open ended investigations.

WHS regulations and duty of care place the onus on teachers to issue appropriate instructions, warnings and control strategies for any activities which may involve students using hazardous chemicals. This includes any out-of-class activities.

When students are required or wish to design their own experiments using chemicals, a teacher must:

- restrict students to using the chemicals listed in the category of use allowed for their year of schooling under the Department's risk assessment protocol
- approve any student-designed activity involving hazardous chemicals, only after providing the student with appropriate safety information and after being confident that effective controls will be applied by the student.

Teachers should have discussions with students who wish to use chemicals for independent practical investigations and encourage and guide them to use only non-hazardous chemicals. Very often, effective results for a wide range of chemical interactions are best achieved using very low and non-hazardous concentrations of chemical. For example, students wishing to investigate the effect of acids on seed germination will achieve better and more realistic research outcomes using acids in parts-per-thousand concentrations than using them in concentrated form.

Where the use of a hazardous chemical is important to the educational outcome of a project, the teacher can support the student by supervising at school the practical component of the project which requires the hazardous chemical.

For student-designed practical investigations to be carried out away from school:

- students should use chemicals under the supervision of a responsible adult/parent or guardian
- a teacher should require students to submit a safety check list as a means of accounting for their safe use of chemicals or for use in discussing chemical safety.

3.2.3.7: Use of chemicals by distance education students

At times distance education students need to conduct practical investigations using chemicals. Some courses include mandatory and recommended practical experiences involving the use of chemicals. There are also requirements to complete the practical components of Board of Studies course.

WHS regulations and duty of care require teachers to issue appropriate instructions, warnings and control strategies for any out-of-class activities which may involve students using hazardous chemicals.

A teacher must provide clear and safe instructions and provide adequate precautions for any activity involving a hazardous chemical.

Distance education teachers should only instruct students to use or carry out activities using relatively safe and commonly available chemicals. The department *operational guidelines* must also apply.

The student should be required to submit a safety check list as a means of accounting for their safe use of chemicals or for use in discussing chemical safety with their teacher.

Alternative experiences, such as the observation of video footage of chemicals reacting, should be provided where the chemicals needed would constitute a significant risk to the student.

Students must use chemicals under the supervision of a responsible adult/parent or guardian. This may be a home supervisor.

Most distance education students are based in a different school to their subject teacher. Where the use of a hazardous chemical is important to the educational outcome of an activity, the subject teacher may be able to arrange for the direct supervision of the student by another teacher in the student's school.

3.2.4: Information about common dangerous or hazardous activities

3.2.4.1: Unauthorised experiments

(a): Use of animals

In general, teachers must always consider alternatives to the use of animals when planning lessons. Where the use of animals is justified, only approved activities may be undertaken. Activities that are automatically approved may be found in the publication *Animals in Schools: Animal Welfare Guidelines for Teachers*.

All other activities involving animals must have the approval in writing of the Schools Animal Care and Ethics Committee (SACEC).

An appropriate application form is in the publication *Animals in Schools: Animal Welfare Guidelines for Teachers*.

(b): Use of human tissue in experiments

Experiments using fresh human blood or fresh human tissue, e.g. cheek cell smears, should not be undertaken. Teachers are to use only commercially prepared slide

preparations to study the cellular components of blood and are not to undertake practical work to determine students' blood groups (e.g. A, B and O).

(c): Use of starting pistols and caps

Teachers are reminded that there are department restrictions on the use of starting pistols and caps that must be observed in practical activities. These restrictions apply to the type of pistol that can be used, the storage of pistols and caps and the use of pistols by students.

In particular, no student is to operate a starting pistol or have access to a starting pistol or caps. During practical activities, staff must observe department requirements, implement control measures and wear personal protective equipment.

The safety requirements to be followed by staff are clearly set out in Requirements for all [sport and physical activity](#) (updated September 2020).

3.2.4.2: Potentially dangerous activities involving chemicals

table showing potentially dangerous activities involving chemicals

Activities	Hazard/s
exothermic reaction	heat, explosion
making flammable gases	explosion, heat
heating solvents/volatiles near a naked flame	fire, explosion
diluting concentrated acid	heat, boiling, ejection of acid damage to eyes/skin/clothing
using strong base solutions	highly corrosive to eye, skin
heat/grind/compress strong oxidising agents	explosion
lithium or sodium near water	heat, flammable gas, fire
calcium oxide, calcium carbide, lithium hydride or phosphorus chloride near water	heat, flammable gas, fire

table showing potentially dangerous activities involving chemicals

Activities	Hazard/s
mercury	vapour (10 mg vapour in a laboratory near to "safe limit"; 5-10 g vapour in a closed laboratory saturates the air)
sodium, lithium, calcium, magnesium powder or aluminium powder + acid	explosion
heating ammonium nitrate by self or in mixtures	explosion
evaporating ammonium nitrite solutions	explosion
potassium permanganate + concentrated sulfuric acid	explosion
potassium permanganate + glycerol	fire
Al powder + lead oxide or copper oxide	can explode on heating
Al powder + caustic alkalis or hot sulfur or iron oxide	violent reaction
Zn dust + chlorinated hydrocarbons or sulfur	violent reaction
Zn dust + oxides or oxidising agents	violent reaction
Zn dust + caustic alkalis or hot sulfur	violent reaction
ammonia + iodine	explosion
hydrogen + chlorine in light	explosive reaction
alcohol + concentrated nitric acid	may explode after mixing

table showing potentially dangerous activities involving chemicals

Activities	Hazard/s
lead nitrate + reducing agents	can explode on heating
Mg powder + silver nitrate	explodes with trace of water
reduction of lead oxide or mercury oxide on charcoal	toxic metal vapour released
heating naphthalene	highly toxic vapour
using Millon's reagent	1 drop down the sink exceeds the whole school's Hg waste limit/day
ammoniacal silver nitrate solution (<i>Tollen's reagent</i>) (surplus should be acidified with HCl then added to a silver waste bottle)	explosive when evaporated
nitrite, sulfide or sulfite + acid	poisonous gas
metal + concentrated sulfuric acid	poisonous gas
metal + dilute or concentrated nitric acid	poisonous gas
grinding solid oxidant and reductant in a mortar	explosion
chloride or bromide or iodide + concentrated sulfuric acid	poisonous, irritant gas

table showing potentially dangerous activities involving chemicals

Activities	Hazard/s
formalin + hydrochloric acid	can produce potent carcinogen
plastics testing by heating	harmful fumes
thermite reactions	extremely exothermic; molten metal products
preparation of gases	escape of harmful gases
gases under high or low pressure	explosion or implosion
explosion of gases, gas/air mixtures	moving objects, heat, loud sound
distillation and refluxing	explosion if equipment blocked

3.2.4.3: Other potentially dangerous activities

table showing potentially dangerous activities and hazards

Activities	Hazard/s
voltages above 25 V from electrical equipment	current could penetrate skin
gas discharge tubes operating above 5000 V	can produce soft X-rays
solar and UV (<315 nm) sources	can damage retina, skin
microwave transmitters	can affect heart pacemakers
using radioactive sources or eluent/eluate	radioactive contamination
using a laser	eye damage
stroboscope or signal generator between 7 and 15 Hz	can trigger epileptic attacks
using circular motion apparatus	fast moving objects
some projectile motion experiments	potentially harmful projectile
wires under tension	break, flick loose, cut or puncture eye or skin
using a centrifuge	fast moving objects
steam, under high pressure or low pressure	explosion, implosion, burns

table showing potentially dangerous activities and hazards

Activities	Hazard/s
explosion of gases, gas/air mixtures	moving objects, heat, loud sound
heating, flames, hot liquids, hot objects such as tripods	burns
volatile liquids and flammable gases near Bunsen flame/spark source	burns, fire
blowback in Bunsens	burns, fire
models of steam engines	pressure explosion, flammable liquids, steam burns
cutting, heating or using glassware	cuts, burns
using biological materials (particularly microbiological, saliva of another person, poisonous plants, materials from butchers or abattoirs or farms)	infection, poisoning
using dissecting instruments and sharp instruments	cuts
using a geological hammer	flying fragments
heating large lumps of moist clay or certain rocks	explosion, fragmentation, burns
using students as subjects (in exercise or body temperature experiments)	physical and psychological stress, asthma
taste testing	poisoning
setting plaster of Paris or freezing water in glass	expansion and cracking of the glasses

table showing potentially dangerous activities and hazards

Activities	Hazard/s
cryogenic/freezing mixtures/dry ice	low temperature "burns"
food experiments	students may eat contaminated food

3.2.4.4: Test tubes and heating

Heat resistant glass is also called borosilicate or Pyrex.

Heat resistant glass is not recycled in Australia.

Dispose of all glass carefully e.g. place in a sharps disposal container or wrap in many layers of newspaper or cardboard so that sharp edges will not penetrate wrapping and injure waste disposal personnel. This is very important. Consider the possible anxiety created for a person injured and not knowing what chemicals or biological specimens had been in contact with the glass.

Test tubes used in schools are generally of three sizes:

75 x 8 mm (small test tubes or ignition tubes)

- Useful for micro scale work.
- Wear eye protection when used for potentially exothermic or endothermic reactions.
- Do not use for very exothermic reactions; there is a possibility the narrow opening could be blocked by reagents or products.
- Often used for very endothermic reactions requiring strong heating or where a "test tube" needs to be broken open to obtain a fused product.

150 x 15 mm (medium test tubes)

- Most commonly used size for observing reactions.
- To mix contents well: hold tube between the thumb and top two fingers of one hand; hit the bottom of the tube with the first finger of the other hand moving in a horizontal motion.

150 x 25 mm (large test tubes or boiling tube)

- Best size for heating or boiling liquids.
- Keep the quantity as small as possible; the depth should not exceed 50 mm.
- Use a small Bunsen flame with just sufficient air for full combustion.
- Hold the tube at 45° using a test tube holder just under the rim.
- Make sure the mouth of the tube points away from yourself and others.
- Keep the contents agitated by to and from movement of the wrist in order to prevent superheating, sudden formation of gas and spurting.

1. Do not use damaged or dirty tubes.

2. Never leave a hazardous substance unlabelled in a tube.
 3. Wear eye protection whenever heating solids or liquids - inside or outside a tube.
- Tubes with square rather than curved sections, e.g. specimen tubes, gas jars, measuring cylinders, must never be heated with a flame.
 - If warm liquid is to be placed in these tubes, check carefully for glass defects before use; then gradually raise the temperature as you stir.

Note: Do not heat chemicals in soda glass tubes. Only apply heat to heat resistant glass.

3.2.4.5: Electrical safety

Domestic safety switches (formerly called earth leakage protection units) compare the current entering a circuit (active line) with the current leaving a circuit (neutral line). If a current difference of 30 mA is detected, a circuit breaker is operated within 30 milliseconds thus switching off the power supply.

In general, currents below 30 mA can cause pain and injury only from secondary effects such as a fall.

Currents as low as 50 mA can kill.

A dangerous level of current may pass into the body at a voltage of 25 V.

High voltage equipment, such as van de Graaff generators or induction coils, should be limited to provide less than 5 mA output. Check manufacturer's instructions.

Electric shock

Shock is caused by the passage of electric current through the body to earth. The amount of current passed depends on the voltage, the resistance between the body and the earth and the time of contact. The effects are more serious if the current flows through or near the heart. The effects of the current are as follows:

table showing effects of electric shock currents

Current (mA)	Effects
1	muscular contraction
10	involuntary movement

table showing effects of electric shock currents

Current (mA)	Effects
15	cramp inability to release the conductor
30	heart disturbances rise in blood pressure
50	ventricular fibrillation unconsciousness burns and current marks death

(Adapted from Chemistry in Action! No 39, Spring 1993, p.21, Safe Science by Peter A. Start).

An induction coil operated at 6 V from a transformer-rectifier unit with a 5 A circuit breaker would produce about 1 mA.

A school van de Graaff generator produces up to about 0.1 mA.

3.2.4.6: Ionising radiation

The three key processes of radiological protection are:

- Justification - showing that the benefits outweigh the detriment that the radiation might cause.
- Optimisation - keeping all exposures as low as reasonably practicable/achievable.
- Dose limitation - keeping the total relevant dose for employees and others undertaking work, and for the public below specified limits. These apply to the potential for accidental exposures as well as predictable normal exposures

Good planning and use of risk assessments can achieve the aims of justification and optimisation. Thus, only useful experiments/ demonstrations should be carried out. Experiments should be carefully planned to minimise the handling of radiation sources and to avoid unnecessary repetition of experiments/demonstrations.

Exposure to ionizing radiation sources can be minimised by using the three principles of radiation protection:

- Time – keep the time you stay next to a radiation source to the minimum necessary in order to reduce the total exposure.
- Distance – keep the distance from the source to the maximum practicable as the further away you are from a source, the lower your exposure. The inverse square law applies to physically small radiation sources and describes the relationship between distance and dose rate. The inverse square law means that if you double the distance from a source, the dose rate will be $\frac{1}{4}$ of the original; triple the distance and the dose rate becomes $\frac{1}{9}$ of the original etc.
- Shielding – the thicker the appropriate barrier between you and the source, the less you get exposed.

Although the radiation sources recommended for use in schools are such that the potential for harm is very low, you should treat them as potentially hazardous and take advantage of the opportunity to train students in dealing with hazardous items.

Figure 3.2: Radiation units of measure

Ionising radiation consists of:

table showing what ionising radiation consists of

alpha (α) particles	Stopped by a sheet of paper or surface layers of skin
beta (β) particles	Stopped by a few millimetres of aluminium or 1-2cm of plastic
gamma (γ)	Almost completely stopped by about 1m of concrete or 5cm of lead; most will pass through the human body.
X-rays (medical)	Almost completely stopped by 2-3 mm of lead or about 10-15 cm of concrete. Will pass through the body with some absorption, depending on the density of organs in the beam.

Information on alpha, beta and gamma (α , β and γ) sources is provided later in this section.

Radiation Protection Series No. 18 (RPS-18) Use of Radiation in Schools (Australian Radiation Protection and Nuclear Safety Agency, June 2012) provides specific information and guidance for the safe use of radiation in schools. The information from this safety guide is summarised within this section however further detail can be obtained from this safety guide.

<https://www.arpansa.gov.au/sites/default/files/legacy/pubs/rps/rps18.pdf>

Code of Practice for the Safe Use of Ionising Radiation in Secondary Schools (1986)
National Health and Medical Research Council states:

- "7.1 X-ray generators shall not be used in schools, except where they are required for special trade or technical courses. In such cases it may be necessary for the school or the recognised (designated) teacher to hold a licence. This matter should be discussed with the relevant statutory authority.
- 7.2 Where X-ray generators are used the code of practice relevant to that particular appliance shall be used. Such codes are available from the relevant statutory authority.
- (EPA Radiation Control PO Box 136 Regents Park NSW 2143. Telephone: 02 9795 5014 Fax: 02 9649 4470). However, the radiation protection limits contained in this code (see part (c) of this section) shall apply."

Some pieces of equipment in secondary schools, although not called X-ray generators, have the potential to inadvertently generate by-product X-radiation (often called soft X-rays).

Gas discharge tubes (Crooke's tubes, vacuum scale tubes, spectrum tubes) connected to induction coils may produce unwanted X-rays from the tubes when operated above 5 000 V. A rough guide to the operating voltage can be inferred from the size of the spark produced between the adjustable sparking points of an induction coil. 5 000 V will normally produce a spark of 0.5 cm in air.

Warnings such as that shown below, often seen on induction coils (and other equipment capable of producing over 5000 volts), do not apply to the induction coil by itself.

X-RAYS MAY RESULT FROM THE OPERATION OF THIS EQUIPMENT

X-rays can be emitted from a gas discharge tube when the tube has sufficiently low pressure and a voltage is applied by an induction coil or van de Graaff generator. X-rays are produced when electrons accelerated in a low gas pressure discharge tube are stopped by collision with an electrode or the glass. The lower the pressure in a gas discharge tube, the greater the velocity achieved by the accelerated electrons and the more energy that is available for the production of X-rays.

Note: If a school keeps or uses any sources of radioactivity, the principal should designate a member of staff (the Radiation Supervisor) to monitor the safe use of the sources within the school.

Refer to RPS-18 Section 4.1 for responsibilities of the Radiation Supervisor.

X-rays may result from the use of Crooke's tubes. X-rays are not produced by sparks in air from an induction coil or a van de Graaff generator.

(a): Radioactive sources and equipment

UNITS:

S.I. unit: Becquerel Bq

1 Bq = 1 nuclear transformation per second

Non-S.I. unit: Curie Ci

1 Ci = 3.7×10^{10} Bq

The only radioactive materials used in science practical work should be:

1. sealed sources
2. sources supplied with equipment such as cloud chamber kits
miniaturised radioisotope generators or mini-generators which generate short-lived daughters of Cs-137 or Sr-90
3. uranium ore samples or compounds. The radioactivity per gram of such samples or compounds is extremely small, and because of this, on a weight basis they represent a low radiological hazard. However, they are chemically as toxic as arsenic and must only be handled by staff. Ore samples should be stored in sealed containers (glass if possible) in a secure area. Secure area includes the chemical store, equipment store or locked display cabinet.

Strict procedures must be adopted to avoid contact with the source material. If quantities exceeding a few grams of uranium or thorium compounds or natural ores are held they should be kept in a ventilated area to prevent the build-up of radioactive radon gas. Accumulating large volumes of ore samples is undesirable.

Note: A school should keep the number of radioactive sources stored on site to a minimum.

Storage

All radioactive sources in a school must be stored in a locked metal, or metal-lined, container which is permanently labelled to indicate that it contains radioactive substances. Contents of the box should be listed on the outside.

During 1979, one of the first storage boxes issued to a NSW school was withdrawn and monitoring tests carried out in respect to residual and surface activity. This action was taken as a safety measure to ensure that school staff were not exposed to any significant level of radiation whilst handling the box. All monitoring tests carried out on this box, which had been exposed to radioactive materials for approximately 11 years, proved to be negligible.

You should keep all radioactive sources in suitable containers when not in use. These should be locked in a secure store when a member of staff is not supervising them.

Best practice is to keep each radioactive source in a suitable container. This is normally the container in which the source was supplied. It allows the source to be identified easily and carried safely. For example, the cup source is kept in a lead pot inside a wooden box. Labelling on each container should uniquely identify the radioactive source(s) inside and include a trefoil warning sign with the wording 'radioactive materials'. An example of a suitable radiation warning sign is given in Figure 4. Australian Standard AS 1319-1994 (Standards Australia 1994) contains further detail about requirements for such signs.

Further guidance on the location, construction, signage and security of stores can be found within RPS-18. Note: Radioactive sources do not induce radioactivity in the materials surrounding them.

Some smoke warning alarms

These typically contain 0.5 microcurie of Am-241 or other alpha emitter. Smoke particles in air absorb some of the alpha emissions reducing ionisation of the air and the electrical signal received by a detector. This absorption triggers a circuit which sets off the alarm. These alarms should not be dismantled, nor the source removed. An unwanted alarm can be disposed of intact in the normal garbage service.

Cloud chamber kits and radioactive sources

In the early 1970s NSW schools received cloud chamber kits and radioactive sources of the plug, pin and socket type.

Radioactive source at the tip



Image: image of radioactive source at the tip

The plug and pin sources (supplied from overseas) were designed to fit into a hole in the side of the cloud chamber kit. The type of source was stated on the plastic handle to the plug but, with handling, this information wears off and can be difficult to read. The 0.5 μ curies (20 kBq) of radioactive material were in the pin. The two source pins were an alpha emitter - Americium 241 (half-life 432 years) or Radium 226 (half-life 1622 years) and a beta emitter - Caesium 137 (half-life 30 years) or Strontium 90 (half-life 29 years).

Operation of the Cloud Chamber is described in Getting it to work: Physics equipment for high schools.

Sealed radioisotope sources

The main supplier of sealed radioactive sources in Australia is Australian Radioisotopes (ARI), a commercial unit within the Australian Nuclear Science and Technology Organisation (ANSTO) based at Lucas Heights. Sources supplied to schools are:

- an alpha-emitting Americium (Am-241) source: activity 20 ± 10 kBq; half-life 432 years.
- a beta-emitting Strontium (Sr-90) source: activity 80 ± 40 kBq; half-life 29.0 years (this is sometimes listed as a Sr-90/Y-90 source because the daughter nuclide Y-90 (half life in hours) is the main beta emitter; the rate of production of the beta-emitting Y-90 is determined by the half-life of Sr-90 which also emits a beta when changing to Y-90)
- a gamma-emitting Cobalt (Co-60) source: activity 200 ± 100 kBq; half-life 4.26 years.

School sources are available from ARI and can be delivered anywhere within Australia.

ARI will take back any radioactive sources no longer required by schools if they were purchased from ARI or its predecessor, the Australian Atomic Energy Commission (AAEC). This is in accordance with government legislation. However, the sources cannot be sent through the mail and will need to be specially packed and sent via a dangerous goods carrier. Check with ARI on the appropriate procedure.

ARI are also certified to check for contamination and source viability. Replacements can be supplied if sources are found to be faulty.

Sealed Radioactive Sources

The NDRP provides broad guidance for sealed radioactive sources that are suitable for use in schools. The activities of the specified sealed radioactive sources are listed in column 2 of Table 3 taken from RPS-18.

Table 3: Sealed radioactive sources for use in schools and colleges

Radionuclide	Max activity of sealed radioactive sources in NDRP for use in schools (kBq)	Exempt activity in NDRP (kBq)
Cobalt-60	200	100
Strontium-90	80	10
Caesium-137	200	10
Polonium-210	–	10
Radium-226	20	10
Americium-241	40	10

Sealed radioactive sources should never be picked up with fingers, but always with tongs or tweezers.

The NDRP exempts the end user from the requirements of registration and of licensing to possess or use sealed radioactive sources with the activities specified in column 2 above when such sources are used for teaching. Radioactive sources with the activities specified in column 3 are exempt from all regulatory requirements and may be dealt with in general as though they were not radioactive. Radioactive sources with up to these activities may be suitable for many experiments and should be the first choice for sources to be used in schools. Use of exempt activities also allows other radionuclides to be considered, for example polonium-210 with activity less than 10 kBq may be an alternative to an americium-241 source for demonstration of the properties of alpha particles.

Unsealed Radioactive Sources

Other radioactive sources that may be found in schools include:

- small quantities, possibly up to 100 g, of uranium compounds as chemicals
- protactinium generators for half-life experiments
- radon-220 (thoron) generators for half-life experiments
- mini-generators using caesium-137 for half-life experiments

- low-level radioactive artefacts such as protected luminous dials, cloud chamber sources and spinthariscopes
- radioactive rocks.

Because of the possibility of spillage leading to contamination when working with unsealed radioactive sources, extra care is required in the use of unsealed radioactive materials. Thus, specific laboratory facilities and work procedures should be provided for the use of unsealed radioactive materials. Refer to RPS-18 Section 4.2 for further information.

Radioisotope mini-generators

Radioisotope mini-generators have been in department schools since the early 1980s. They should be used only by qualified science teachers, who must follow the Radioisotope Mini-generator guidelines below taken from RPS-18.

Unsealed radioactive materials can be useful in the form of 'mini-generators', which are used to produce short half-life radioactive materials. A risk assessment, however, may show that unsealed radioactive materials are not suitable for use at your school. The following information may assist you in making this decision. One currently available mini-generator uses caesium-137/barium-137m with an activity of 370 kBq. As this is an unsealed radioactive source, with activity higher than that specified in the NDRP for a sealed radioactive source, you should contact your radiation regulatory authority if you wish to use such a mini-generator.

In this type of mini-generator, the caesium-137 is held on an ion exchange column. (An ion exchange column is made by filling a glass cylinder with an exchange resin, which is usually in the form of tiny plastic beads.) The caesium, which has a long half-life of 30 years, decays continuously to form a short-lived barium isotope. A few drops of a solution, called an eluent, are passed through the column to wash away only the barium ions, leaving the caesium ions on the column. The solution coming from the generator is collected in a suitable container and placed under a radiation detector and the count rate is measured over time. Therefore, this experiment involves dealing with small volumes of unsealed radioactive material and you should follow the protocols in Section 3.2 of RPS-18. When we are working with unsealed radioactive materials, we should also consider the chemical risks associated with the materials.

For some materials, e.g. those containing thorium or uranium, the chemical risks may dominate the radiation risks. Some historical mini-generators, such as the protactinium or radon-220 (thoron) generators, contain such materials. The protactinium generator contains uranyl nitrate, hydrochloric acid and an organic solvent. The radon-220 generator contains thorium hydroxide. Neither is recommended for continued use in schools or colleges.

Geiger counter tubes

Geiger tubes (also called Geiger-Muller or GM tubes), connected to an electronic counter, have been used for experiments detecting alpha, beta and gamma radiation.

Not all Geiger tubes will detect all radiation. The Geiger tubes used in schools sometimes respond only to beta and gamma radiation, the end window of the tube being too thick to allow penetration of alpha radiation. The source most commonly used as an alpha emitter in schools – Americium 241 – simultaneously releases a gamma ray which penetrates the end window. The signal resulting from this emission of a gamma ray can be interpreted as the emission of an alpha particle if the Geiger tube only responds to beta and gamma radiation.

To see if a Geiger tube is penetrated by alpha particles use paper to block the alpha particles:

1. Measure background radiation for ten seconds.
2. Place the alpha source with the opening (on one of the sides of the plastic disk) facing and about 2 mm from the Geiger tube end window. Measure radiation for ten seconds.
3. Keeping the alpha source and Geiger tube in exactly the same position, insert a sheet of paper between them to stop most alpha particles. Measure radiation for ten seconds.
4. If reading 2 minus reading 1 is similar to reading 3 minus reading 1 the Geiger tube detects only beta and gamma rays. Stopping most of the alpha particles with paper has not affected the counting.
5. If reading 2 minus reading 1 is significantly greater than reading 3 minus reading 1 then you have a Geiger tube with a very thin end window that allows alpha particles to enter.

If your results are uncertain, repeat your measurements over longer time periods, say up to a minute.

Alpha spark counter

Alpha spark counters have been used in schools since the late 1950s. They use a high voltage applied between a thin wire and a metal plate. When alpha particles from a source cause sufficient ionisation of the air between the wire and plate a spark jumps the gap. An attached counting circuit counts the number of sparks.

N.B. Geiger counters and alpha spark counters give relative measurements not absolute measurements. The instrument reading depends on many factors such as the sensitivity of counting electronic circuits, the thickness of the Geiger tube end-window and the voltage applied to the alpha spark counter. The relative measurements obtained are still useful for things such as comparing different sources and investigating the effect of distance of source from the detector.

(b): General precautions when using radioactive sources

The teacher responsible for radioactive sources at a school (the Ionising Radiation Safety Officer) should carry out a routine check of all radioactive sealed sources. A routine check should be made at least every five years. If there are any concerns about the condition of a source after a fire or physical damage (especially the alpha source

which is not completely sealed in plastic) the source should be returned to ARI and replaced.

Sources more than ten years old should be wipe tested or returned to ARI and replaced with new sources. Wear disposable gloves and be especially careful with the alpha source when carrying out a wipe test.

Alpha source:

- wipe the source with some filter paper moistened with ethanol.
- allow the ethanol to evaporate so the paper is dry (the solvent is no longer present to absorb alpha particles) before measuring the radioactivity level near the wipe area on the paper.
- make sure you are using a Geiger tube able to detect alpha particles (see previous page for a method).

Beta and gamma sources:

- wipe the source with some filter paper moistened with water.
- measure the radioactivity level near the wipe area on the paper.

Transport of radioactive sources around the school and in a laboratory must only be carried out by a teacher or SASS using the locked metal container permanently labelled to indicate that it contains radioactive substances.

Radioactivity experiments should be set up on a side bench or teacher's bench rather than at a student work bench. The radioactive sources must be returned to the metal storage box and all sources accounted for by the teacher before the period of instruction is concluded.

Sealed radioactive sources may be handled and used by Year 11 and 12 students only when under the direct supervision of a teacher. Teachers may demonstrate radioactive sources and their detection to Year 7-10 but the students must not handle the sources.

Alpha emitters have the radioisotope embedded in a metal matrix which should be exposed to the air but protected from scratching. Discolouration of sections of the metal matrix is not of concern.

(c): Radiation exposure

X-rays, beta particles and gamma rays all produce similar amounts of biological damage for the same deposition of energy.

Alpha particles are 20 times more effective in producing biological damage and deposit their energy in a very small volume of tissue because they are not very penetrating. These facts, and the packaging of "sealed" alpha sources so they are not completely sealed in plastic, indicate the need for especially careful handling of alpha sources.

The effective dose, measured in sieverts, measures the biological damage to the whole body. The effective dose takes into account the effects of different radiations and the different susceptibility of living tissues to damage by ionising radiation.

RPS-1 Standard for Limiting Exposure to Radiofrequency Fields – 100kHz to 300 GHz (Rev 1) gives guidance on the basic restrictions for basic restrictions for exposure. Table below extracted from RPS-1.

Table 1. Basic restrictions for RF electromagnetic field exposure from 100 kHz to 300 GHz, for averaging intervals ≥ 6 minutes

Exposure Scenario	Frequency Range	Whole Body Average SAR (W kg^{-1})	Local Head/Torso SAR (W kg^{-1})	Local Limb SAR (W kg^{-1})	Local S_{ab} (W m^{-2})
Occupational	100 kHz – 6 GHz	0.4	10	20	NA
	>6 GHz – 300 GHz	0.4	NA	NA	100
General Public	100 kHz – 6 GHz	0.08	2	4	NA
	>6 GHz – 300 GHz	0.08	NA	NA	20

Notes:

1. 'NA' signifies 'not applicable' and does not need to be taken into account when determining compliance.
2. Whole body average SAR is to be averaged over 30 minutes.
3. Local SAR and S_{ab} exposures are to be averaged over 6 minutes.
4. Local SAR is to be averaged over a 10 g cubic mass.
5. Local S_{ab} is to be averaged over a square 4-cm² surface area of the body. Above 30 GHz, an additional constraint is imposed, such that exposure averaged over a square 1-cm² surface area of the body is restricted to two times that of the S_{ab} restriction.

Radiation dose limits:

RPS-18 provides practical advice on how justification, optimisation and dose limitation can be applied, in order to ensure the safe use of ionizing radiation sources. It also provides practical advice and guidance on procedures that, if followed, will:

- reduce the likelihood of exposure to ionizing radiation to staff and students
- ensure the safety of all persons where sources of ionizing radiation are used for teaching purposes in schools.

The National Directory for Radiation Protection (NDRP) has adopted dose limits, for occupational exposure and exposure of members of the public, proposed by the International Commission on Radiological Protection (ICRP) and published in Australia in RPS1 (ARPANSA 2002).

In the school situation, there is no reason for any person to receive doses in excess of the dose limits for members of the public and most people should receive very much less than these. The dose limits are for whole body exposure, lens of the eye, skin and hands and feet.

Section 4.7 and 4.8 of RPS-18 give guidance on disposal and transport of radioactive waste.

Radioactive sealed sources should be disposed of only after contacting:

ANSTO at Lucas Heights
Telephone **(02) 9717 9504**.

The only radioactive waste disposed of at school premises should be eluate from radioisotope mini-generators.

Further information can be obtained from the ANSTO A Nuclear Source Book.

Sections 6.14 and 6.15 of the Nuclear Source Book show how students can calculate their annual radiation dose.

Note: All doses should be kept **As Low As Reasonably Practicable (ALARP)**

Figure 3.2: Radiation units of measure

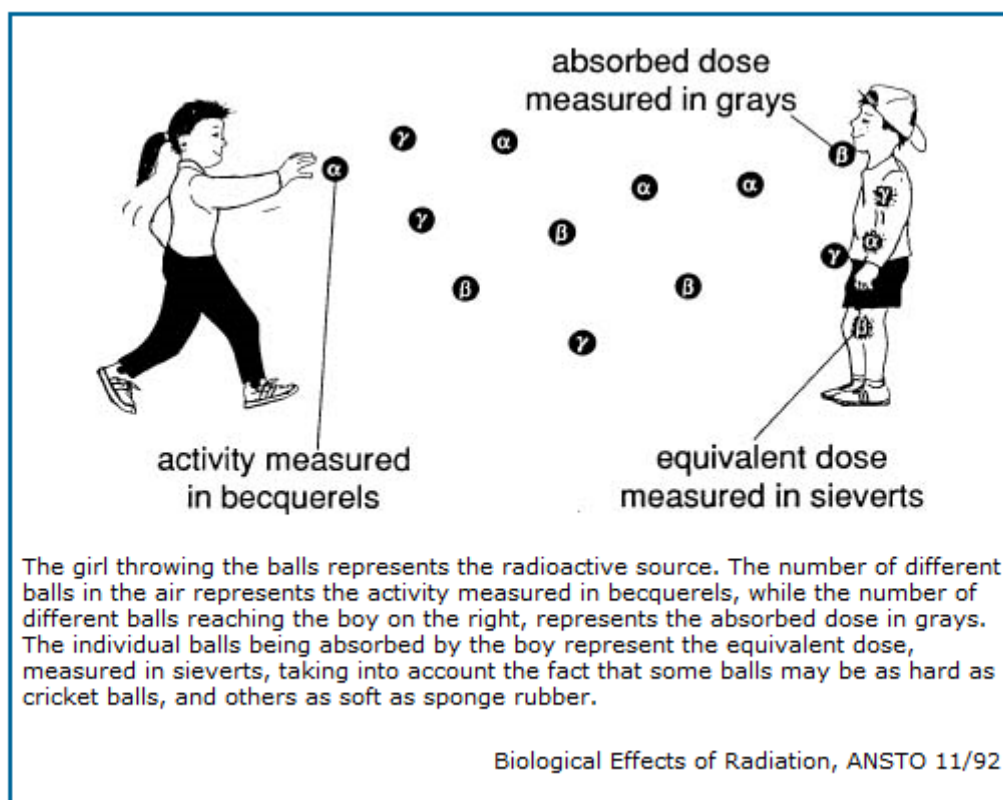


Image: image showing radiation units of measure

Incidents/Spills

RPS-1 (ARPANSA 2002) requires that all incidents or accidents involving radiation sources, such as a situation where a radiation source cannot be found, be reported to the radiation regulatory authority. In the first instance, this will usually be the Principal.

If you suspect that someone has removed the source unlawfully from the premises, the Principal, in consultation with the radiation regulatory authority, will need to inform the police.

Refer to Section 5 of RPS-18 in the event of an incident or accident involving radiation sources.

3.2.4.7: Lasers

Radiation Protection Series No. 18 (RPS-18) Use of Radiation in Schools (Australian Radiation Protection and Nuclear Safety Agency, June 2012) provides specific information and guidance for the safe use of lasers in schools. The information from this safety guide is summarised within this section however further detail can be obtained from this safety guide.

Entertainment or construction laser usage on school premises should not be under the direct control of school staff.

Lasers are commonly used for teaching and demonstration purposes in schools. In particular, laser light is useful for demonstrations or experiments dealing with optical phenomena and the properties of light. In addition, laser diode sources may be used in the teaching of electronics. The light output from most electronically controlled laser diodes can be modulated and they are particularly useful as light sources in optical communications links. Laser diodes are also found in compact disk (CD) players. Laser pointers are sometimes used in classes as a teaching aid for pointing out information on blackboards, projection screens or computer screens.

Continuous wave (cw) lasers emit continuously with a stable power output over long periods of time (usually hours). Lasers supplied to schools are usually of the continuous wave type.

Pulsed lasers emit in the form of a single pulse or a train of pulses (a pulse is usually less than 0.25 s). Pulsed lasers are generally higher in power than continuous wave lasers and are not especially suited to the majority of optical demonstrations carried out in schools. The only pulsed lasers that may be used for teaching purposes are Class 1 pulsed lasers.

RPS-18 specifies that if a school has a number of lasers that are used regularly for experiments or demonstrations, then consideration should be given to appointing a Laser Safety Officer (LSO). The LSO would normally be a staff member who is familiar with this Safety Guide, understands the laser classification system and has a good working knowledge in the use of lasers. The LSO would be available to assist other staff with performing risk assessments and may assume the role of ensuring all staff comply with the safe storage requirements that are part of the school's safety policies.

Note: LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. A laser designed for use in one of these three areas should never be used elsewhere.

The following laser classes must NOT be used in schools for teaching purposes: Pulsed Class 2 and pulsed Class 3A, Class 3A with wavelengths in the invisible region of the

electromagnetic spectrum (ultraviolet or infrared), Class 3B (Restricted), Class 3B and Class 4. Laser pointers in excess of Class 2 must not be used on school premises.

(a): Lasers that can be used in science

Only Class 1 (pulsed or continuous) or continuous wave Class 2 or continuous wave visible Class 3A lasers may be used for demonstrations or experiments in schools.

- Laser pointers must be Class 1 or Class 2 only.
- Class 1 and Class 2 are <1 mW.
- Class 3A is between 1 mW and < 5 mW.
- Class 1 lasers are considered safe under reasonably foreseeable conditions of operation.

Class 2 lasers are low power devices that emit visible light (and may also emit invisible radiation up to the Class 1 limit); they are not completely safe but eye protection is normally afforded by aversion responses, including the blink reflex. They are not capable of causing injury to the skin.

Class 3A lasers emit higher levels of radiation and more stringent precautions are required than those necessary with Class 2 lasers. They emit more power in a beam of larger cross-section; when the output is directly viewed, the power of the beam entering the eye should not exceed that of a Class 2 product (the pupil diameter is assumed to be 7 mm). Again, for Class 3A visible radiation, eye protection is normally afforded by aversion responses, including the blink reflex. However, if the beam is viewed through large-diameter collecting optics, for example binoculars then the hazard is usually increased.

See the diagram below on the danger of viewing a large cross-section Class 3A laser beam (up to 5 mW) through a viewing aid.

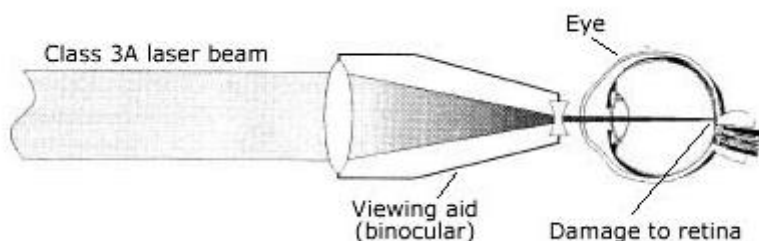


Image: image showing the danger of viewing a large cross-section Class 3A laser beam

Certain laser components, such as laser diodes or gas laser tubes, are commercially available for use as components in laser products. If a school assembles such components into an operational laser device (for example by connecting a laser diode to an appropriate power supply), the school is deemed to be the manufacturer of a laser product and must comply with all of the relevant manufacturing requirements of AS/NZ 2211.1:1997.

Recently purchased lasers should have a label indicating the class and giving hazard warnings. Check the manual for information about class. If no class is stated, contact the supplier.

(b): Hazards in the use of lasers

1. For a typical visible laser beam, the irradiance of the image formed on the retina is about 100,000 times the irradiance of the laser beam at the cornea.
2. Many lasers employ high voltage internal power supplies.
3. Many laser products (especially Class 1 products) are able to meet the relevant Accessible Emission Limit (AEL) only through specific engineering design features, such as shielded enclosures and special optical systems. It is possible that a Class 1 laser product could have Class 4 radiation levels inside, so care should be taken to keep the housing or shielding intact. CD players contain Class 3B laser diodes but the product is classified as Class 1.
4. If using optical fibre with a laser, be careful that the fibre is not scratched or bent so that it breaks and emits uncontrolled laser radiation. There is also risk of mechanical injury to the eye when handling fibres (in particular, small diameter fibres without cladding are difficult to see) and from small particles when fibre is cut or broken.

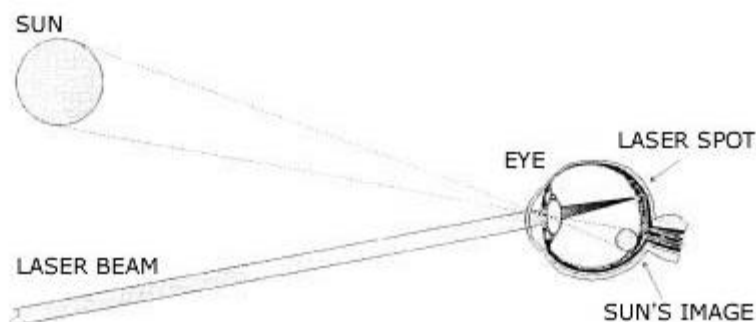


Image: image showing glass optical fibre viewing dangers
Glass optical fibre is potentially more dangerous than plastic optical fibre.

Students examining glass optical fibre should handle specimens embedded in plastic or alternatively wear goggles or spectacles.

Explanatory warning labels for lasers

1. Positioned so that persons reading it will not be exposed to radiation.
2. Black legend and border on a yellow background

The following table extracted from RPS-18 gives guidance on the typical labels that should appear on lasers.

Table 7: Reproductions of labels that would appear on lasers classified under AS/NZS IEC 60825.1:2011









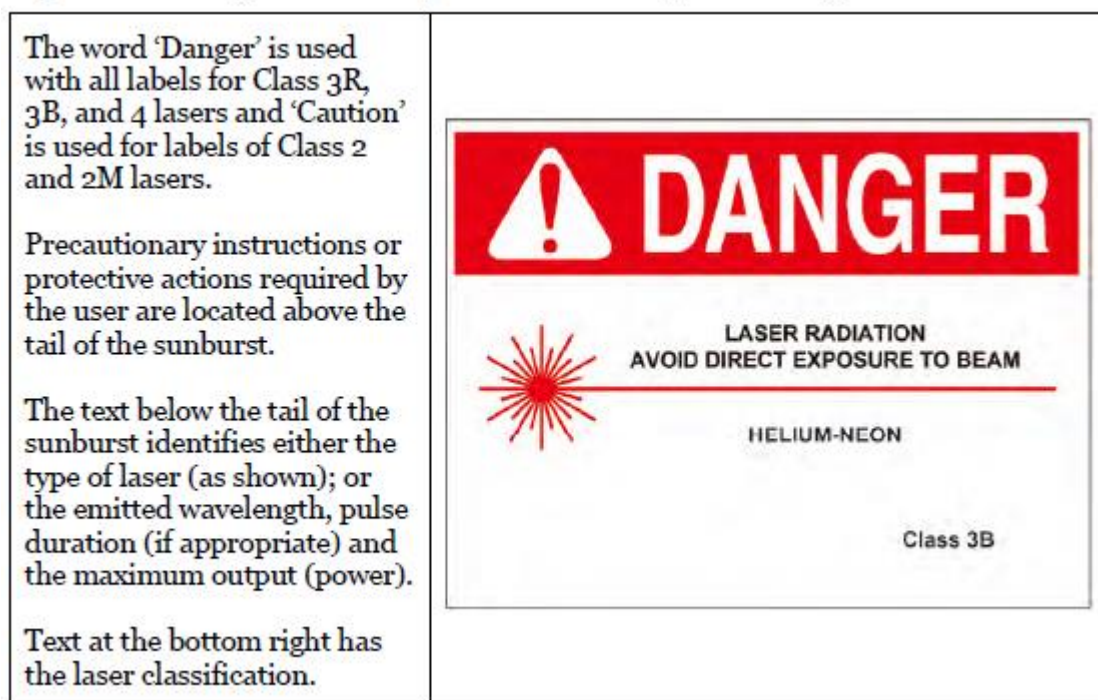
Class 1 laser products are identified by a text label only.	
Class 1M laser products will have a label stating	
In addition to labels containing text, the equilateral triangle surrounding a sun-burst pattern warning label will appear on all laser products classified as Class 2 or greater.	
Class 2	
Class 2M	
Class 3R	
Class 3B	
Class 4	

Figure 8: Example of a Class 3B Label according to ANSI Z136.1



(C): Laser safety precaution

Before a new demonstration or experiment is introduced, a trial run should be carried out by the teacher, without any students present, to evaluate safety aspects.

1. Ensure the laser is Class 1 (pulsed or continuous wave), Class 2 continuous wave or Class 3A continuous wave visible. These lasers all have power output less than 5 mW and are considered safe for use in schools. The following laser classes shall NOT be used for teaching purposes: Pulsed Class 2 and pulsed Class 3A, Class 3A with wavelengths in the invisible region of the electromagnetic (ultraviolet or infrared), Class 3B (Restricted), Class 3B & Class 4. Laser pointers in excess of Class 2 shall not be used on school premises.
2. When a Class 2 laser (excluding a laser pointer) or Class 3A laser is in operation, AREA WARNING SIGNS must be displayed in conspicuous locations both inside and outside the demonstration or experiment area and on doors giving access to the area. Access to any room where a laser is in operation should be limited and casual observers excluded (see next page for a suitable AREA WARNING SIGN).
3. Warn all persons of potential hazards and instruct them never to look into the direct beam or reflected beams.
4. Do not operate the laser at eye level as the beam, if deflected into the eye, may do serious damage to the retina.
5. Do NOT darken the room more than is absolutely necessary as this enlarges the pupil of the eye, thus increasing the risk of eye damage.

6. Before switching on the laser consider what surfaces around it might reflect the beam (glassware, metal fixtures, etc). Remove or cover all reflective surfaces.
7. The laser must not be moved when switched on.
8. When not in use either turn it off or block the beam at the laser. At the end of the lesson lock the laser away or disable it by means of the key switch.

It is recommended that a risk assessment be carried out prior to any experiments using lasers. Guidance is provided within RPS-18 including a risk assessment template and example experiment using the risk assessment template.

Area warning sign

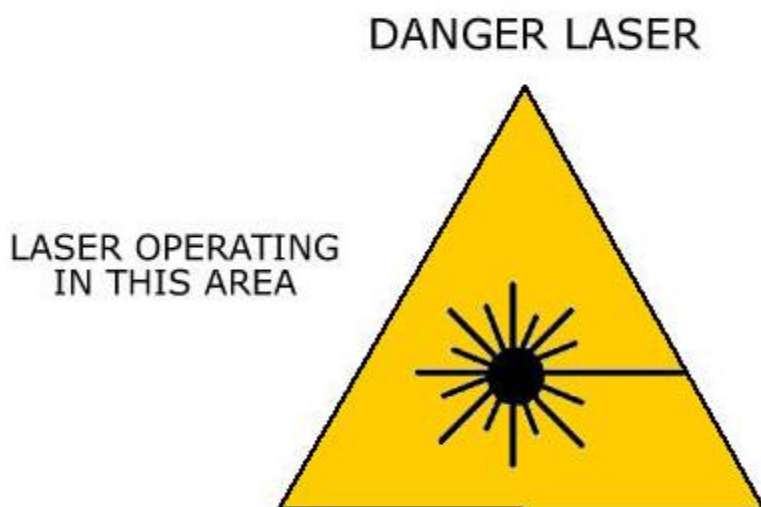


image of area warning sign

Image:

3.2.4.8: Gas discharge tubes

Operation of gas discharge tubes is described in Getting it to work: Physics equipment for high schools.

These tubes can produce X-rays when they are connected to an induction coil.

Although many induction coils carry a warning label stating "X-rays may result from the operation of this equipment", X-rays are not produced by discharge between the sparking points of the induction coil. X-rays are produced when electrons are accelerated to high velocities in low pressure gas discharge tubes and are stopped suddenly by hitting glass or metal surfaces. The warning "Avoid standing within three metres when the equipment is operating" refers to equipment attached to the induction coil capable of producing X-rays rather than the induction coil itself.

When the equipment is set up using a minimum operating voltage from the induction coil the X-rays produced are of low energy and are significantly attenuated through the glass. Minimum operating voltage is achieved by moving the outer secondary coil so that about 10 cm length of the inner primary coil may be seen.

The cathode electrode of a Crooke's tube is generally the one with a plate. If the DC input terminals of an induction coil are correctly connected the end output terminal (the one furthest away from the DC input) should be negative. This negative output must be connected to the cathode to minimise X-ray production. If uncertain whether your induction coil output terminal is negative briefly connect the induction coil to a Maltese cross tube. A negative induction coil output connected to the cathode gives more fluorescence and a better Maltese cross shadow.

Do not leave this equipment on for longer than is necessary to perform the desired experiment. Darkening the room should make discharge effects easier to see.

3.2.4.9: Sources of high voltage

Operation of this equipment is described in Getting it to work: Physics equipment for high schools.

Remove all metal jewellery and watches before using the equipment.

Keep one hand behind your back when operating the apparatus. This helps to ensure that you do not provide a short circuit for the high voltage electric current.

School van de Graaff generators can produce up to 400 000 volts but maximum discharge current is less than 0.1 mA. This current will stimulate but not harm a healthy person. However, don't bring your head close to a charged dome. A discharge to the eye could cause serious damage.

School induction coils can produce up to 40 000 volts in ideal conditions. The current available of about 1 mA however will be higher than from a van de Graaff generator.

3.2.4.10: Model rocketry

This information replaces all previous memoranda (79/003 and 5/12/1977) on rocketry

Model rocketry involving students can be carried out in schools, provided the following guidelines are followed.

Manufacturers and supplier's information must be carefully consulted and directions followed, where these directions do not conflict with the following guidelines:

1. A teacher with previous experience of model rocket launching must be in charge.
 - other teachers, SASS or other adults approved by the principal may assist with the activity.
2. The launch site must be outdoors, in a cleared area free of trees, power lines, buildings, dry bush and dry grass.
 - **no rocket is to be launched within 5 km of an airport or in high winds over 30 km/h.** Any rocket capable of exceeding an altitude of 91 m (300 feet) must be cleared with Air Traffic Control.
3. Teachers and students must not make their own rockets or engines.
 - only commercially manufactured engines are permitted.
 - model rocket engines are classified by type according to the installed total impulse (Newton seconds).
 - the following table describes the engine types and the minimum clear site dimensions required for a safe launch:

table showing engine types and minimum clear site dimension for safe launch

impulse (Newton seconds)	Equivalent engine type	Minimum site dimensions (metres)
0.00 - 1.25	1/4 A & 1/2 A	15
1.26 - 2.50	A	30
2.51 - 5.00	B	60
5.01 - 10.00	C	120
10.01 - 20.00	D	150
20.01 - 40.00	E	300
40.01 - 80.00	F	300

table showing engine types and minimum clear site dimension for safe launch

impulse (Newton seconds)	Equivalent engine type	Minimum site dimensions (metres)
80.01 - 160.00	G	300
160.01 - 320.00	2Gs	450

Type A engines are adequate for most educational purposes.

No engine type greater than type B is permitted for use at DET schools.

Use only rockets and engines obtained from reputable suppliers who:

- use a code of conduct/safety code/list of regulations; one copy is issued to the purchaser. Another copy is signed by the purchaser and retained by the supplier
- make only rockets and engines available to adults, 18 years and over
- provide detailed instructions and safety information.

Students may assemble, but not alter the design of the rocket.

Only the teacher or experienced adult can handle and insert the rocket engine. Do not modify the commercially made engine in any way.

Use only an engine recommended for the rocket design selected.

4. The teacher, or an adult experienced in the requirements of model rocketry to whom this responsibility has been delegated, is responsible for launching the rocket and is in control of the launch device.

- No student is allowed to launch, be in control of the launch device or use the ignition system. The launch device should be pointed no more than 10 degrees from the vertical and away from spectator\
- the launch device must be stable and provide rigid guidance until the rocket has reached a speed adequate to ensure a safe flight path in the direction intended.
- injuries have occurred when a rocket has travelled along the ground and into a group of students. Ensure that this could not occur.

5. The ignition system must be electrically operated by the teacher or experienced adult who shall be at least ten metres away from the rocket during launch.

- starters should be stored in dry conditions and in good order before insertion into the rocket engine.
- care needs to be taken to ensure that the starters are correctly connected and cannot be accidentally ignited when inserting.

6. Students must be at least 80 metres from the launch device.

- This will enable students to observe the ascent and descent, measure altitude reached and videorecord the flight and drift back to ground for later analysis.

7. If a rocket fails to fire (misfires):

1. make sure the ignition system cannot work by either removing the key/interlock or batteries
2. wait at least two minutes before the teacher or the adult to whom responsibility has been delegated approaches the rocket.

8. Rockets, once in flight must be observed at all times.

- In the event of recovery system failure, rockets will fall with considerable velocity.

9. If the rocket becomes entangled in a power line or lands in other dangerous places, do not attempt to retrieve it.

- report the entanglement to the local electricity authority or other appropriate authority.

Note: Also consider other rocket systems for use with students. There are a number of compressed air powered rockets available commercially, many of which are suitable for the intended educational purpose.

3.2.5: Safe procedures for out of classroom/laboratory activities

3.2.5.1: School grounds

Before the lesson, survey the area outside the classroom where you plan to carry out an activity. Hazards need to be identified in advance and precautions taken.

Could future weather conditions require you to change the area or timing of the lesson?

Plan what equipment will be needed and how it will be safely transported to and from the area. What equipment of their own will students need to bring?

Develop a work strategy for students at the site.

Will students always be in view? Do students need to work under close supervision.

Make sure you know how many students and what equipment were taken to the site and that the same number of students and quantity of equipment returns from the site.

When testing vehicle emissions ensure that the vehicle cannot accidentally move. Collect exhaust samples in plastic bags and apply chemical tests away from the vehicle.

3.2.5.2: Field work/excursions

The [excursions policy](#) provides candid advice on conducting offsite school excursions, available [here](#).

Parents (which includes guardians) should be informed of the full details of any planned excursion in writing, including details of all planned activities for the excursion. Signed consent forms granting permission for students to participate in an excursion must be obtained from the parents.

If it is not possible to obtain a signed consent form from parents, oral approval can be sought. The principal must keep a record of any oral approvals given by parents.

When it is inappropriate to obtain parental consent because of the age or living circumstances of the student, the consent can be sought from any other person considered appropriate by the principal. If no other person is available, agreement from the student himself or herself to participate in the excursion must be obtained.

All excursions must be accompanied by a member of staff who has undertaken emergency care training. Any excursion involving swimming or water activities and or overnight stays must be accompanied by a member of staff who possesses current training in cardio-pulmonary resuscitation (CPR) and emergency care.

Consider whether a mobile phone would be a useful emergency back-up to take on the excursion. Assess whether the situation/place is in the network coverage area.

Students should also be reminded not to interfere with animals they may encounter on the excursions.

3.2.5.3: Industry visits

The teacher remains responsible for the behaviour of students at all times during the excursion.

1. Check on clothing and footwear requirements.
2. Find out what the students will see and do and the length of time to be spent on different activities.
3. Inform parents and students of the educational justification for the visit and important features of the visit.
4. Remind students of the industry's expectations as well as your own expectations before entering the site.
5. Follow all instructions given by tour guides.
6. Students are not to touch anything unless instructed to do so. Be careful not to inhibit or hinder normal operations.
7. Students are not to venture into another area without the permission of the tour guide.

3.2.6: Safe use of biological materials/organism/tissues

3.2.6.1: Human blood, tissue and fluid

Human blood, blood products (other than commercially prepared microscope slides of blood) and human tissue, e.g. cheek cell smears and urine, must not be used in science practical work. There is a risk, although statistically very slight, of contracting a virus such as HIV, Hepatitis B or C from incorrectly or carelessly performed experiments involving blood or tissue.

Since it is not possible to guarantee the complete safety of students when undertaking experiments using human blood or blood products, teachers are to use only commercially prepared microscope slides to study the cellular components of blood and not to undertake practical work to determine blood groups.

There is little hazard from saliva, and only if students, teachers or SASS come into direct contact with saliva other than their own. If a student uses his or her saliva, he or she should be the only person to fill, handle, empty and wash out the glassware before placing it in an undiluted bleach (sodium hypochlorite) solution. Take care not to splash bleach solutions on clothing. SASS must be warned that saliva has been used and should wear gloves when carrying out the final clean-up of the glassware.

Mouth pipetting is not allowed - always use a pipette filler.

3.2.6.2: Microbiology

Very large numbers of potentially harmful organisms may grow in experiments involving the culture of micro-organisms on nutrient agar in Petri dishes. The Petri dish can become a potent source of infection after incubation.

Approved activities

The subculturing of bacteria from wild cultures must not be performed in department schools.

However, commercially obtained pure strains of non-pathogenic bacteria can be sub cultured from one plate to another, provided the appropriate safeguards are followed.

Microorganisms are classified into risk groups in *Safety in Laboratories: Microbiology*, AS2243.3:2010. Only use organisms from Risk Group 1, which are classified as "unlikely to cause human, plant or animal disease" and are commonly found in the environment. Some of these are found in commercially available biotechnology kits or from commercial biological supply companies.

Examples include:

Bacteria

- *Bacillus subtilis*
- *Escherichia coli*
- *Rhodospirillum rubrum*
- *Sarcina lutea* (*Micrococcus luteus*)
- *Serratia marescens*
- *Staphylococcus albus* (*Staphylococcus epidermis*)

Fungi/Yeast

- *Mucor*
- *Penicillium*
- *Aspergillus*
- *Saccharomyces*

Lactobacillus acidophilus (from yoghurt) or *Lactobacillus casei* (from Yakult) are safe strains that can be easily obtained.

If there is any doubt about the purity of the bacterial sample, it should not be used.

Subculturing of blue/green mould from oranges or lemons to verify Koch's postulates can be carried out by senior students provided aseptic techniques are followed under the guidance and supervision of a science teacher experienced in microbiology techniques.

- Ensure cultures are incubated at temperatures below 30°C.
- Dispose of or clean all Petri dishes after use as described for bacterial cultures below.
- Dispose of mouldy fruit in sealed bags to garbage.

Preparation

Micro-organisms can be transferred from the source to the mouth or skin by poor laboratory practice, by air currents or by inexperience e.g. touching the plate with fingers. Hazardous situations can arise from the use of cultured organisms, from coughing or sneezing or from the possible culturing of antibiotic resistant organisms as a result of particular experimental procedures. Visual examination cannot identify the specific micro-organisms present, so it must be assumed that plates could contain potentially harmful micro-organisms and should be treated accordingly.

The nutrient used in agar based medium should not be any material that could select for potentially pathogenic organisms.

Media and Petri dishes should be pre-sterilised or sterilised before use by autoclaving (sterilising in a pressure cooker).

Petri dishes can be glass (non-sterile, reusable) or plastic (pre-sterilised, disposable). In the case of glass, these need to be heat sterilised in an autoclave or pressure cooker before sterile nutrient agar is poured into the dishes. In the case of pre-sterilised plastic Petri dishes, the hot sterilised liquid nutrient agar must be allowed to cool to 50-55 °C, then poured directly into the dishes and allowed to set. Note that the setting temperature of agar is 45°C.

Aseptic techniques should be used in order to minimise contamination of the nutrient agar plates. Unused nutrient agar plates should be stored in the refrigerator at 5-6°C until required.

A significant risk associated with microbiology is the generation of microbial aerosols, where fine droplets of water containing cells and/or spores are released into the air. Aerosols can be formed when liquid surfaces are broken or material is crushed or ground. The small aerosol particles are easily carried by air currents and can penetrate the respiratory system.

Experimentation

Before work is started, students should wash their hands with soap and water and cover any cuts with waterproof coverings. The use of disposable gloves is advisable. There must be no hand-to-mouth operations such as chewing, sucking, licking labels or mouth pipetting. Hands should always be washed thoroughly with soap and water and dried with disposable paper towel after finishing work with micro-organisms.

After exposure or inoculation, and before incubation, dishes containing cultures should be sealed with clear adhesive tape. The lid of a Petri dish should be taped to the base with two or four pieces of tape so that the lid cannot be accidentally removed.

The sealing of the dishes should be checked by the teacher and, if need be, added to, before examination by students.

Storage of cultured dishes should be short-term only (a few weeks), in a refrigerator, but never in one used for human food or drink.

The safeguards listed below should be adopted by all staff and students:

- Wash hands before and after the experiment.
- Wear disposable gloves.
- Use an inoculating loop which has been sterilised by heating to red heat in a Bunsen burner flame before and after inoculation.
- Have a bacterial spills kit available. This should be either 70% alcohol (skin surfaces only), and for hard surfaces, either undiluted bleach, 2% hospital grade phenolic disinfectant (Biogram or Clearosol), or 10% QAC industrial grade disinfectant. In the case of a spillage on hard surfaces, allow the chemical disinfectant a contact time of at least five minutes before cleaning up. All chemical disinfectant solutions must be freshly prepared. NOTE: 70% alcohol is not suitable for hard surface disinfection.

To prevent visual obstruction of the medium by condensation on the inner surface of the lid, incubate plates upside down.

Incubation temperatures should range from room temperature to 30°C. This will reduce the quicker growth of organisms which are adapted to human body temperature. (Exceptions to this could include yoghurt making at 43°C to discourage unwanted pathogens or culturing of *Bacillus stearothermophilus* at 65°C, too high for human pathogens.)

NOTE: It is important to recognise that most organisms found on or in the human body (including most human pathogens) will also grow, albeit much more slowly, at temperatures less than human body temperature.

All observations must occur with the Petri dish taped. It may be useful to observe the colours and textures of individual bacterial colonies using a stereomicroscope or with a video camera.

After use

When students and teachers have finished with the Petri dishes, the dishes must be sterilised before opening and cleaning. Check the seals and safety valves of the pressure cooker. Heat the pressure cooker electrically or with a cooking gas jet. Bunsen flames are not recommended. Sterilisation must be carried out on disposable plastic Petri dishes as well as the recyclable glass Petri dishes.

The dishes should be placed in an autoclavable biological waste disposal bag or a microwave oven cooking bag and sterilised in a pressure cooker for 25 minutes (110kPa/15psi, 121°C). Let the pressure cooker cool slowly without releasing the steam. Rapid cooling or the release of steam to lower the internal pressure may shatter glassware and/or cause liquid media to boil over. The bag and its contents should be sealed in a plastic bag and disposed of without opening in the normal waste disposal service.

Chemical sterilisation is an unsatisfactory alternative to autoclaving.

However freshly prepared undiluted bleach (sodium hypochlorite) or 10% hospital grade clear phenolic solution (e.g. Biogram, Clearsol) could be used in an emergency. Hospital grade, clear phenolic solution is effective against bacteria and fungi, but not viruses, and the cultures must be opened under the surface of the solution and left 24 hours. Bleaching solution is inactivated (i.e. neutralised) by large amounts of organic matter but is more effective against viruses than phenolic solutions.

Microwave ovens are not suitable for sterilisation (though they are useful to liquify prepared agar media).

Clean glass equipment can be sterilised by dry heating in an oven at 160°C for 2 hours.

Wire loops can be sterilised by heating to red heat in a Bunsen flame.

3.2.6.3: Gas-generating reactions: bio-gas and fermentation

Bio-gas generators release mostly methane gas which is flammable and can form potentially explosive mixtures with air when near naked flames or electrical equipment. Bio-gas generation using animal dung is not recommended; use grass clippings inoculated with well-rotted garden compost or pond mud.

Yeast fermentations release carbon dioxide gas which, although inert, is denser than air and displaces air from large containers; deaths from lack of oxygen have occurred from entering fermentation tanks.

Vessels used for bio-gas generation and yeast fermentation must be suitably vented to allow safe storage or escape of vented gas. The venting system must also prevent aerosol formation or entry of unwanted organisms.

3.2.6.4: Biotechnology

Biotechnology covers any process that uses microorganisms, plant or animal cells to make food, medicines and other chemical products.

The dominant and most rapidly growing part of modern biotechnology is genetic engineering. Genetic engineering involves removing a gene from its original position and inserting it into a new position, either in the same organism or in a different one. Useful genetic recipes can be transferred between plants, animals and microorganisms, e.g. genetically engineered microorganisms can make human insulin for treating diabetes.

Commercially produced biotechnology experimental kits in biotechnology are becoming available to schools. Techniques involved are similar to those used in microbiology experiments and so the safeguards used should be at least as stringent as for microbiology work.

Where the investigation involves dealing with a single strain of a non-pathogenic organism (as opposed to a wide variety of unknown organisms that you would expect in soil, in water, or on skin surfaces) it may be desirable or even essential, to transfer material from one plate to another. All procedures should be carried out strictly as described in the kit instructions.

3.2.7: Disposal of unwanted materials

3.2.7.1: Broken glass

Dispose of all glass carefully e.g. by wrapping in many layers of newspaper or cardboard so that sharp edges will not penetrate wrapping and possibly cause injury to waste disposal personnel.

Ordinary glass can be recycled, but heat resistant (borosilicate or Pyrex) glass is not recycled in Australia.

Particularly sharp pieces of glass should be placed in a suitable sharps container.

3.2.7.2: Sharps

Sharps such as needles, pins, broken glass tubing, broken Pasteur pipettes, razor blades, scalpels, etc. should go in a properly designed sharps container.

Containers can be purchased which remove and safely store used scalpel blades. These remove the need to touch used scalpel blades; only the handle and the container are touched.

3.2.7.3: Chemical waste bottles

Where possible include waste treatment as a component of your class activity, rather than allow the bulk accumulation of waste.

The following is a recommended science faculty waste bottle set for use in storing waste for eventual collection by a licensed waste collection contractor. Make sure the containers and their labels are clearly distinguishable.

table showing waste bottle sets, for collection

Bottle	Comments
WASTE: halogenated organic liquids	<ul style="list-style-type: none">• use for immiscible liquids only• keep away from ignition sources• for use during lessons, keep in fume cupboard
WASTE: non-halogenated organic liquids	<ul style="list-style-type: none">• use for immiscible liquids only• keep away from ignition sources• for use during lessons, keep in fume cupboard
WASTE: mercury residues	<ul style="list-style-type: none">• keep well sealed, especially if mercury metal is present (see Appendix E: Figure E-3)
WASTE: silver residues	<ul style="list-style-type: none">• see Appendix E: Figure E-3 for treatment of residues

WASTE: lead residues	<ul style="list-style-type: none"> • see Appendix E: Figure E-3 for treatment of residues
WASTE: copper residues	<ul style="list-style-type: none"> • treat for recycling or dispose to garbage (see Appendix E: Figure E-3)
WASTE: zinc residues	<ul style="list-style-type: none"> • treat for recycling or dispose to garbage (see Appendix E: Figure E-3)
WASTE: heavy metal mixtures	<ul style="list-style-type: none"> • See Appendix E: Figure E-3

For silver, mercury, lead, copper and zinc residues, make sure that acidified solutions are not added to metal sulfides (this may produce hydrogen sulfide gas)

All users of the chemical waste bottles must take responsibility for ensuring that the bottles are used properly.

There could be a set of waste bottles in each preparation room or in each laboratory.

If one set of bottles is used for the whole school, the appropriate waste bottles could be delivered when any organic compound, or silver, mercury, lead, copper, zinc or their compounds is ordered for class use.

Teachers need to:

- give clear indications of the quantities required to the SASS
- order only what they need
- consider using microtechniques
- ensure students take appropriate quantities, leaving sufficient for all other students
- be familiar with *Appendix E, Figure E-4: Sydney Water, Limits for disposal of chemicals to the sewer* and use this information to decide if disposal in sinkhole is appropriate when small quantities have been used

- ensure that the waste bottles are used correctly by students; one careless action, such as using the wrong waste bottle, can cause problems for recycling or disposal of the contents.

Students need to:

- know what they are trying to dispose of
- ensure that the waste goes into the appropriate waste bottle
- be given appropriate opportunities to carry out recycling of suitable waste (see Section below)

When excessive quantities of these wastes have accumulated, EITHER contact and use a chemical broker or a recycling company see *Appendix E* OR use the following procedures.

Note: Treating waste will be easier if small quantities are used initially.

If these waste bottles start to produce hydrogen sulfide gas (rotten egg gas), add sufficient solid sodium hydroxide to make the solution basic ($\text{pH} > 7$).

Leave in the fume cupboard with the lids off until the production of gas ceases.

3.2.7.4: Recycling - some ideas

An aluminium drink can may be used as a calorimeter (e.g. to measure heat released by a burning peanut), crushed by air pressure (boil a small amount of water in the can to fill with steam, invert the open top and place just under the water surface in a trough) or made into an electroscope (using strips of the thin wall). After any of these activities (could you do all 3 with the one can?) the aluminium can still be recycled.

Minimise copper and zinc disposal down the sink. Sydney Water sets a limit of 4 g of each per day per school.

Collect copper and zinc salt solutions in separate waste bottles. Solutions of copper salts in particular are useful for demonstrating recovery of the metal, e.g. displacement from solution by a more active metal such as scrap iron or steel wool or by electrolysis. (Discuss with students why displacement of copper with zinc is not environmentally sound in the Sydney Water region.)

Alternatively, make sure the solutions are not acidic (to prevent hydrogen sulfide gas forming); precipitate insoluble copper or zinc sulfide by adding sodium sulfide solution; filter off the insoluble sulfide, dry and dispose of as solid waste.

Copper residues can be treated to recover copper sulfate by evaporation.

If disposal is intended, copper residues can be treated with iron to reduce copper ions to metallic copper. Place copper residues in a large container and add sufficient steel wool to achieve discolouration of the blue solution. Pour off the iron solution. Wrap the solid reduced copper in newspaper and dispose in your solid waste bin. The iron solution can be flushed with water to the sink or poured over the ground or garden. Alternatively, iron salts could be recovered by evaporation and subsequently disposed in your solid waste bin.

Silver should be recycled. By law commercial photographers must recycle silver. Most metals will displace silver metal from soluble silver salt solutions forming attractive silver crystals. Watching this makes it easy for your students to visualise minute silver particles in solution, which are too small to see, forming a crystal, in such huge numbers, that it can be seen growing. Silver residues can be given to local photographic processors for recycling.

Silver residues can be treated by the addition of solid sodium chloride to precipitate the silver as silver chloride. The silver chloride can be collected by filtration and delivered to a photographer for recycling in the photographic industry.

Metallic silver could be recovered by the following procedure carried out as a class experiment:

1. add sodium carbonate to waste fixer to form a precipitate of silver carbonate
2. collect and dry the precipitate

3. heat the precipitate with carbon powder or on a carbon block to form metallic silver.

Lead residues will often be a mixture of metallic lead, solid lead salts and lead ions in solution. These should be kept in one container for disposal by a licensed waste contractor. Lead should not be recycled on site.

Waste mercury should not be cleaned on site. Store waste mercury for removal by waste contractor.

3.2.7.5: Biological waste

Most biological waste, e.g. waste from a dissection, can be disposed of by wrapping in newspaper, placing in a plastic bag and disposing of in the normal waste disposal (garbage) service.

Microbiological material should be disposed of by placing in an autoclavable bag or a microwave oven cooking bag and sterilising in a pressure cooker for 25 minutes (110kPa/15psi, 121°C). Let the pressure cooker cool slowly without releasing the steam. Rapid cooling or the release of steam to lower the internal pressure may shatter glassware and/or cause liquid to boil over. The bag and its contents should be sealed in a plastic bag and disposed of without opening in the normal waste disposal service.

3.2.8: Appendices

Appendix 1: [Good practise guides for six experiences of the 2 Unit Chemistry course](#)

Appendix 2: [Information on gas preparation and handling](#)

Appendix 3: [Technical information about concentrated acids and ammonia solution](#)

Appendix 4: [Science-related memoranda](#)

Appendix 5: [Sample safety audit of a science laboratory](#)

Appendix 6: [Sample school science safety policy](#)

Appendix 7: [Responsibilities for the Ionising Radiation Safety Officer](#)

Appendix 8: [Responsibilities for the Laser Safety Officer](#)

Appendix 1: Good practise guides for six experiences of the 2-unit chemistry course

(a): Acids and bases: A quantitative study to determine the concentration of one of the reactants by titration

Materials and risk assessment:

table showing materials and risk assessments for acids and bases

Acid solution	<ul style="list-style-type: none">• corrosive risk
Base solution	<ul style="list-style-type: none">• corrosive risk• dissolves glass of storage containers and stoppers• more dangerous to the eyes than acid

Indicator solution

Equipment and safe use (safety glasses):

table showing equipment and safe use for acids and bases

burette	<ul style="list-style-type: none"> • protect the tip from damage • always carry in the vertical position • check that the tap is easily opened and closed before use • check that the burette is firmly held by the clamp • ensure eyes are away from and well above the top when filling to avoid splashing of solution into face
pipette	<ul style="list-style-type: none"> • ALWAYS use a pipette filler (don't push the pipette above the valve of the pipette filler) • make sure the pipette will not roll when placed on the bench • protect the tip from damage
volumetric flask	<ul style="list-style-type: none"> • labelled with solution, concentration, date and user • keep safe, away from edge of the bench
conical flask	<ul style="list-style-type: none"> • test flow from the water tap first; hold firmly when washing out in the sink

Safer alternatives:

- check all glassware for cracks and defects before use.
- prepare and use solutions 0.1 M or less in concentration.

- add 2 drops of indicator solution directly to the solution in the conical flask.
- ensure all benches are wiped down and dry before the next class enters the laboratory.

Disposal:

- dispose of basic solutions first, then water, followed by acid solutions, then water (sewerage authorities request pH 7-10).
- use enough water to thoroughly wash the mixture down the sink.

(b): Carbon chemistry; Refluxing of an organic reaction, e.g. esterification of alkanols

Materials and risk assessment:

- alcohol and alkanoic acid reflux/conc. H_2SO_4 \rightarrow ester and water
- check [Appendix D](#) and SDS for specific risk assessment advice for the particular alcohols and alkanoic acids you select for use **and** for the products produced.

Equipment and safe use:

table showing equipment and safe use for carbon chemistry; refluxing of an organic reaction

safety glasses	<ul style="list-style-type: none">• to be worn from when chemicals are used until refluxing is complete and equipment is cool
glassware	<ul style="list-style-type: none">• boro-silicate (pyrex)• check for cracks before use• if not using ground-glass socket and joint equipment avoid contact of rubber stoppers with organic liquids (to avoid swelling and solution) and check that bark corks are tight and uncracked
glassware assembly	<ul style="list-style-type: none">• hold close to the parts being assembled• avoid leverage of parts and possible glass breakage

	<ul style="list-style-type: none"> ensure that you have not created a "bomb": that there are no blockages between the mixture and the top of the condenser
final assembly	<ul style="list-style-type: none"> use firm but not tight clamping
condenser	<ul style="list-style-type: none"> ensure the water inlet is firm and at the bottom of the condenser ensure the water outlet is firm at the top of the condenser initially use a slow flow of water into the condenser to avoid breakage and expel all air ensure water flow is substantial throughout the experiment to deliver adequate condensation
anti-bumping granules	<ul style="list-style-type: none"> porous, unglazed ceramic must be added before any chemicals are heated commercial supplies available
water bath	<ul style="list-style-type: none"> use a container large enough to hold the flask and provide at least a centimetre of water between the outside of the flask and the container use electric heating or a small flame well away from vapour

Safer alternatives:

- use alkanols and alkanoic acids only. Check relative toxicities of alcohols and acids before selecting reagents.
- although butanoic acid is the least toxic it has an offensive odour and precautions should be taken to avoid exposure to this.
- a round shaped flask is less likely to crack than a pear-shaped flask; never use a flat-bottomed flask. The flask should not be more than half-filled with the mixture.
- alcohols can absorb water from the air, so add alcohol to the flask first, then alkanoic acid, followed by anti-bumping granules (which must be added **before** any heating).
- last addition to the flask: 2-3 drops of the concentrated sulfuric acid catalyst, added directly to mixture by the teacher, using a dropper bottle. Keep the dropper bottle in a spill tray on the teacher's bench.
- all containers of alcohol and acid should be sealed and removed to the preparation room or store, all student apparatus assembled and condensers cooled with water before any flames are lit.
- check that the flow of water through the condenser is maintained and not reduced by water use at other benches or in other rooms.
- the odour of the ester can be detected when the cooled mixture is added to a beaker of water.
- if the mixture is to be separated see Good safety practice guides on separating aqueous and non-aqueous layers and Distillation and determination of B.P.

Disposal:

- an ester can be kept for odour comparison with the acid and alcohol from which the ester was formed. The ester can be disposed of by evaporation in a fume cupboard.
- dispose of the mixture in a fume cupboard sink (best if the sink is isolated from the other sinks) or preparation sink to minimise disturbance to other classes from odours.

- wait until the mixture is cool, then run water into sink and slowly pour the mixture into the sink hole.
- use enough water to wash the mixture past the s-bend.

(c): Carbon chemistry: Distillation and boiling point (BP) determination

Materials and risk assessment:

- check risk assessment advice in [Appendix D](#) for each substance used.

Equipment and safe use:

table showing equipment and safe use for carbon chemistry; distillation and boiling point

safety glasses	<ul style="list-style-type: none">• to be worn from when chemicals are initially used until distillation is complete and the equipment is cool
glassware	<ul style="list-style-type: none">• boro-silicate (pyrex)
glassware assembly	<ul style="list-style-type: none">• check for cracks before use• if not using ground-glass socket and joint equipment avoid contact of rubber stoppers with organic liquids (to avoid swelling and solution)• check that bark cork are tight and uncracked
final assembly	<ul style="list-style-type: none">• ensure the water inlet is firm and the bottom of the condenser
condenser	<ul style="list-style-type: none">• ensure the water outlet is firm at top of condenser

	<ul style="list-style-type: none"> initially, ensure a slow flow of water through the condenser to avoid breakage and to expel all air. Ensure the water flow is adequate to maintain condensation
condenser outlet	<ul style="list-style-type: none"> Keep the condenser away from the flame, especially if collecting the volatile liquid fraction, which is flammable
anti-bumping granules	<ul style="list-style-type: none"> porous, unglazed ceramic must be added before any chemicals are heated
water bath	<ul style="list-style-type: none"> use a container large enough to hold the flask and at least 1cm of water between the outside of the flask and the container use water if the BP<100C;CaCl₂(aq) for higher BP
electric heating	<ul style="list-style-type: none"> safest for reaching high BPs
direct Bunsen heating	<ul style="list-style-type: none"> double check flask and quickfit joints before heating
thermometer	<ul style="list-style-type: none"> must not be heated to the maximum of its temperature range the thermometer bulb should be level with the inlet to the condenser

Safer alternatives:

- Aqueous residues should be washed down the sink with enough water to clear the s-bend.

(d): Carbon chemistry: Separating aqueous and non-aqueous layers using a separating funnel

Materials and risk assessment:

- this procedure can be conducted using an equilibrium mixture from an esterification experiment.
- check risk assessment advice in [Appendix D](#) for each substance used. Also, anhydrous sodium carbonate and calcium chloride (fused) as indicated below.

Equipment and safe use:

table showing equipment and safe use for carbon chemistry; separating aqueous and non-aqueous layers

safety glasses	<ul style="list-style-type: none">• wear at all times
stand, bosshead and clamp	<ul style="list-style-type: none">• check stability• use tight clamping of the bosshead and clamp
separating funnel with stopper	<ul style="list-style-type: none">• check that the stopper provides a gas-tight seal• check that the tap opens and closes easily
beaker	<ul style="list-style-type: none">• use to receive the lower (denser) layer

conical flask	<ul style="list-style-type: none"> • use for storing and drying the non-aqueous layer
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Safer alternatives:

- clamp the outside of the neck of the funnel firmly so that it hangs vertically.
- add a volume of distilled water to the funnel approximately equal to the volume of the esterification equilibrium mixture.
- the equilibrium mixture should be cooled to room temperature before pouring it into the separating funnel.
- pour the mixture into the funnel, avoiding contact with the inside of the neck.
- stopper the funnel, remove it from the clamp, hold the funnel horizontally with a thumb against the stopper and shake for a minute.
- reclamp the funnel with the neck uppermost so that the funnel hangs vertically. The denser aqueous layer and less dense non-aqueous layer should separate.
- carefully remove stopper so that air can enter from the top to replace liquid to be drained from the bottom.
- slowly open the tap to drain away the unwanted aqueous layer into the beaker.
- close the tap when the interface between the aqueous and non-aqueous layers is in the tap hole.
- add small (rice grain size) pieces of anhydrous sodium carbonate through the top opening of the funnel until no more gas is released by acid reaction.
- add distilled water with shaking until all the anhydrous Na_2CO_3 is dissolved.
- stopper, hold a thumb against the stopper, invert and shake the mixture.

- while still inverted, make sure the funnel opening is not pointed towards any person nearby. Open the tap slowly to release any gas build up and then close the tap.
- re-clamp the funnel at the neck so that the funnel hangs vertically.
- remove the stopper and gently open the tap to drain the unwanted aqueous layer to the beaker.
- close the tap after the interface has moved completely through the tap hole.
- position the conical flask under the tap and then run the non-aqueous layer into the conical flask.
- add lumps of fused calcium chloride to the non-aqueous layer and shake the flask gently to allow the calcium chloride to remove any water.
- after standing for a few minutes the non-aqueous layer can be decanted off the calcium chloride and distilled: see *Good practice guide on distillation and BP*.

Disposal:

- the aqueous residue can be washed down the sink with an adequate volume of water to clear the s-bend. The non-aqueous layer should be collected in an organic residue bottle or allowed to evaporate in a fume cupboard.

(e): Reactions involving ions which form gases: H₂, CO₂, H₂S, SO₂

Materials and risk assessment:

- use 2 M hydrochloric acid. Check risk assessment advice in [Appendix D](#) for all reactants and products involved.

Typical reactions:

- $\text{Mg}_{(s)} + 2\text{HCl} \longrightarrow \text{MgCl}_2 + \text{H}_{2(g)}$
- $\text{CaCO}_{3(s)} + 2\text{HCl} \longrightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_{2(g)}$
- $\text{FeS}_{(s)} + 2\text{HCl} \longrightarrow \text{FeCl}_2 + \text{H}_2\text{S}_{(g)}$
- $\text{Na}_2\text{SO}_{3(s)} + 2\text{HCl} \longrightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{SO}_{2(g)}$
- $\text{Na}_2\text{S}_2\text{O}_{5(s)} + 2\text{HCl} \longrightarrow 2\text{NaCl} + \text{H}_2\text{O} + 2\text{SO}_{2(g)}$

Equipment:

- safety glasses (wear throughout this laboratory exercise)
- borosilicate (pyrex) test tubes
- test tube rack
- taper and matches
- pasteur pipette with teat

Safer alternatives:

- only carry out reactions with sulfide and sulfite/metabisulfite in a fume cupboard.

- ensure that the borosilicate test tubes are not chipped or cracked.
- add rice grain volumes of solids to 2 mL of 2 M HCl.
- hold a test tube upside down over the Mg + HCl test tube to collect H₂.
- when sufficient H₂ has been generated to fill the upside-down test tube takes it at least 2 m away from the test tube generating H₂. "Pop" the H₂ collected using a taper.
- hold the Pasteur pipette with the teat squeezed and place it a centimetre above the reacting mixture of CaCO_{3(s)} + HCl. Open the teat to draw some CO₂ into the pipette. Bubble the gas in the pipette through some clear limewater in a test tube to observe the effect of CO₂ on limewater.
- Hydrogen sulfide is extremely toxic and flammable. Generate it in a fume cupboard away from flames. The gas is detected by its characteristic "rotten egg" odour.
- Sulfur dioxide is toxic, a lung irritant and can affect asthmatics. Generate in a fume cupboard. Notice an odour of burning sulfur.
- if the odour cannot be detected because of the solubility of SO₂ in water then place the test tube in a beaker of hot water to release the gas. Keeping the test tube 30 cm away, waft the gas above the test tube mouth towards your nose, taking the occasional small sniff.

Disposal:

- the small quantities used should be added to running water in the corner of a sink, with washed unreacted solids removed to garbage bin.

(f): Carbon chemistry: Chemical test to differentiate between alkanes and alkenes (using Br₂ and KMnO₄)

Materials and risk assessment:

table showing materials and risk assessment for carbon chemistry: chemical test to differentiate between alkanes and alkenes

cyclohexane cyclohexene bromine water approx. 0.01 M KMnO₄ approx. 0.1 M H₂SO₄	Check with assessment advice in Appendix for each substance. It is important to keep the volume and concentration of bromine water to a MINIMUM to ensure a colour change (otherwise the colour change can be masked by excess bromine water).
--	--

Equipment and safe use:

table showing equipment and safe use for carbon chemistry: chemical test to differentiate between alkanes and alkenes

safety glasses borosilicate (pyrex) test tubes test tube rack	<ul style="list-style-type: none">• worn throughout this laboratory exercise• use micro test tubes to reduce the odour of cyclohexene and cyclohexane• pipettes should be filled using finger control only, not mouth
--	---

droppers OR Pasteur pipettes	
---	--

Safer alternatives:

- add 3 drops of cyclohexane and 3 drops of cyclohexene to 3 drops of bromine water in separate micro test tubes. Gently mix by holding the top of a test tube below the rim between a thumb and first two fingers of one hand while tapping bottom of test tube with a finger of the other hand. Note any colour changes.
- add 3 drops of cyclohexane and 3 drops of cyclohexene separately to 3 drops of KMnO_4 solution. Gently mix by holding the top of a test tube below the rim between a thumb and first two fingers of one hand while tapping the bottom of the test tube with a finger of the other hand. Note any colour changes.
- if there are no colour changes at all in any test tube after a few minutes, add a further 3 drops of cyclohexane and cyclohexene and mix. If still no colour changes in any test tube use more dilute solutions. Check with assessment advice in [Appendix D](#) for each substance. It is important to keep the volume and concentration of bromine water to a MINIMUM to ensure a colour change (otherwise the colour change can be masked by excess bromine water).
- should this be unsuccessful, check the "age" of the cyclohexene. Alkenes oxidise with time and lose their activity (oxidation of alkenes in petrol can affect the petrol's performance as a fuel). Alkenes are best kept in a sealed container with minimal air space in the container.

N.B. Because oxidation of alkenes can form unstable peroxides over time, never evaporate old samples of alkenes to dryness.

Disposal:

- place products into the non-halogenated organic wastes bottle or allow to evaporate in a fume cupboard.
- do not pour down the sink as the odour can remain for days. This odour is frequently mistaken for a gas leak.

- wash test tubes and droppers/glass graduated pipettes with warm water and a small amount of detergent.

Appendix 2: Information on gas preparation and handling

The following notes are supplemented by a table providing technical and safety notes for the preparation of fifteen common gases. The table can be found at the end of this appendix.

(a): Gas preparation

Most gases are easily prepared in the apparatus shown below.

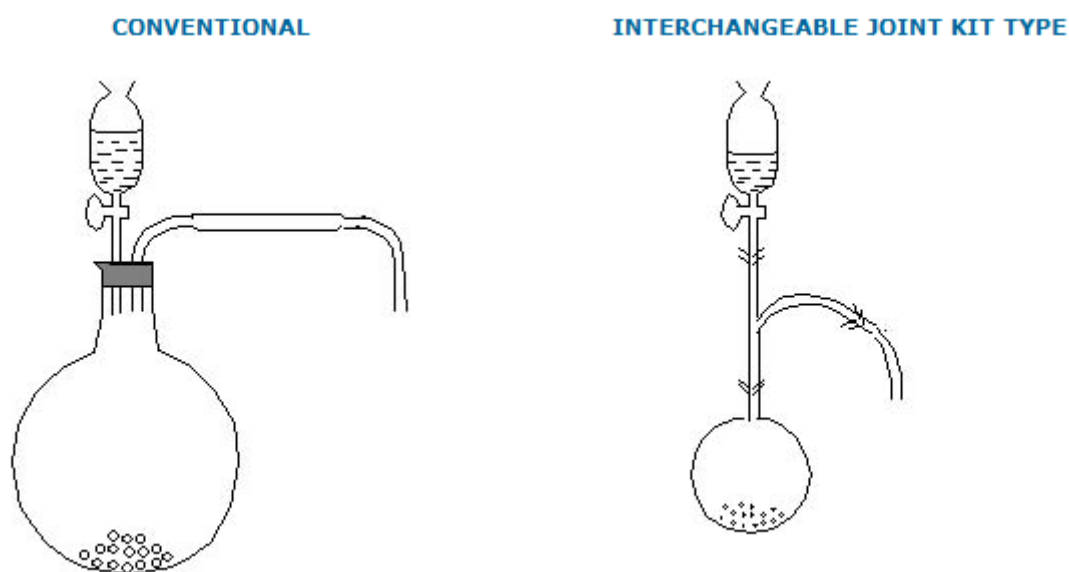


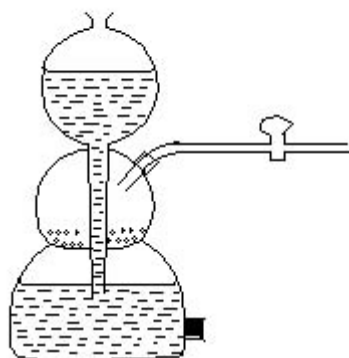
Image: image showing gas preparation apparatus

A round bottom flask is best used where the flask needs to be heated by a flame; a round bottom flask is more resistant to heat stress.

If little heating is required, a conical flask can be used; a conical flask apparatus can be free standing without the need for a clamp and stand.

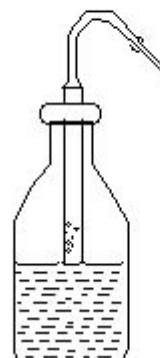
Examples of commercially available gas preparation equipment are:

KIPP'S APPARATUS



*Kipp's Apparatus:
Make sure the tap does not leak. If it does, then
acid will fill the bottom bowl and react until all the
solid and acid as been consumed.*

PLASTIC AND GLASS



*Squeezing the plastic brings the liquid in contact
with the solid.*

Image: image of commercially available gas preparation equipment
These devices are suitable for reaction between large solid lumps e.g. FeS and a liquid e.g. acid, where control of the amount of gas produced is important e.g. extremely toxic H₂S.

(b): Good practice guide for gas preparation

- before using any equipment, make sure that you have not created a "bomb", where there is no release of a build-up in pressure. Visually check that there are no blockages.
- use a safety shield, goggles or safety glasses for eye protection.
- if the gas-producing reaction is too slow, surround the flask with a beaker of hot water. Adjusting the temperature of the water can be used to control the rate of reaction and rate of gas production.

If the reaction is still too slow, a Bunsen flame may be used ONLY IF both the reactants and the gas are not flammable. After ensuring there are no cracks or defects in the glass flask gradually heat the flask with a low flame.

N.B. Never use a flame if preparing hydrogen, acetylene, ethene or any other flammable gas.

- add liquid reagent slowly and cautiously from the dropping funnel. Close the tap quickly once gas is given off. Be wary of rapidly produced gas pressure forcing gas back through the dropping funnel. Work near a water tap so that any liquid from an accident can be washed away immediately.
- remember that most of the volume inside the gas preparation equipment is air.
If the purity of gas produced is important, e.g. for a quantitative experiment on Gay-Lussac's Law, wait until two to three times the internal volume of gas has been produced before collecting samples.
- a good way to obtain pure hydrogen, uncontaminated with air or oxygen, is by using a voltameter constructed so that there is no chance of oxygen from the anode mixing with the hydrogen from the cathode (connected to the negative terminal).

If pure hydrogen can be generated this way in a voltameter the burning of hydrogen can be demonstrated:

- use eye protection
- ensure no hydrogen has recently been released into the air
- light a match and hold it just above the tap outlet
- open the tap to release a steady stream of gas which should ignite.

Pure oxygen generated from the anode (connected to the positive terminal) can be used to re-ignite a glowing piece of wood.

Burning hydrogen

Note: A drop of water is often trapped in the tap. Clear it as this can otherwise put out the flame.

(c): Gas collection

If small amounts of gas are to be used by students, collect the gas in a 15 mm wide test tube or 25 mm wide boiling tube. If larger amounts are required for demonstrations, collect the gas in a gas jar.

The collection method used depends on:

- (i) density of gas compared to air
- (ii) solubility of gas in water

The average molecular mass of air molecules is 80% of 28 + 20% of 32 = 28.8

Gases with molecular mass > 28.8 are denser than air and can be collected by upward displacement of air.

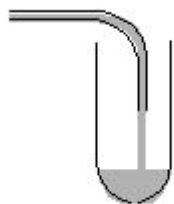


Image: image of gases being collected by upward displacement of air

Gases with molecular mass < 28.8 are less dense than air and can be collected by downward displacement of air.

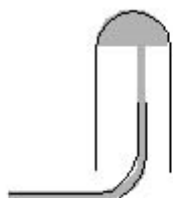


Image: image of gases being collected by downward displacement of air

All gases (any density) which are not very soluble in water can be collected by displacement of water.

1. Fill one third of a trough with water.
2. Fill a tube or gas jar with water by placing it on its side in the trough.
3. Invert the tube or gas jar full of water.
4. Position the gas outlet inside or under the tube or gas jar.

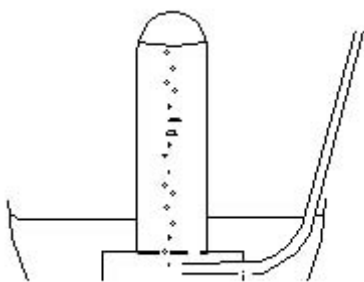


Image: image of tube or gas jar submerged in water

If the gas is soluble in water, using warm or hot water will considerably reduce the amount of gas that dissolves in the water.

Note: HCl, SO₂, NO, NO₂ dissolve in water, generating heat and acid. NH₃ dissolves generating a basic solution.

Note: Gas jars crack easily on heating. If using a gas jar with warm or hot water, gradually warm the gas jar before placing it in hot water.

If the gas is to be collected in water solution, e.g. Cl₂, use this arrangement:

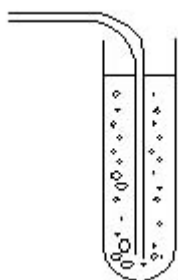
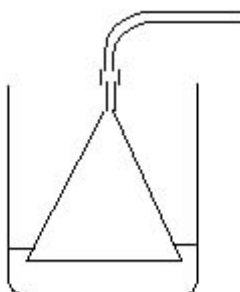


Image: image of gas arrangement to be collected in

water solution

N.B. If gas preparation equipment using downward displacement of water or collection of the gas in water solution is allowed to cool, water can be forced back into the equipment. The water "sucked" back can break hot glassware or interfere with reactants. The sucking of water when collecting a gas can be prevented by using an upside-down glass filter funnel.



filter funnel

Image: image of gas collection using an upside-down glass

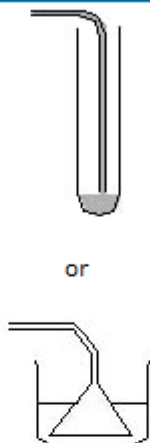
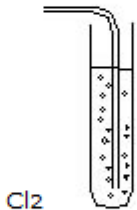
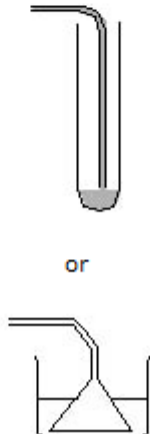
Gas	Formula	Formula mass	Reagent in flask	Reagent in funnel	Collection method	Equation
ammonia	NH ₃	17	NH ₄ Cl	conc. NaOH		$\text{NH}_4\text{Cl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{NH}_3(\text{g})$
bromide water	Br ₂ (aq)	160	bubble Cl ₂ (g) through a bromide solution			$\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2(\text{aq})$ Br ₂ (g) or Br ₂ (l) are too dangerous to prepare
carbon dioxide	CO ₂	44	CaCO ₃	dil. HCl acid		$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2(\text{g})$

Image: image showing different gas collection methods (ammonia, bromide water, carbon dioxide)







chlorine	Cl ₂	71	bleaching powder	dil. HCl acid	 or 	$\text{CaOCl}_2 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{Cl}_2(\text{g})$
hydrogen	H ₂	2	Zn	dil. HCl acid	 or 	$\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2(\text{g})$ FLAMMABLE
hydrogen chlorine	HCl	36.5	conc. HCl or NaCl	conc. H ₂ SO ₄	 or 	$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}(\text{g})$

Image: image showing different gas collection methods (chlorine, hydrogen, hydrogen chlorine)

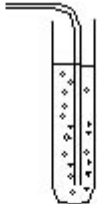
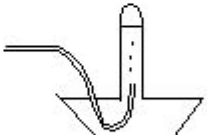
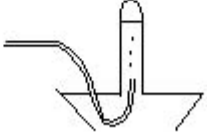
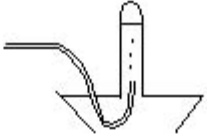
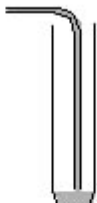
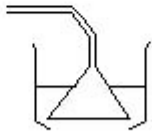
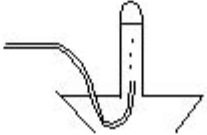
hydrogen sulfide	H ₂ S	34	FeS	dil. HCl acid	 or 	$\text{FeS} + 2\text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2\text{S(g)}$ EXTREMELY TOXIC USE FUME CUPBOARD
nitrogen	N ₂	28	NaNO ₂ solution	NH ₄ Cl solution		$\text{NH}_4\text{NO}_2 \rightarrow 2\text{H}_2\text{O} + \text{N}_2(\text{g})$
oxygen	O ₂	32	KMnO ₄ crystals	3% H ₂ O ₂ solution		$2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2(\text{g})$
nitrogen dioxide	NO ₂	46	Cu	conc. HNO ₃	 or 	$\text{Cu} + 4\text{HNO}_3 \rightarrow 2\text{H}_2\text{O} + 2\text{NO}_2(\text{g})$
nitrogen monoxide	NO	30	Cu	cold 7M HNO ₃		$3\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + 4\text{H}_2\text{O} + 2\text{NO}(\text{g})$

Image: image showing different gas collection methods (hydrogen sulfide, nitrogen, oxygen, nitrogen dioxide, nitrogen monoxide)

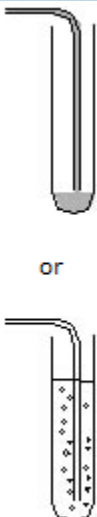

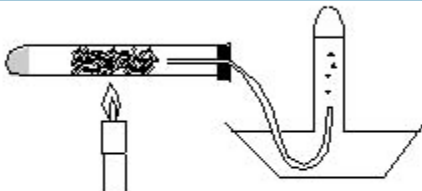
sulfur dioxide	SO ₂	64	Na ₂ SO ₃ or Na ₂ S ₂ O ₅	dil.HCl acid	 or 	$\text{Na}_2\text{SO}_3 + 2\text{HCl} > 2\text{NaCl} + \text{H}_2\text{O} + \text{SO}_2(\text{g})$ $\text{Na}_2\text{S}_2\text{O}_5 + 2\text{HCl} > 2\text{NaCl} + \text{H}_2\text{O} + 2\text{SO}_2(\text{g})$
acetylene	C ₂ H ₂	26	<ol style="list-style-type: none"> 1. Carefully controlled addition of water (drop by drop) to lumps of calcium carbide. FLAMMABLE or 2. Collect from acetylene cylinder of oxy-acetylene equipment 			
ethene	C ₂ H ₄	28	 Add 3 mL C ₂ H ₅ OH to a plug of glass wool in bottom of boiling tube; cover with porous pot; heat porous pot. $\text{C}_2\text{H}_5\text{OH} > \text{C}_2\text{H}_4(\text{g}) + \text{H}_2\text{O}$ FLAMMABLE			

Image: image showing different gas collection methods (sulphur dioxide, acetylene, ethene)

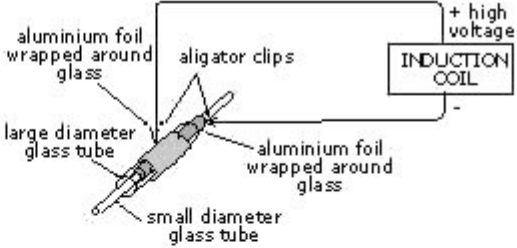
ozone	O ₃	48	 High voltage induction coil. The smell of ozone comes from the glass tubes (i) Use ozoniser OR (ii) electrolysis of 4 M H ₂ SO ₄ using carbon electrodes and 12 V. There will be a smell of ozone at the anode.			
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Image: image showing different gas collection methods (ozone)

Appendix 3: Technical information about concentrated acids and ammonia solution

table showing technical information about concentrated acids and ammonia solutions

Reagent	Formula	Formula weight	Name, molar concentration and % of concentrated solution	Volume of conc. soln. needed for 1 L of 2 M*
acetic acid	CH ₃ COOH	60	glacial acetic acid 17 M 99%	120 mL
hydrochloric acid	HCl	36.5	concentrated 10 M 35%	200 mL
nitric acid	HNO ₃	63	concentrated 16 M 95%	130 mL
phosphoric acid	H ₃ PO ₄	98	concentrated 16 M 95%	130 mL

table showing technical information about concentrated acids and ammonia solutions

Reagent	Formula	Formula weight	Name, molar concentration and % of concentrated solution	Volume of conc. soln. needed for 1 L of 2 M*
sulfuric acid	H ₂ SO ₄	98	concentrated 18 M 95%	110 mL
ammonia solution	NH ₃	17	concentrated/ 18 M 35% 35% / 0.88g mL ⁻¹	110 mL

* 2 M is a suitable dilution for most student use of these reagents. [Appendix D](#) limits concentrations of phosphoric acid to 1 M for use by 7-10 students.

The volume shown of concentrated solution should be added slowly, with stirring, to 500 mL of water (be especially careful diluting sulfuric acid) and then water added to give a total volume of 1 L.

Always add concentrated **A**cid to **W**ater

(in English you read the word **A** r r o **W** from **A** to **W**)

Appendix 4: Science-related memoranda

table showing safety policy guidelines for appendix 4

Section	Memoranda/safety/bulletins/policy
3.2.1.2	Guidelines for management of critical incidents in schools, June 1993
3.2.3.1	Location of fire fighting equipment in schools, Safety Bulletin No 3, November 1993. Fire safety, Safety Bulletin No 7, November 1989. Fire precautions in schools, Safety Bulletin No 2, June 1989. Proper storage of flammable liquids and dangerous goods, Safety Bulletin No 10, March 1983. Fire precautions in schools: action in the event of a fire, Safety Bulletin No 3, March 1983.
3.2.4.1	Memorandum No BOS46/95: Use of fresh human blood in experiments, April 1995. Memorandum No BOS76/96: Experiments involving animals, August 1996. Animals in schools: Animal welfare guidelines for teachers DSE 1991
3.2.4.2	Memorandum DN/05/00493 - Security Sensitive Ammonium Nitrate (SSAN) - SAFETY NOTICE No. 12 — Explosives Regulation 2005
3.2.4.8 (b)	Memorandum 83-135: Radioisotope generators (miniature) REPLACED

table showing safety policy guidelines for appendix 4

Section Memoranda/safety/bulletins/policy

3.2.4.9	Memorandum 83-197: Safe use of lasers in schools. (Currently being revised)
3.2.1.13	Memoranda 79/003 and 5/12/1977: Rocketry. REPLACED
3.2.5.1	Safety bulletin No 3, March 1983: Length of hair and safety in practical work. REPLACED Safety bulletin No 1, November 1993: Electrical repairs and double adaptors Safety bulletin No 3, July 1989: Safe use of electrical equipment Safety bulletin No 17, March 1983: Eye protection in practical work area. REPLACED Safety bulletin No 4, November 1993: Footwear and safety in practical work. REPLACED
3.2.6.2	Memorandum 97/137 (S.129): Excursions and other visits

"REPLACED" indicates memoranda that have been replaced by information in this document

Appendix 5: Sample safety audit of a science laboratory

Laboratory safety audits could be carried out annually, whenever there is a change of personnel using the laboratory or to stimulate and assist the discussion of safety at a faculty level.

Audits are best done by at least two people for thoroughness, efficiency and safety.

Most of the audit should be conducted when the laboratory is free of students. However, some items on the checklist are best completed after observations made while a class is in the laboratory.

Participants in the survey of a laboratory could be:

- Health and Safety Committee (HSC) members
- the head teacher, science and SASS, science
- science teachers who share the laboratory
- a science teacher and students who use the laboratory. Such an activity can be used to revise safe practices with students.

PROCEDURE

Step 1:

Make a sketch of the laboratory and associated preparation and store rooms.

Include:

- placement of work benches
- exits and possible emergency exits
- chemical storage areas

- fire safety equipment
- first aid equipment
- main service controls, such as main water and gas tap and main electrical switch
- fume cupboard
- safety shields and safety glasses
- rubbish and glass bins.

Step 2:

Complete the details below:

example of safety audit checklist

Checklist for safety audit of school science laboratory

Name of school: _____

Date of audit: _____

Personnel conducting audit: _____

Name _____ Position _____

Name _____ Position _____

Laboratory name or number: _____

- [Print the checklist for safety audit of school science laboratory \(DOCX 12.13KB\)](#)

Step 3:

- complete a safety audit checklist while in the laboratory or its environs.
- the sample checklist included here can be adapted by deleting items which are not relevant or by adding other items to suit.
- when additional space is needed use the comment sheets at the end.

Step 4:

1. decide which actions have highest priority for the improvement of safety.
2. create an action list starting with the highest priority.
3. alongside each action, list responsible personnel and time lines for completion.

4. keep a copy of the audit checklist and the action list for a follow up review.

Safety audit checklist

1. Physical environment

table showing safety audit checklist for physical environment

	Question	Yes	No	Action
1.1	Is the laboratory clean and tidy ?			
1.2	Is the floor free of obstruction ?			
1.3	Are laboratory benches positioned so water, gas and electrical services are safe from damage?			
1.4	Are laboratory benches free of sharp edges?			
1.5	Are laboratory bench tops in satisfactory condition?			

table showing safety audit checklist for physical environment

	Question	Yes	No	Action
1.6	Are stools/chairs free of sharp edges?			
1.7	Are stool/chair legs damaging the floor?			
1.8	Are facilities for disabled students in good condition?			
1.9	Are exits kept free of obstruction when a class is in the laboratory?			
1.10	Can exits be opened from the inside without a key?			
1.11	Are all water taps in working order?			

table showing safety audit checklist for physical environment

	Question	Yes	No	Action
1.12	Are all sinks free of blockages?			
1.13	Are all gas taps in working order?			
1.14	Is a bin for broken glass provided?			
1.15	Is a bin for solid waste provided?			
1.16	Are chemical waste bottles provided or available?			
1.17	Is ventilation (natural or fanned) adequate?			
1.18	Is the fume cupboard effective?			

table showing safety audit checklist for physical environment

	Question	Yes	No	Action
1.19	Are live animals used in the laboratory?			
1.20	Are facilities adequate for proper care of the animals?			
1.21	Is biological waste material disposed of in a manner that will not threaten health or safety?			
1.22	Is food prepared, consumed or stored in the laboratory?			
1.23	Is the lighting level adequate for this laboratory?			

- [Print the physical environment safety audit checklist \(DOCX 14KB\)](#)

2. Laboratory emergency equipment

table showing safety audit checklist for laboratory emergency equipment

	Question	Yes	No	Action
2.1	Is the laboratory provided with a CO ₂ fire extinguisher ?			
2.2	Check and note condition of extinguisher			
2.3	Check and note date extinguisher last serviced			
2.4	Is the laboratory provided with a fire blanket ?			
2.5	Is a sand bucket available ?			
2.6	Is the sand clean and dry ?			

table showing safety audit checklist for laboratory emergency equipment

	Question	Yes	No	Action
2.7	Is the first aid kit available ?			
2.8	Is the first aid kit accessible ?			
2.9	Is there a list of contents of the kit ?			
2.10	Are any contents missing ?			
2.11	Does the science assistant regularly check contents of the first aid kit ?			
2.12	Is there a safety shower in the laboratory ?			

table showing safety audit checklist for laboratory emergency equipment

	Question	Yes	No	Action
2.13	If yes, check operation of safety shower.			
2.14	Are eyewash facilities provided in the laboratory ?			
2.15	If yes, check operation of eyewash stations.			
2.16	Is there a standard accident report or investigation procedure ?			

- [Print the laboratory emergency equipment safety audit checklist \(DOCX 13.43KB\)](#)

3. Protective equipment

table showing safety audit checklist for protective equipment

	Question	Yes	No	Action
3.1	Is a demonstration safety shield available ?			
3.2	Is yes, is it in good condition ?			
3.3	Are safety glasses or goggles available ?			
3.4	If yes, are they in good condition and sufficient numbers ?			

- [Print the protective equipment safety audit checklist \(DOCX 12.48KB\)](#)

4. Associated preparation rooms and store rooms

table showing safety audit checklist for associated preparation rooms and store rooms

	Question	Yes	No	Action
4.1	Can preparation and store rooms be locked ?			
4.2	Can the doors be opened from the inside without a key?			
4.3	Are students allowed into the preparation room ?			
4.4	If yes, note when and why they are allowed in.			
4.5	Are students allowed into the store room?			
4.6	If yes, note when and why they are allowed in.			

table showing safety audit checklist for associated preparation rooms and store rooms

	Question	Yes	No	Action
4.7	Are chemicals stored as required by WHS legislation?			
4.8	Note the date of the last chemical register and stocktake			
4.9	Is a register of chemicals readily available?			
4.10	Are unwanted chemicals disposed of as recommended?			
4.11	Have all unlabelled chemicals been disposed of?			
4.12	Is information on the safety of chemicals freely available to all who require it?			

table showing safety audit checklist for associated preparation rooms and store rooms

	Question	Yes	No	Action
4.13	Where are the Safety Data Sheets (SDS) kept?			
4.14	What sources of information on hazardous chemicals are available to science SASS?			
4.15	What sources of information on hazardous chemicals are available to teachers?			
4.16	What sources of information on hazardous chemicals are available to students?			
4.17	Are all chemical containers clearly labelled with name (not just formula) to identify the contents?			
4.18	Do the labels indicate the year of supply?			

table showing safety audit checklist for associated preparation rooms and store rooms

	Question	Yes	No	Action
4.19	Do the labels show signal words, hazard phrases and pictograms in accordance with GHS requirements?			
4.20	Are all chemical containers colour-coded blue, green, orange, red or black?			
4.21	Are storage shelves permanently fixed to the wall?			
4.22	Are chemicals of different classification that require separation and segregation appropriately stored?			
4.23	Do the shelves or their supports show signs of corrosion?			

table showing safety audit checklist for associated preparation rooms and store rooms

	Question	Yes	No	Action
4.24	Are materials and equipment available for control of chemical spills?			
4.25	Is the chemical storeroom vented to the outside by fan or natural cross-ventilation?			
4.26	Is the preparation room vented to the outside by fan or natural cross-ventilation?			
4.27	Is the preparation room provided with hot and cold water and draining areas?			
4.28	Are trolleys, wire carrier baskets or plastic buckets available for transport of chemicals between rooms?			

table showing safety audit checklist for associated preparation rooms and store rooms

	Question	Yes	No	Action
4.29	Are lighting levels adequate in preparation and store rooms ?			
4.30	Is the room provided with a CO ₂ fire extinguisher?			
4.31	Check and note condition of extinguisher.			
4.32	Check and note date extinguisher last serviced			
4.33	Are radioactive materials kept in this area?			
4.34	If yes, are the radioactive materials kept in a lockable metal box with the contents listed on the outside?			

- [Print the protective equipment safety audit checklist \(DOCX 15.27KB\)](#)

5. Comments

table with questions and comment section

QUESTION	COMMENT
<hr/>	
<hr/>	
<ul style="list-style-type: none">Print the comments sheet (DOCX 11.98KB)	

Appendix 6: Sample school science safety policy

Safety Policy

Aims:

To create a safe working environment for staff and students. This should include:

- developing and promoting safe working habits
- correct use of equipment and chemicals
- requiring staff and students to use safety procedures and equipment including Personal Protective Equipment (PPE) where indicated by a risk assessment
- responsible disposal of wastes.

Those involved:

- all students
- all teachers entering science areas
- school administrative and support staff (SASS)
- visitors.

Responsibility:

The teacher is responsible for:

- maintaining a safe working environment by planning lessons thoroughly and appropriately supervising students as they work
- assuring a level of safety in keeping with the Department's safe work practices
- promoting safe habits during practical lessons
- keeping themselves informed of relevant safety information provided in:
 - Chemical Safety in Schools (CSIS)
 - SDS
- assessing the hazards and dangers of the chemicals they use themselves, near others or with students.

Implementation

table showing implementation of school science safety

Group	Document	Implementation
Year 7 classes	Introduction to the science laboratory	<ul style="list-style-type: none">• Orientation lessons• Science skills lessons
Year 7-10 classes	Laboratory rules	<ul style="list-style-type: none">• Paste in front of book• Signed by student• Signed by parent or guardian
Teachers	School science safety policy	<ul style="list-style-type: none">• Week 1 each year
New teachers	School science safety policy	<ul style="list-style-type: none">• On appointment
Casual teachers	School science safety policy	<ul style="list-style-type: none">• On employment
Senior students	School science safety policy	<ul style="list-style-type: none">• On enrolment in senior science class

Safety guidelines for teachers

Wear clothing and footwear suitable for the laboratory.

Know, for each laboratory used,

- the position of the main gas, water and electrical controls, how to turn on and off and how to secure where possible
- the location of the fire blanket, fire extinguisher, sand bucket
- the location of a safety screen and the safety glasses
- the position and correct operation of the fume cupboard
- the availability of chemical waste bottles
- suitable emergency exits

- the location of the first aid kit
- the location of rubbish and glass bins.

Leave doors:

- unlocked when any teacher or student is in the laboratory
- locked at beginning of recess and lunchtime and at the end of the school day
- of preparation rooms closed when not in use
- of store rooms locked when not in use.

Insist that junior students' bags are left outside the laboratory adjacent to the wall.

Insist that senior students' bags if placed in the laboratory are not a hazard.

Clean up and repair minor breakages immediately.

Report accidents and major breakages and damage promptly to the head teacher, science.

Read safety information on all chemicals with which you are unfamiliar before use (see Chemical Safety in Schools: [Appendix D](#) and SDS).

Apply the results of the department generic risk assessment where appropriate. Use safety screen/ safety goggles/ fume cupboard as required by a risk assessment.

Food or drink intended for human consumption must not be prepared with laboratory equipment or in a laboratory (unless with specially kept equipment available on order from the laboratory SASS, e.g. taste testing, fossil models made from chocolate).

Turn off gas mains at the end of each day. Lock the gas cupboard, if one exists, and return the key to preparation room.

Sample science safety rules for students

Sample 1 (General instructions): Laboratory conduct

Laboratory safety begins with the right attitude.

- Concentrate on the laboratory work and follow instructions.

"Good housekeeping" helps everyone.

- Keep the laboratory clean and organised.
- Handle materials carefully.
- Use equipment properly and return it to the correct location.
- Clean up thoroughly at the end of a task; you know what the mess is, others may not.

Be alert for hazards.

- Keep the laboratory safe for everyone.
- Think ahead; what is the best thing to do if an accident occurs?

Use the protection provided.

- Following instructions and demonstrated techniques carefully is the best protection.
- Use safety glasses or shields, gloves, fume cupboards when required.

Sample 2 (more specific instructions): Laboratory rules

1. Leave bags outside the laboratory.
2. Always wear shoes that cover all of your foot when in the laboratory.
3. Do only what your teacher tells you to do.
4. Do **not** run in the laboratory unless approved for special experiments or activities.
5. Do not eat or drink in the laboratory unless approved for special experiments or activities.
6. Stay in your place unless directed to move.
7. Take care at all times.

8. Only use gas and water taps when your teacher instructs you to.
9. Leave all benches clean and dry.
10. Clean and return all equipment after an experiment.
11. Put all rubbish in the bins provided.
12. Report all accidents to the teacher.

Appendix 7: Responsibilities for the Ionising Radiation Safety Officer

The responsibilities listed below are based on Section 5. Responsibility Code of Practice for the Safe Use of Ionising Radiation in Secondary Schools (1986) NATIONAL HEALTH AND MEDICAL RESEARCH COUNCIL.

Direct quotations from this document are in italics. Supplementary information is given below.

5.1: Responsibility for radiation safety shall be clearly assigned

5.2: Ultimate responsibility for government schools is with the State Departments of Education which are generally empowered to delegate responsibility to the principal of each school. The principal, in turn, should delegate to a responsible teacher.

5.3: It is standard practice to have a statutory authority whose role it is to advise on matters relating to the safe use of ionising radiation and to implement the provisions of the relevant legislation.

Note: Statutory authorities contact in Annexe 3 has changed to:

Environmental Protection Authority
Radiation Control Section
Po Box 136
REGENTS PARK NSW 2143

Phone: (02) 9795 5014
Fax: (02) 9649 4470

5.4: The responsible teacher shall ensure that:

5.4.1: experiments are planned and conducted in such a way that recommended dose limits cannot be exceeded.

Annual limits of radiation exposure are:

Adults:

- 1 mSv per year from artificial sources excluding medical doses.
20-50 mSv to a single organ.

School students:

- 0.5 mSv per year, excluding doses from medical procedures and natural background.
 - 5 mSv per year to a single organ or tissue such as the eye lens or the skin.
- A new school gamma source (200 kBq of Cobalt-60) held 10 cm from the body for approximately 60 hours would give an effective dose of about 0.5 mSv, the annual limit for a school student.

*Note: All doses should be kept As Low As Reasonably Achievable (**ALARA**)*

5.4.2: Sources of radiation are securely stored and shall not be used or handled frivolously.

All radioactive sources in a school must be stored in a locked metal, or metal-lined container, which is permanently labelled to indicate that it contains radioactive substances. Contents of the box should be listed on the outside.

Sealed sources may be handled by teachers, SASS and Year 11 or 12 students under the direct supervision of a teacher.

Always wear disposable gloves when handling any radioactive sources.

Minimise handling time.

Keep the source away from the trunk of your body.

Never put anything into the opening of the alpha source plastic disk.

5.4.3: All sources of radiation are accounted for.

This is a responsibility of all science teaching staff using radioactive sources and SASS distributing or storing sources.

Radiation sources are an essential part of any stocktake of equipment or chemicals undertaken. The teacher responsible for radioactive sources at a school (the Ionising Radiation Safety Officer) must be informed immediately if any radiation source is missing.

The Ionising Radiation Safety Officer should carry out a routine check of all radioactive sealed sources at least every five years. If there are any concerns about the condition of a source after a fire or physical damage (especially the alpha source which is not completely sealed in plastic), the source should be returned to Australian Radioisotopes (ARI) and replaced.

Sources more than 10 years old should be wipe tested or returned to ARI and replaced with new sources.

Wipe test procedure:

Wear disposable gloves and be especially careful with the alpha source when carrying out a wipe test.

Alpha source: wipe with filter paper moistened with ethanol. Allow the ethanol to evaporate so the paper is dry (solvent no longer present to absorb alpha particles) before measuring radioactivity level near the wipe area on the paper. Make sure you are using a Geiger tube able to detect alpha particles ([see 3.2.4.6 \(a\)](#) for a method).

Beta and gamma sources: wipe with filter paper moistened with water. Measure the radioactivity level near the wipe area on the paper.

5.4.4 If a source of radiation is lost, or suspected to be stolen or damaged, the matter is to be reported, in the first instance, to the principal who shall then inform the Department of Education and statutory authority. The statutory authority shall advise on procedures to follow and will provide assistance if any is needed. In the case of theft, the police may also need to be informed.

Staff first noticing loss, suspected theft or damage, the responsible teacher and head teacher, science, should investigate the situation before referral to the principal.

5.4.5 Only such sources of radiation which are approved by the relevant statutory authority are used in the school.

Radioactive materials used in school science practical work should be:

- sealed sources, such as those supplied by ARI or other suppliers
- sources supplied with equipment, such as cloud chamber kits
- "miniaturised radioisotope generators" or "mini-generators" which generate short-lived daughters of Cs-137 or Sr-90 ([see section 3.2.4.6 \(a\)](#))
- uranium or thorium ore samples or compounds kept in sealed glass containers.

5.4.6 A contingency plan is prepared for the event of a teacher or student being accidentally exposed to radiation.

A contingency plan is only needed for a situation where a staff member or student is exposed to radiation doses in excess of recommended dose limits. This is an unlikely situation in a school given the radiation which could be expected from the sources approved to be used in schools. For example, accidental exposure to an approved source during the period of a day would

NOT require this response. Refer to [Section 3.2.4.6 Ionising radiation](#) for information on dose limits in schools.

The following is a sample contingency plan for a situation where a staff member or student is exposed to radiation doses in excess of recommended dose limits.

Contingency plan in the event of accidental exposure to radiation in excess of dose limits

1. Ensure all personnel are removed from the source of the radiation.
2. Ensure that others are prevented from entering the area.
3. Assess potential consequences in relation to:
 - the size of the source
 - the period of exposure
 - the extent of shielding.
4. Seek immediate medical attention for exposed person/s.
5. Contact the appropriate regulatory body, which is NSW EPA, Radiation Control Section (telephone: (02) 9795 5014).
6. Carry out remedial action to ensure that the source of radiation is contained.
7. Write and keep a report detailing the events leading to the incident, the actions taken and measures adopted to prevent a recurrence.

5.4.7 Items of equipment which might produce by-product X-rays are identified and appropriate radiation protection measures for these devices are instituted

5.4.8 High voltage electronic tubes are checked for the possible emission of extraneous X-rays

Gas discharge tubes (Crooke's tubes, vacuum scale tubes, spectrum tubes) connected to induction coils may produce unwanted X-rays from the tubes when operated above 5 000 V. A rough guide to the operating voltage can be inferred from the size of the spark produced between the adjustable sparking points of an induction coil. 5 000 V will normally produce a spark of 0.5 cm in air.

Appendix 8: Responsibilities for the Laser Safety Officer

The responsibilities listed below are based on Section 5. General administrative requirements: Code of practice for the safe use of lasers in schools (1995) RADIATION HEALTH SERIES No. 36 NATIONAL HEALTH and MEDICAL RESEARCH COUNCIL.

Direct quotations from this document are in italics. Supplementary information is given below.

5.1 Responsible staff member and Laser Safety Officer (LSO)

The principal of the school shall designate a member of staff to be responsible for the use of lasers within the school. If any of the lasers are classified as Class 2 or Class 3A, a Laser Safety Officer (LSO) shall be appointed in accord with AS/NZS 2211 (harmonised).

The 1997 version of this Australian Standard (AS/NZS2211.1:1997) defines the LSO as a member of staff "competent in" use of lasers. Note that Australian Standards do not have legal status like Acts or Regulations but what they contain can be referred to in a court case.

5.2 Duties of responsible staff member (or LSO)

The staff member (or LSO if applicable) referred to in 5.1 shall be responsible for the procurement, storage and issue of lasers and associated safety equipment, and shall ensure that the requirements of this code are met when lasers and associated safety equipment are first obtained by the school and at all times thereafter. In addition, this person shall:

- be responsible for the preparation of specific working rules and warning signs for use with particular laser equipment as required; and*
- ensure that laser equipment is securely stored and a proper inventory system maintained.*

Many of these tasks are shared responsibilities of science teaching staff, SASS and HT science. The LSO is the staff member who should be involved in major decisions involving lasers and a resource person to whom others can refer for advice.

5.6 Information to be made available

The following information shall be held in a secure place and shall be readily available on request:

(a) the name of the LSO or responsible staff member (**see 5.1**);

(b) a copy of this code;

(c)-(h) refer to information that should be provided by the manufacturer of the laser product; this information should be available in the handbook supplied with the laser.

(c) instructions for assembly and safe use of the laser, including precautions to avoid exposure to harmful radiation;

(d) maintenance instructions necessary to keep the laser within its stated classification;

(e) information on the laser medium or emitted wavelength(s) and the maximum output power of the laser;

(f) legible reproductions of all warning plates and labels and an indication of the location of each of these on the laser;

(g) a list of controls, adjustments and procedures for operation and maintenance of the laser with the warning:

CAUTION: Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.

(h) when applicable, a statement on the compatibility requirements for a laser energy source; and

(i) a warning that certain modifications to the laser shall require a reassessment of its classification

3.3: Technology and applied studies (TAS)

3.3.1: Introduction

3.3.1.1 Rationale

Section 3.3.1 contains further information about the safe use of chemicals and is particularly relevant to all teachers and school administrative and support staff working in the Key Learning Area of Technological and Applied Studies (TAS).

Teachers have responsibilities for the health and well-being of the students in their care, their co-workers and themselves.

Many of the materials, processes and substances in use in TAS KLA subjects could be dangerous if used incorrectly.

Staff should be fully aware of all issues related to chemical safety in order to ensure the safety of themselves and students.

To ensure that all employees and others undertaking work are aware of the safety issues involved, it is recommended that a copy of this document be given to all relevant staff.

3.3.2: Organising chemicals

3.3.2.1: Labelling

In addition to being stored in the correct container, all hazardous chemicals must be appropriately labelled. This is achieved either by leaving the substance in its original packaging (which must be labelled correctly by law), or by producing a label using the online Chemwatch package ([Section 2](#)) and attaching the correct label to the container. In addition, colour-coded labels must be applied to identify the categories of chemical usage (see [Section 1.4](#)).

Chemicals are often purchased in bulk to save costs. It is common for these substances to be decanted into smaller containers ready for use. This presents a problem with labelling.

Purchasing a number of smaller quantities of the particular chemical in commercially labelled containers is recommended. Subsequent bulk purchases can be decanted into the correctly labelled container. This also avoids the problem of using unsuitable containers, such as food containers, to store chemicals (e.g. PVA in sauce bottles).

3.3.2.2: Signs

Teachers need to ensure that there is clear and consistent communication about potential hazards in all technology learning spaces and storage areas. This can be achieved through the use of signage which complies with Australian Standards. These use coloured pictograms to communicate the existence of hazards to everybody in the vicinity.

GHS hazard pictograms are used to identify hazards related to chemical substances. This signage should already be a part of any commercially produced container.

Foster a safety conscious learning environment by taking appropriate opportunities to educate students about the significance of safety warning signs and symbols.

Around agriculture plots and sporting fields, warning signs should be erected on the perimeter of any area being sprayed with chemicals. These signs must indicate the date of spraying, what was sprayed, the chemical used and the date when the withholding (of access) period is over.

3.3.2.3: Storage

As outlined in [Section 1.3](#), hazardous chemicals must be stored according to the requirements of the legislation. Within storage areas, separation may be required between types of hazardous chemicals. Technology teachers should recognise the dangers associated with chemical substances in use in TAS KLA subjects.

The risk can be increased by poor storage methods, especially when chemicals are left in or near the teaching area. Even small quantities can present a significant risk. The storage of chemicals in unsecured areas, such as the classroom is to be avoided.

Technology teachers and support staff should ensure the following.

- Chemicals, such as cleaning agents and pesticides, should be stored well away from food, food storage and preparation areas.
- Chemicals, such as dyes and textile testing agents, should be labelled and stored in a locked cupboard.
- Any utensils used for preparing and storing chemicals, such as dyes, should never be used for any other purpose, e.g. food preparation.
- Small quantities of lacquers, paints and thinners are stored in a lockable cabinet when not in use. Larger quantities should not be stored in the work space areas.

- Oxygen and acetylene gas bottles should be removed from workshops when not in use. **It is recommended that a storage area separate from workshop areas should be used to store gas bottles.** See also **Section 3.3.4.2 (j)**.
- All fuels should be stored in a well ventilated, secure storage facility which has an appropriate fire extinguisher located nearby.
- All poisons should be secured in a locked poisons cabinet or in secure storage which is not accessible to unsupervised students. This includes any chemical with such labels as KEEP OUT OF THE REACH OF CHILDREN, DANGEROUS POISON, POISON, CAUTION or WARNING.

The chemical risk assessments provide guidance on the storage controls required for hazardous chemicals. As a general principle, the below table provides guidance on the separation and segregation requirements for chemical classification types.

Class	2.1	2.2	3	4.1	4.2	4.3	5.1	5.2	6	8
2.1										
2.2										
3										
4.1										
4.2										
4.3										
5.1										
5.2										
6										
8										

Segregation key	Segregation type
	COMPATIBLE: Chemicals with similar hazards are usually compatible. However chemicals may have more than one hazard and you should still check the SDS.
	REFER TO SDS: Separation of these chemicals may be necessary. Consult the SDS for further guidance.
	MINIMUM THREE METRE SEPERATION: These chemicals may react dangerously if stored together may and should be kept at least three metres apart.
	MINIMUM FIVE METRE SEPERATION: Storing these chemicals together will significantly increase the likelihood or severity of an incident. They should be kept at least five metres apart or in separate storage areas.
	ISOLATE: Dedicated storage areas or storage cabinets are recommended for self-reactive chemicals and organic peroxides, as is separation from other buildings and property boundaries.

Source: SafeWork Australia - Managing risks of storing chemicals in the workplace : Guidance Material

3.3.3: Safe practice for technology learning environments

3.3.3.1: Lesson planning

Before using a hazardous chemical for the first time you must have completed a risk assessment.

Lessons that involve the use of chemical substances require thorough planning. This includes:

- identifying if the substances to be used or produced are hazardous chemicals
- following department advice given in [Appendix D](#) about the use of the chemical
- giving school administrative and support staff (SASS) advance notice of requirements
- implementing appropriate control measures
- obtaining appropriate chemicals and equipment for use during the lesson
- ensuring that all materials and equipment are available when required
- ensuring that students are wearing appropriate clothing, footwear and any other personal protection equipment required by risk assessment
- planning for sufficient time to clear away equipment and clean up.

3.3.3.2: Preparation and maintenance of learning environments

All learning spaces should be kept clean and the equipment and resources maintained ready for use. This includes:

- storing all tools and equipment safely
- storing all chemicals appropriately
- keeping fixed and portable machinery, tools and equipment in good order
- optimising room layout to reduce hazards
- keeping locked any storerooms used to hold chemicals. They need to be kept tidy and well ventilated. The bulk of flammable liquids should be stored in a flammable liquid storage cabinet

- avoiding the use of pesticides, such as cockroach baits and fly sprays in food preparation, consumption and storage areas
- maintaining fly screens on doors and windows in all areas where food is prepared, consumed and stored
- seeking professional advice for the extermination of pests.

3.3.3.3: classroom management strategies

Students need to be aware of the safety procedures required when using chemicals. In addition to specific safety lessons or demonstrations, students should be reminded frequently about safety procedures when using chemicals.

Eating and drinking must not be permitted during lessons where hazardous chemicals are being used.

All students and staff should wear personal protective equipment where necessary. Teachers should always model safe practice when working with chemical substances.

Do not allow students' bags to remain in walkways. They should be left outside or locked away.

Plan the distribution of materials and equipment to minimise congestion.

3.3.3.4: Contingency planning

Before each lesson involving the use of chemicals, teachers should be aware of:

- the degree of sensitivity to chemicals of the students in their classes. This information can be obtained from student records or by asking the students themselves
- the correct emergency care procedures to apply in the event of a student reacting adversely to a chemical substance
- the location of fire extinguishers, fire blankets, and first aid equipment.

3.3.3.5: Emergency evacuation procedures

- Emergency evacuation procedures for each learning space should be known by all staff and students.

- The evacuation plan for each room must be displayed clearly.

3.3.3.6: Using chemicals

- [\(a\): Containers](#)
 - [\(b\): Preparation of chemicals](#)
 - [\(c\): Heating chemicals](#)
 - [\(d\): Fumes](#)
-
- [\(e\): Spills and cleaning up](#)

(a): Containers

Containers must be appropriate for the chemical being used and have the correct labelling.

Note: See [Section 1.3](#) and [1.5](#)

(b): Preparation of chemicals

Prepare chemicals before the lesson, wherever possible. Chemicals should be checked for condition by opening the container.

Do not use substances that:

- have obviously deteriorated, e.g. "cracked" or oxidised the "appearance" section of the SDS will tell you what the chemical should look like if you are not sure
- are in damaged containers or have damaged or illegible labels
- are beyond their use-by date, should the chemical have one

(c): Heating chemicals

Heating of chemicals occurs in numerous activities in TAS KLA lessons. Teachers must ensure that the correct technique is used for the activity, and that all safety equipment required is readily available.

Students should remain standing up when carrying out heating processes, as this enables quicker escape in the case of accidents.

Flammable liquids should generally not be heated, nor should they be allowed near heating devices.

(d): Fumes

The generation of fumes is a common occurrence for many technological processes. Whilst appearing to be insignificant, they can cause serious injury in the form of poisoning. This can occur via inhalation, ingestion or absorption through the skin, depending upon the type of fumes. Whenever fumes are generated, teachers need to ensure that:

- the amount of fumes developed is kept to a minimum
- the work area is well ventilated
- exhaust fans are in place and used where appropriate
- respiratory equipment is available when required.

(e): Spills and cleaning up

Spills should be cleared up immediately. Some spills can be simply cleaned up with a damp cloth, whilst others require the use of protective equipment or specific procedures, e.g. gloves and neutralising chemicals.

Flammable chemicals should not be absorbed using paper towels, as these can easily ignite.

Cat litter (clay-based not paper-based cat litter), expanded perlite or vermiculite are good absorbents for spilled chemicals, especially flammable or corrosive substances.

Students should be encouraged to report all spills to the teacher to ensure immediate clean-up.

Ensure that facilities for washing and drying hands are readily available.

Note: A recommended spill kit is described in [Appendix E](#)

3.3.3.7: Safe practices in food preparation areas

The accidental food poisoning caused by the ingestion of certain pathogens often results from poor workplace habits in food preparation areas.

The following safe workplace procedures should be followed in food preparation areas.

- All food handlers should wash their hands with soap or an alternative before preparing food.
- Food should be stored promptly after purchase.
- All fresh produce should be washed to remove chemicals such as pesticides before use.
- Meats, dairy produce and fresh produce should be covered and stored separately to prevent cross-contamination.
- Surfaces should be cleaned regularly, particularly after preparing meats.
- Food should not be thawed and re-frozen.
- Reconstituted food or cooked food which is stored in the refrigerator should be kept for a minimal time only and a date marked to ensure safe use.
- Packages should be checked for degradation and disposed of if freshness is compromised.
- 'Use-by' dates should be checked before presenting foods for use. Cupboards, refrigerators and freezers should be regularly monitored to remove out-of-date products.
- Frozen meat should be date-stamped with the 'use-by date' clearly visible.
- Refrigerator and freezer temperatures should be regularly checked.
- Utensils and surfaces used for the preparation of meat should not be used for another food without washing in hot soapy water.
- Food preservation, such as pickling and bottling, should be carried out according to the directions on the bottling kit and seals checked. Sterilisation of bottles should be carried out according to the manufacturer's instructions.
- In situations where minor injuries, such as cuts, occur to the students while handling food, the injuries should be cleaned and a dressing applied. The student should participate in another activity for that lesson.

3.3.3.8: Using electric power tools

These include hand-held power planes, drills, saws and angle grinders. As a general principle, only teachers and students with a sound knowledge of the operating principles and appropriate training should use this equipment.

The leads should always be inspected prior to use to ensure that connections and the cable itself are sound and that the protective insulation is not cracked or frayed. Only heavy-duty leads should be used outside.

Keep electrical equipment away from sources of water such as taps, sinks, glaze buckets, etc. Be particularly vigilant if hair dryers are being used as a heat source. Students must not be able to use electrical appliances at power points near sources of water.

Use eye protection which is resistant to impact and heat to reduce the risk of eye damage from fast moving, tiny, hot fragments of metal or other materials being worked on.

When using the tools, hold them in a way that minimises the chance of injury to yourself and others.

A standard 240 V power outlet should not have more than 10 A (Amperes) of current passing through it. If the total power of electrical appliances operating from the outlet is limited to 2 400 W (Watts) i.e. 2.4 kilowatts, the current should not exceed 10 A. Leads coming from a power outlet should have a rating of 10 A. If a lead feels warm after use check that it is at least

10 A rating and has not been connected to more than 2 400 W load of appliances.

3.3.4: Information about common dangerous or hazardous activities

Information on chemicals for use in TAS is available from:

- labels and manufacturer's information sheets
- SDS
- [Appendix D](#).

3.3.4.1 General advice for chemicals commonly used in TAS KLA courses

The following Section includes product specific advice which is intended to supplement, but not replace the information found in the label and Safety Data Sheets (SDS) for the product. It may help teachers make decisions when completing risk assessments. The department protocol must be followed or a site-specific risk assessment completed before these chemicals are used for the first time.

(a): Adhesives

A wide range of adhesives are used in TAS KLA subjects for a variety of purposes. The following information provides a brief outline of common adhesives used in schools. It is recommended that teachers obtain SDS for all adhesives, fillers, etc. to determine the level of hazard involved.

Polyvinyl-acetate (PVA)

PVA is a common ready-made adhesive used in TAS classrooms.

It sets by evaporation and absorption. It is non-toxic, but may result in abdominal discomfort if ingested, and may be an eye irritant. Keep skin contact to a minimum as PVA can cause dermatitis. PVA is not considered an inhalation risk unless heated.

Hot melt glue

Hot melt glue is sold in the form of cylindrical sticks for use in specially designed heat guns. Ensure there is adequate ventilation of the work area, as fumes can result from the heating process. Because the molten glue becomes quite hot, ensure that no skin contact occurs, as this may result in severe burns. Suitable gloves should be worn.

Animal glue

Traditional wood glue is made using animal skins and bones to provide the protein which gives this glue its adhesive properties. Whilst it is non-toxic, its

use requires it to be heated in a jacketed glue pot or hot water prior to use. Contact with the skin can result in burns. Ensure there is adequate ventilation of the work area, as fumes can result from the heating process.

High stress wood glue

This glue is a two-part adhesive using urea formaldehyde and formic acid. It cures via a chemical reaction between the urea and a catalyst hardener. It has strong water resistance and gap-filling properties. The hardener is considered quite dangerous. Fumes can cause irritation to mucous membranes and the respiratory tract. Ensure adequate ventilation of the work area. Use protective gloves and safety glasses, as the hardener is corrosive to skin and eyes. Ingestion can result in nausea, vomiting and abdominal pain. Use dust masks to prevent inhalation of the powdered component.

Resorcinol

Another formaldehyde-based adhesive which is similar in many ways to urea formaldehyde. Resorcinol is completely waterproof and weather-resistant. It is a two-part adhesive, consisting of a resin and powdered hardener. As with urea formaldehyde, skin and eye protection are required as the various components and the mixture are harmful. Inhalation of the hardener or formaldehyde vapour can result in serious respiratory problems. Ensure good ventilation. Ingestion of the hardener can result in vomiting, diarrhoea and abdominal pain.

The cutting, sawing or routing of materials containing formaldehyde glue should be avoided as formaldehyde glues present a safety problem when a gas is produced. If a cutter is dull or blunt, the cutting action tends to burn the product. The odour is then apparent and can quickly affect the operator and those in the area. The effect is one of being light headed and can result in headaches. This situation is to be avoided at all times, as formaldehyde gas is a known irritant to the nose and throat. It is also a sensitiser, and may cause allergic dermatitis or asthma.

Note: For more detail, refer to [Appendix D](#).

Contact adhesive

Contact adhesives are applied to both surfaces to be bonded. They are allowed to become touch dry, then the surfaces are pressed together to bond instantly. Solvent-based contact adhesives are highly flammable and produce strong fumes, which if inhaled can irritate mucous membranes and the respiratory tract, and lead to headaches, dizziness and nausea.

Good ventilation is essential. Use gloves to protect the skin as removal of the adhesive requires the use of solvents which may be harmful. Chemical safety goggles are highly recommended to avoid eye irritation. Ingestion can cause irritation of the mouth and oesophagus.

Water-based (acrylic) formulations are safer as they produce lower vapour levels, but they require similar precautions.

Epoxy resins

Epoxy resin adhesives are synthetic, two-part formulations which are mixed in equal portions prior to use. They cure by chemical reaction to form a strong, insoluble bond.

Epoxy resins require specific solvents for clean-up. Check the label before using the resin and have the appropriate solvent ready. If the appropriate solvent is not available to clean uncured glue from surfaces, try using a cloth dampened in methylated spirits.

Avoid skin contact by using protective gloves as epoxy resins may irritate the skin. It is advisable that preparation of the glue is done by the teacher. Material spilt or accidentally wiped onto the skin should be immediately removed with the solvent. The glue can irritate the eyes. Vapours may cause slight respiratory irritation, and may trigger asthmatic problems.

Cyanoacrylates

Cyanoacrylates are commonly called 'super glues'. They may contain ethyl, methyl or butyl cyanoacrylate. They are general-purpose, extremely strong, fast-setting, adhesives and are commonly used in bonding acrylic.

The adhesive is highly discomforting to the skin and may cause chemical burns. Approved chemical resistant gloves are recommended when using the adhesive. The adhesive is flammable and must be kept away from all ignition sources.

The vapour and liquid are both highly irritating to the eyes. The material is capable of gluing the eyelids together and causing damage to the eyes. Approved safety glasses are recommended. The vapour is discomforting to the upper respiratory system and can cause asthmatic or allergic responses. Use small quantities in a well-ventilated area or use an approved respirator.

Building adhesives

Solvent-borne synthetic rubber-based adhesives (e.g. liquid nails, maxibond) are capable of making strong bonds between numerous building materials.

In the liquid form, they can irritate the eyes, skin, mouth and oesophagus. The vapours may irritate mucous membranes and the respiratory tract. Use gloves and safety glasses, and work in a well-ventilated area.

(b): Cleaning chemicals

Staff in technologically-based subjects are involved in cleaning operations of all kinds. Some of the cleaning agents are much more powerful than those used in the home, or in other parts of the school. Some people are more sensitive to cleaning agents than others, and there are a number of cleaning agents which are highly corrosive.

Many of these cleaning agents have specific instructions for use, and these should be strictly adhered to. Virtually all cleaning agents are alkalis, acids or solvents and should be treated accordingly. Wear gloves to avoid contact with the skin.

Detergents

The skin-irritant properties of dishwashing and laundry detergents, and of specialised domestic cleaning mixtures, were described in Useful things to know.

Technology teachers and support staff in the TAS KLA will sometimes use detergent mixtures which are much more powerful than those used for domestic cleaning. These detergents have been formulated for maximum effectiveness in removing chemical residues from glassware, grease residues from metal or for some other special purpose.

They have NOT been formulated to be gentle to the hands! Treat these powerful detergents with respect. Wash any of the concentrated liquid off your hands immediately with a large volume of water. The diluted solutions are less irritant, but avoid skin contact by wearing gloves and wash your hands thoroughly if you get any cleaning liquid on them. Refer to [Section 1.9](#), [Figure 1.9-1](#) for the selection of gloves.

Note: Avoid skin contact with powerful detergents. Wear suitable gloves.

Acids

Strongly acid solutions are often used for cleaning metals. Acids remove the surface coating of oxide from metals, making the surface shiny, chemically active and ready to receive coatings.

Remember always to add acid to water, while stirring if you are diluting acids. If you do it the other way around, the mixture will generate excessive heat, possibly boiling and splashing of hot acid out of the container. This is very hazardous.

Strongly acid solutions are highly irritant to the skin. Do not allow them to come in contact with your hands. Sometimes, concentrated acids are used for cleaning. They are particularly hazardous. Consult the information in the relevant SDS or [Appendix D](#).

Fluxes, used for cleaning metal surfaces during soldering, silver soldering, and brazing are often strongly acid, and may contain highly toxic chemicals such as fluorides (also see [3.3.4.2\(f\)](#) Metal joining).

Note: Never add water to acid. Always add acid to water, while stirring! Wear eye protection when using concentrated acids.

Alkalis

Alkaline cleaning mixtures are often used for cleaning metals such as aluminium, and for etching. Most of them are based on caustic soda (sodium hydroxide). This material dissolves fats and is used in the most powerful domestic cleaners (for clearing drains and removing oven grease).

Alkaline cleaning materials containing caustic soda (sodium hydroxide) are very corrosive to the eyes and skin.

If you splash an alkaline solution in your eye, you must wash it out INSTANTLY with water since it will damage the surface of your eye (cornea). Use any water that is nearby. The most important thing is speed. Seconds count!

If the sodium hydroxide solution is hot or concentrated, it may cause permanent damage to the surface of the eye before first aid is possible.

If you must use a strongly alkaline cleaning preparation, wear gloves, and eye and face protection.

Note: Wear eye protection and gloves when using caustic soda (sodium hydroxide)

Solvents

Methylated spirits or "alcohol" is used in many cleaning preparations. It is relatively non-toxic if used sensibly, but you should use gloves when handling it as it can dissolve fat in the skin causing dryness.

Other hydrocarbon solvents, such as "white spirit", kerosene and mineral turpentine (turps), are used for removing grease. Always wear gloves when using these materials since they dissolve the oils in your skin, making the skin dry and rough. Don't use petrol as a cleaning solvent, since it contains benzene and may contain lead compounds.

Methylated spirits and hydrocarbon solvents are highly flammable. Take care to store the minimum quantities of flammable solvents outside flammable liquids cabinets and keep solvents away from any sources of ignition.

The inhalation of fumes from oven cleaners, bleaches etc. should be avoided. The area should be well ventilated

Note: FIRE HAZARD !

Remember that: methylated spirits, mineral turpentine, white spirit, kerosene are highly flammable.

(c): Fabric dyes and printing inks

Some dyes are highly toxic and a few may be carcinogenic. Unlike food colourings, dyes were never intended for human consumption. When first using a manufactured product, always assess the risks using information on the product label, the SDS and [Appendix D](#) to determine the required control measures and any usage restrictions. Whenever the product is used, do so in accordance with the directions for use on the label and manufacturer's instructions and the initial risk assessment.

Take care to avoid skin contact with dyes and wash them off as soon as possible if you should get them on your hands. An organic solvent such as methylated spirits or mineral turpentine (turps) may be necessary to remove the bulk of a dye from the skin; follow this with careful scrubbing using soap and water.

Many fabric dyes are toxic and are irritants to skin and lungs. Suppliers of dyes can provide MSDS, and these should be requested when ordering. Some dyes are advertised as non-toxic, and these should be used wherever possible. In general, water soluble dyes are less toxic.

Thick gloves should be worn when handling all dyes to avoid contact with skin. This eliminates the need to use solvents to remove the dye from skin.

Some dyes need to be heated, producing fumes which may be toxic. An appropriate face mask should be worn when preparing these dyes. The MSDS will specify the type of face mask to be used. Always follow manufacturer's recommendations for heating.

Toxic dyes or substances used in the dyeing process should be used only by the teacher, in a well-ventilated room.

Naphthol and diazo fabric dyes should be used with extreme care. Naphthol is toxic if ingested or absorbed through the skin. Always mix dyes according to the instructions provided, as alternative combinations can produce potential carcinogenic compounds. The use of naphthol is restricted to students in Years 11 and 12, under teacher supervision.

Photographic chemicals used in screen printing also require extreme care, and SDS should be obtained for these products.

The following substances are commonly used in dyeing and printing processes. Before using these substances assess the risks using the information on product labels, SDS and [Appendix D](#).

- caustic soda (sodium hydroxide)
- wax

- white spirit
- Gutta solvent (has a flammable solvent)
- soda ash (sodium carbonate)
- methylated spirits
- mineral turpentine
- sodium sulphate

Note: Wear eye protection when required by the risk assessment

(d): Fixatives

Fixatives, in the form of aerosol spray adhesives and sealers, are commonly used in lessons involving drawing and textiles. Although these materials are widely available and used regularly, they still represent a hazard if used incorrectly. It is important to ensure that:

- the fixative is used according to the manufacturer's instructions
- the work is done outdoors to reduce risks to others
- appropriate masks are available to students, especially those who may suffer from minor respiratory ailments that may be aggravated by spray fumes. In such cases, it may be prudent for those students to either wear a full respiratory mask or avoid that particular activity
- no naked flames or sources of electrostatic charges which could cause ignition of the spray are nearby.

Spraying against a work hung vertically can dislodge the particles of colorant and increases exposure of the sprayer to fixative. It is a good idea to test the spray device on scrap paper.

Minimise exposure to the xylenes and n-hexane used in many spray fixatives by choosing less toxic alternatives.

(e): Metals

Contact with the dust or fumes from some metals or metal compounds may cause health problems. The long-term effects of some of these metals are indicated in Figure 3.3-1 below.

Most metal dusts settle rapidly to the floor. Some very fine particles of metals and abrasives used in cutting equipment may remain airborne for some time and lodge in the lungs, causing injury. Take appropriate precautions, and use a respirator that complies with Australian Standards.

Always wear eye protection when using equipment for cutting or grinding metals. Angle disc grinders produce abrasive dust as well as metal dust (also see [Section 3.3.4.2 \(f\) Metal joining](#)).

It is important that adequate ventilation is available when any sanding or grinding of these metals or metal compounds occurs.

Care should be taken to ensure that welding fumes are not inhaled.

Figure 3.3 - 1: Potential long-term health effects from some metals or their compounds

table showing long term health effects from some metals

Material	Potential effects from overexposure
aluminium	nuisance effects
chromium (III) compounds	lung disease, nasal irritation
chromium (VI) compounds	carcinogenic, banned (X) or restricted use
cobalt	lung disease, wheezing, hypersensitivity
copper	metal fume fever, respiratory irritation, hair discolouration
iron oxide	siderosis, pigmentation of lung
lead	central nervous system effects, lead poisoning
magnesium	metal fume fever
manganese	nervous system effects, pneumonia
molybdenum	respiratory irritation

table showing long term health effects from some metals

Material	Potential effects from overexposure
nickel	asthma, congestion, lung disease
tin	stenosis - benign ling disease
vanadium	respiratory irritation, bronchitis, emphysema, pneumonia, green tongue, cough
zinc oxide	metal fume fever

(f): Paints

Oil-based paints contain flammable solvents. Products containing flammable solvents should be stored in a secure place away from any sources of ignition.

Most solvent based paints are flammable liquids, and should not require special storage, such as in a flammable liquids cabinet (FLC), in the quantities used by schools.

The vapours from solvent-based products can contain toxic chemicals and inhalation of the vapours should be avoided. There is a general trend to substitute water-based products for solvent-based ones. As far as possible, use water-based products. Solvent based paints should only be used in well ventilated areas.

Products containing isocyanates may only be used if the necessary controls to minimise the risk as specified in the SDS.

Before using any type of finish, the instructions given with the product should be carefully read. It is particularly important to use solvents or thinners appropriate to the finish being applied.

When using any type of finish the following procedures must be observed.

- Cover the bench space to minimise problems of spillage.

- Prepare paints and stains in a well-ventilated area. Make sure that any mixing is carried out before the lesson.
- Label any paint and solvent used.
- Select water-based products where available.
- Require all students to wear protective clothing to minimise the effects of spillage and splashing.
- Make sure that paints and solvents are used only in areas away from naked flames.
- Clean up benches and brushes after use. Make sure the correct thinners are used. To prolong the life of brushes, wash in warm soapy water after cleaning with the appropriate thinner.

(g): Petroleum products

Petroleum products are used in numerous technology activities. Teachers must ensure that the appropriate SDS have been obtained and are fully understood before using these products with students.

Vapours from petroleum products can affect the respiratory system and therefore good ventilation is required. Petroleum products can also cause skin irritations. The correct gloves and other protective equipment should be worn. Use safety glasses to protect the eyes.

Fuels

Petrol, diesel and kerosene are used as fuels for various technology projects and equipment. It is recommended that only small quantities of fuels be stored and used. Their fumes are toxic and can irritate the skin and eyes. Petrol is highly flammable and has a limited shelf life (approximately six months).

Oils

Oils include a range of petroleum-based products used for lubrication.

Clean oil contains irritants. Used oil also contains contaminants. Contact should be kept to a minimum. Use gloves and eye protection when working with oil.

Do not allow oil to come in contact with hot engines. Toxic fumes are emitted from hot or burning oil.

Spills should be cleaned up immediately, as they can result in slippery floors and work surfaces. Cotton waste should not be used to clean up spills, as this will form a highly volatile medium which may lead to spontaneous combustion. Oil spills should be cleaned up using an absorbent material such as sand or perlite. The surface should then be washed down using detergent and warm water.

Grease

Grease contains significant amounts of oil. It is important to use gloves and eye protection when working with grease.

Dropped grease should be cleaned up immediately as it can result in slippery floors.

Decanting of fuels into machines

Extreme care should be taken not to spill the fuel when decanting diesel or petrol into the fuel tanks of machinery. Teachers and SASS must ensure that the engine of a machine being refuelled is turned off and that the machine has had time to cool down before filling.

It is difficult to pour from a full 20L drum without spillages. The use of drum pumps is highly recommended.

Most school farms use a range of machines which require different types of fuel. It is recommended that all drums be colour-coded as well as the tops of the fuel tanks. Charts indicating the colours used for the different types of fuel should be clearly displayed in the machinery storage area.

It is recommended that large amounts of fuel not be stored on a school farm. The practice of ordering a 200L drum of diesel which is slowly used up over the year (or longer) is not recommended. This can lead to condensation of water in the partially filled drum resulting in engine failure. There is also a high risk of fire.

In order to keep fuel levels to a minimum, the amounts of fuels listed below are recommended. These quantities should be sufficient to last for reasonable periods of time.

Figure 3.3 - 2: Recommended quantities of fuel stored in a school

table showing quantities of fuel recommended to be stored

Fuels	Recommended amounts
oils and grease	40 L
petrol	20 L
diesel	20 L
two-stroke petrol mix	10 L
kerosene	5 L

(h): Polymers

There are two different types of plastics, thermoplastics and thermoset plastics.

Thermoplastics are made of long thin molecules which form tangled chains. There are weaker forces between the chains than along the chains and so the chains can slide past each other easily. Thermoplastics can bend and can be softened or melted reversibly with heat.

Thermoplastics include:

- celluloid and other cellulose plastics
- lucite (perspex or plexiglas)
- nylon
- polythene
- polyethylene
- styrene polymers
- vinyl polymers
- poly-formaldehyde
- polycarbonates.

Working with thermoplastics may involve cutting, shaping, polishing and joining using an adhesive or joining agent.

Possible hazards include:

- airborne particles resulting from various shaping processes
- vapour arising from adhesives, resins, solvents and joining agents
- fumes generated by plastics being heated, welded or accidentally burnt.

In all situations involving thermoplastics, staff should follow risk assessment procedures and ensure appropriate controls are in place. This will usually involve ensuring that there is adequate ventilation. Appropriate respiratory devices, such as dust masks or filter masks, must be worn where indicated by the risk assessment.

Thermoset plastics are made of long chains of molecules with strong bonds between the chains. They are made when simpler molecules are converted with heat and pressure and for some by addition of a hardener. Thermoset plastics are much harder and less flexible than thermoplastics and cannot be remolded. They don't melt when heated, but rather they char as the bonds between the long chains are broken down.

Examples of thermoset plastics include:

- epoxy resins
- phenol resins like *bakelite*
- polyesters
- silicones
- urea-formaldehyde and melamine-formaldehyde resins
- some polyurethanes.

Thermosetting resins are used for casting and fillers.

Thermoset resins are used in conjunction with a catalyst, usually methyl ethyl ketone peroxide (MEKP). They can generate significant amounts of heat when mixed with the catalyst. They are especially hazardous if too much catalyst is used. This can lead to burns from contact with the hot material, or possibly the resin may ignite or explode.

MEKP is not overly toxic, but it is highly flammable. Over time, MEKP can become concentrated and unstable, and should be disposed of in an appropriate manner. Use MEKP only from its original container, and do not mix batches. Because of its instability, MEKP should not be stored in the flammable liquids cabinet. It should be stored in a refrigerator or cool place.

Thermosetting resins are also used with fibre reinforcing to create *fibreglass reinforced plastics* (FRP). The hazards are mostly due to particles and fumes.

The following are the main hazards associated with the production and use of FRP. The hazards are mostly due to particles and fumes.

- Contact with glass fibres as it can irritate the skin. Some chemicals in resins and hardeners are sensitisers and can cause a more serious form of dermatitis
- Many chemicals used are flammable. These include most resins, acetone and MEKP. Rags soaked in MEKP can self-ignite. MEKP and promoter can explode when combined.
- If MEKP splashes in the eyes it can cause blindness.
- Styrene, found in most polyester resins, is a solvent which can enter the body through the lungs and skin. Styrene can cause headaches, nausea and drowsiness as well as long term neurotoxic effects.
- Dust from cutting or sanding can irritate the eyes, nose, throat and skin. The glass fibres currently available are not thin enough to pass deep into the lungs and so are not suspected of causing cancer. Schools generally

do not have the facilities for the use of FRP due to the difficulties of controlling hazards and disposing of waste. **School programs should not include the production of fibre glass reinforced plastics unless SafeWork NSW approved control measures are implemented.**

Note: See [Section 1.9](#) for advice about suitable dust masks or filter masks.

(i): Solvents

All solvents (including thinners) are highly flammable, and must be stored in the appropriate manner, according to the manufacturer's label or instructions.

Air circulation must be sufficient to prevent the inhalation of vapour or spray mist. The use of solvent-resistant gloves and an approved respirator with the correct filters is recommended. Barrier creams applied to the hands are also beneficial.

Students should not be permitted to decant solvents or come into contact with large quantities of solvents. When decanting from 20 litre containers, the use of drum pumps is recommended.

It is strongly recommended that solutions (e.g. paints) using solvents or thinners be prepared before the lesson to eliminate the possibility of students coming into contact with these chemicals.

It is vital that all containers are of the correct type and are labelled clearly. Avoid glass containers of any type.

Ensure that the correct solvent is used for the chemical or application.

Kerosene

Kerosene is a highly flammable solvent. Ensure a well-ventilated work space, so that the fumes are continually removed from the area.

Avoid prolonged contact with the skin, as this may cause dermatitis. Wear approved gloves, chemical-resistant safety glasses and an apron when handling kerosene.

Do not use kerosene as a degreaser for engines and motor parts. Use a commercial product instead. Use a commercially developed parts washer with a lockable lid.

Methylated spirits

Methylated spirits is used in the manufacture of lacquer thinners, industrial and domestic cleaners and solvents. Avoid inhaling or ingesting the liquid as it is discomforting and harmful to the respiratory tract and may cause dizziness, disorientation, mental confusion and slurred speech. Ensure a well-ventilated work area. It is toxic if swallowed in large quantities.

The liquid may cause eye discomfort, resulting in pain and redness. Wear approved safety goggles and avoid splashes of the liquid. The liquid may cause discomfort to the skin. This may lead to dermatitis. Wear approved chemical-resistant gloves when handling the liquid.

Mineral turpentine

Mineral turpentine is a clear, colourless, volatile liquid with an aromatic odour, derived from petroleum hydrocarbons. It is used as a solvent for paints, lacquers and varnishes, and in the manufacture of wood preservatives.

Avoid swallowing the liquid as it is discomforting and is considered harmful.

The liquid may cause eye discomfort, resulting in pain and redness, impairment of vision and ulceration. Wear approved safety goggles and avoid splashes of the liquid.

The liquid may cause discomfort to the skin. This may lead to dermatitis. Wear approved chemical gloves when handling the liquid.

AP 502 polythinners

AP 502 is a colourless liquid with a strong odour used as a lacquer thinner with *AP 107 clear* to form a quick drying lacquer. *AP 502 thinner* is a blend of organic solvents used in spraying and the cleaning of spray equipment.

The liquid may be harmful if swallowed and is moderately toxic. Contact with the skin may result in inflammation and may lead to dermatitis and sensitisation.

Contact with the eyes may cause moderate to severe eye irritation. Wear approved gloves and eye protection.

(j): Timber products and preservatives

Sawdust

Sawdust particles from certain timbers are highly irritant to the lungs and can cause respiratory diseases and/or sensitisation. Some particle board products also release free formaldehyde when sawed or cut, therefore requiring exhaust ventilation for cutting operations. Before using or purchasing material or equipment, consider the health and safety implications by referring to the SDS for the wood product being used.

Standard dust extraction equipment is applicable for softwoods, but some hardwoods, particle boards, MDF and treated timbers may require additional ventilation or dust extraction equipment.

Particular requirements for the safe use of particle board, plywood, laminated timbers and medium density fibre board (MDF) are given later in this Section. When safe conditions cannot be provided, the product should not be used.

Exposure to dusts can be minimised by ensuring:

- fixed equipment is connected to a dust extraction system
- protective equipment is provided when needed (disposable face mask, respirator)
- portable equipment has dust collection attachment
- good natural ventilation is provided
- collection of loose sawdust to prevent contamination of other areas, i.e. sweep or vacuum
- minimise use of abrasive papers.

Ensure that cutting edges on powered tools are sharp. Blunt equipment can burn timber, possibly emitting toxic fumes. Always wear eye protection when using cutting equipment.

Health effects

Students showing symptoms of allergy to timber dust should be immediately removed from the classroom. If the symptoms persist, medical attention should be sought.

Some species of timber and some timber products present greater potential hazards because of the poisonous or carcinogenic nature of the dust generated by their use. While many of the species that cause problems are not commonly used, teachers should ensure that they are aware of any problems associated

with species in use and take appropriate action. The following table provides some detail regarding timber hazards.

Figure 3.3 - 3: Potential health effects from some types of timber

table showing health effects from timber

Common name	Possible health hazard
Alpine ash	Irritation to nose, eyes and throat, dermatitis
Australian hardwood (eucalypt)	Irritation to eyes, nose, throat and lungs, skin irritation/dermatitis
Beech and oak	Skin rash or inflammation, nasal inflammation, bronchial asthma
Blackbean	Dermatitis, itchiness, irritation to mucous membranes
Blackwood	Rhinitis, irritation of mucous membranes, bronchial asthma, nasal inflammation
Boxwood	Sap or latex may cause skin irritation, dermatitis
Douglas fir (Oregon)	Dermatitis, nasal cancer
Ebony	Severe respiratory problems within 4 to 8 hours. Symptoms similar to flu. Repeated exposure can lead to fibrosis of lungs
Meranti (red, white & yellow)	Irritation to nose, eyes and throat, dermatitis
Mountain ash (eucalyptus)	Irritation to nose, eyes and throat, dermatitis

table showing health effects from timber

Common name	Possible health hazard
Mulga	Wood contains a virulent poison. Dust may cause irritation to mucous membranes, headache, vomiting.
N.Z. white pine	Irritation to nose and throat, dermatitis
Non-treated plantation pine	Irritation to eyes, nose, throat and lungs, skin irritation/dermatitis
Red cedar	Violent earache, giddiness, stomach cramps, asthma, bronchitis, dermatitis, irritation of mucous membranes
Redwood	Dermatitis, asthma
Rosewood	Dermatitis, asthma
Southern silky oak	Sap may cause blistering of skin, inflammation of eyelids. Dust may cause dermatitis
Teak	Dermatitis, conjunctivitis, over-sensitivity to light, swelling of scrotum, irritation to throat and nose, nausea
Treated plantation pine	Irritation to eyes, nose, throat and lungs, skin irritation/dermatitis. Ingestion may lead to nausea, abdominal pain and diarrhoea
Western red cedar	Asthma, dermatitis, nasal cancer, nausea, rhinitis, nasal inflammation or bleeding, giddiness, stomach pains. Probable carcinogen
White cypress pine	Dermatitis, swelling of eyelids, asthma, irritation of nose and throat, nasal cancer, furunculosis
Yellow gum	Irritation to nose and throat.

Controlling health risks associated with timber products

Some individuals may be highly allergic or sensitised to specific timbers. When this occurs, the timber must not be used with these students. Except for those materials with clearly identified problems, chronic health effects result from continual exposure to wood dust over longer terms.

Preservatised timbers, the most common of which is treated plantation pine, require special care, not only to avoid dust, but also to avoid skin contact. These timbers are pressure-treated with copper chrome arsenic (CCA), which results in full penetration of the chemical into the timber. The use of gloves when handling uncut sections is highly recommended. As a minimum, hands should

be washed thoroughly after handling. Playground equipment, fences, etc. made out of treated pine should be washed down thoroughly before use to remove residual chemicals.

Treated pine presents special problems when it is being cut or machined in any way, as this releases dust particles which have been exposed to the chemical. Regular contact with the skin can cause allergic dermatitis, whilst penetration of open wounds can result in ulcers or infections. Repeated inhalation of this dust may cause cancer, so treated pine must not be machined in a school. Treated pine off-cuts and dust must not be burnt, as the fumes created contain arsenic, which is toxic.

Particle board, plywood, laminated timbers and medium density fibreboard (MDF) are made with formaldehyde-based adhesives and therefore require careful handling. Formaldehyde is toxic by all routes of exposure and is considered to be a probable carcinogen. Inhalation of, or skin contact with, the dust released during cutting and machining should be avoided.

MDF and hardboard produce dust which is much finer and more readily dispersed than dust from solid wood, plywood or particle board. MDF **must not** be machined in schools unless all occupational health and safety issues are addressed, including the use of a SafeWork NSW approved extraction system. Schools generally do not have the facilities to control the hazards from the dust created when MDF is machined.

Creosote is used for timber preservation; its use in schools is restricted to teachers only. All personal contact should be avoided. Always use gloves, safety glasses and other protective apparel, as creosote can cause burns with prolonged exposure. The vapour can cause discomfort if inhaled, and can be absorbed through the skin, causing irritation.

Mobilcer M is a paraffin wax emulsion sealant used to control the seasoning of freshly felled timber. It is considered non-toxic, but because over-exposure can result in slight eye and skin irritation, gloves should be worn. It is non-flammable.

Note: The risks associated with the use of manufactured timber products are significant. A risk assessment must be completed for all projects involving the machining of MDF.

3.3.4.2 Common processes using chemicals

(a): Computing

Radiation is generated by the use of computer hardware, principally the visual display unit (VDU). This may cause a health risk, although opinions on this are divided. The optimum distance from the monitor is 600-700 mm from eye to screen. Newer monitors generally have lower radiation emissions. More radiation is emitted from the back of the monitor and this may have a bearing on the design of computer rooms or the placement of computers in a room.

Ozone is produced by laser printers and, to a lesser extent by all electrical devices. Recent models of laser printers have ozone filters. These should be replaced as required. A well-ventilated room is desirable.

The toner used in laser printers is a fine plastic powder. Care should be taken when handling toner to avoid spilling the powder. A face mask and gloves are advisable if spilling can occur. Sealed laser packs are preferable.

(b): Electroplating

Electroplating involves the pre-treatment (chemical cleaning) of metal objects using both alkaline and acidic chemicals. This is followed by the immersion of the object to be plated in a metallic salt bath, and passing a low voltage current through the plating system to build a metallic coating on the object. Not only are there safety issues related to the use of chemicals, but there are also issues concerning the safe use of electrical currents near liquids.

Electroplating systems used in industry utilise chemical solutions which are significantly stronger (and therefore more hazardous) than those commonly used in schools. Teachers should avoid using industrial strength electroplating chemicals as these require safety controls beyond the scope of the school context.

Teachers must obtain SDS and carry out a risk assessment for each of the chemicals used in the electroplating system.

For the first time use of a manufactured product, always assess the risks using the information on the product label, the SDS and [Appendix D](#) to determine the required control measures and any usage restrictions. Whenever the product is used, do so in accordance with the directions of use on the label and manufacturer's instructions and the initial risk assessment.

"Cleaner rinse"

Cleaner rinse is a weak alkaline corrosive solution containing <32% sodium hydroxide, <23% sodium tripolyphosphate and <26% sodium metasilicate. It is delivered as a powder which is mixed with water to create the solution.

As with all caustic solutions, this solution should not be ingested or allowed to come into contact with eyes or skin.

The powder should not be inhaled, as it can cause respiratory irritation.

The use of safety glasses and PVC gloves is necessary when working with this product.

"Acid rinse"

Acid rinse is a weakly acidic corrosive solution containing 10% sodium bisulphate. The precautions for the cleaner rinse apply equally to the acid rinse.

Nickel plating solution

The plating solution contains nickel sulfate, sodium chloride and boric acid. The method of use necessitates precautions because nickel is toxic (0.05 g is toxic to a rat) and is easily transferred from blood to the placenta during pregnancy.

The use of aeration devices to assist with the plating process can lead to the formation of mists or vapours which can irritate the nose, throat and eyes. To avoid this problem, the area where electroplating is being carried out should be well ventilated, and safety glasses should be worn.

(c): Food testing

Microbes

There are tests outlined in various texts to grow cultures of bacteria, moulds, yeasts and other micro-organisms. It is important that cultures are not opened before adequate sterilisation has occurred, as large numbers of micro-organisms can be harmful.

Tests that involve the culturing of micro-organisms on nutrient agar in Petri dishes can become a potent source of infection after incubation. There are real dangers in carrying out these tests and storing the incubated dishes in a food technology area.

Teachers are advised to read the section on microbiology in the Science Support Document ([Section 3.2.6.2](#)), which outlines the type of samples which can be taken and the correct procedures for sealing, incubating, sterilising and disposing of samples. These procedures involve sterilisation in a pressure cooker and sealed disposal. It is essential to work in a laboratory situation away from food preparation areas.

Nutrients

There is a wide variety of tests to identify nutrients. The tests and chemicals outlined below (Figure below) are the most common.

Note: For safety information refer to [Appendix D](#).

Figure 3.3-4: Some chemical tests for identifying nutrients

table showing chemical test for identifying nutrients

Chemical	Notes
resazurin	Indicates the amount of oxygen in a solution and is used in tests to determine the freshness of products such as milk. This chemical is slightly toxic, and therefore the food product should not be tasted.
PIDCP (phenol-indo-2, 6- dichlorophenol)	Used to determine the presence of Vitamin C. PIDCP is a toxic chemical and should not be used where food is being prepared. It should only be used by students in Years 11 and 12 with close supervision by a teacher.
sodium hydroxide, copper sulphate	<p>Used to test for the presence of protein. All of these reagents are corrosive to the eyes and skin and are toxic if ingested.</p> <p>The Biuret test, using 1 mL of 2 M sodium hydroxide solution and 1 mL of 1 M copper sulfate solution, may be carried out by students in Years 7-10 provided the sodium hydroxide concentration is 2 M or less.</p> <p>The xanthoproteic test using nitric acid and ammonia solution, is not recommended for use in schools.</p>
Benedict's reagent, sodium carbonate, 10% naphthol in alcohol, iodine solution	<p>These are sometimes used to test for the presence of carbohydrates.</p> <p>Benedict's reagent is used to test for the presence of sugar.</p> <p>Sodium carbonate is slightly toxic if ingested, but otherwise harmless.</p> <p>Naphthol may contain carcinogenic impurities. It should be used only by students in Years 11 and 12 with close supervision by the teacher. It should not be used where food is being prepared.</p>

table showing chemical test for identifying nutrients

Chemical	Notes
	Iodine is used to test foods for the presence of starch and is also used in enzyme property tests. Iodine is poisonous and should not be used where food is being prepared.
chloroform	Used to test for the presence of fat in food. This is an N-category chemical. If it is to be used, the teacher performing the procedure must be trained and experienced in its use, must carry out a fully documented risk assessment, and must take responsibility for its purchase, handling and disposal. A safe alternative test is to rub foods with absorbent brown paper to indicate the spread of fat.
amylase	Is used in tests to determine various properties of enzymes. It is harmless.

(d): Foundry work

Metal casting processes present a wide range of physical and chemical safety hazards and should be carried out only where suitable facilities exist. In terms of chemical safety, teachers should be aware that:

- fumes from foundry work occur during the heating and pouring stages
- furnaces generate large amounts of carbon monoxide gas, as can metals being melted and poured
- superheated metals release gaseous compounds and metal particle fumes (in a similar way to welding) which are harmful if inhaled
- gases are released when de-gassing tablets are used
- some moulding sands contain small amounts of graphite, which can lead to the release of carbon monoxide when the casting is being removed from the mould. Oil-bonded or CO₂ sand is safer than green sand.

Therefore, teachers should ensure that:

- the foundry area has good ventilation, and that respiratory equipment is close at hand
- all chemicals and sand additives are labelled and stored correctly.

(e): Heating oils in food preparation

Techniques and procedures for cooking with oils should be demonstrated to students before they undertake a similar activity. The heat should be regulated and monitored to avoid overheating the oil. Overheating the oil could lead to an explosion. To avoid splattering, pat foods dry to remove excessive moisture before the food is added to hot oil.

All kitchens should have an approved fire blanket that is easily accessible. Water should never be used to put out a fat fire.

Note: For further advice on fire fighting equipment see [Section 1.9](#)

(f): Metal joining

Metals are joined using a range of processes including soldering, brazing, electric-arc welding and gas-fusion welding. Chemical hazards stem from fumes generated during the process or from fluxes used to assist in the joining process.

Solder is an alloy of lead and tin, the composition varying to suit different purposes. Because of its significant lead content, solder should not be ingested in any form. Toxic lead fumes may be emitted during soldering, and can be inhaled or absorbed through the skin. Chemical safety goggles and gloves are recommended for longer periods of exposure. Respiratory equipment may also be necessary in areas with poor air circulation.

Soldering fluxes come in liquid or paste forms, and can be acidic resin-based. These fluxes can give off toxic fumes when heated during the soldering process. Dip solutions present a similar problem when overheated soldering irons are immersed in the solution. Avoid contact with the skin and eyes and ensure good ventilation.

Liquid fluxes and dip solutions can be quite corrosive. They should be stored securely on a low level and decanted in small amounts to avoid spillage. Avoid contact with skin and eyes.

Brazing fluxes in the form of pastes or powders can give off fumes when heated. Ensure good ventilation and fume extraction if necessary.

Welding fumes contain very fine particles of metal in air combined with fumes generated by flux or shielding gases. These fumes can lead to *metal fume fever*, *siderosis* or *cancer* if exposure is not controlled.

Fumes from welding special steels, including stainless steel and galvanised steel (zinc and/or iron fumes), and non-ferrous metals, such as aluminium, are toxic.

Welding of different metals will have specific needs for ventilation, fume extraction and use of personal respirators.

Arc welding processes which utilise inert shielding gases can give off significant quantities of carbon dioxide, which can be quite hazardous.

Welding or cutting processes should not be carried out near flammable substances or on containers which have held flammable materials.

(g): Etching

The process of etching may be carried out in schools to prepare

- printed circuit boards
- metal specimens for examination
- etchings and lithographic plates.

A range of etchants types are described in text books including pure substances, dilute solutions or mixtures, or commercial products. Many etchants are hazardous. Appropriate risk assessments are required prior to the use of any chemicals for etching and related processes.

The following etchant chemicals, or mixtures containing them, are banned in department schools:

- chromic acid
- nitric acid + potassium dichromate + water. (This could produce chromic acid)
- picric acid
- hydrofluoric acid.

The following etchant preparations are not recommended for use in schools due to their high corrosive risk and potential fire hazard. These preparations require a full risk assessment by an approved teacher before they are used in schools:

- ammonium hydroxide + hydrogen peroxide
- nitric acid + methanol (Nital)
- glycerol + acetic acid + nitric acid
- concentrated sulfuric acid or solutions greater than 2 M.

The etchants listed in Figure 3.3-5 (See below) can be used safely in schools provided appropriate measures are implemented to control their risks.

Staff must assess the risks of using any etchants and determine usage restrictions by:

- following the DETRA Protocol. Staff should refer to [Appendix D](#) and to the information provided on the label and the MSDS
- conducting a site-specific risk assessment where the use of the DETRA protocol is inappropriate.

For the first time use of a manufactured product, always assess the risks using information on the product label, the SDS and [Appendix D](#) to determine the required control measures and any usage restrictions. Whenever the product is used, do so in accordance with the directions for use on the label and manufactures instructions and the initial risk assessment.

Be aware that using etchants on metals will most likely involve the following type of hazards:

- damage to the skin and eyes
- toxic or corrosive dust or fumes which can damage mouth, lungs and digestive tract.

Figure 3.3-5: Commonly used etchants

table showing commonly used etchants

Etchant	Concentration	Uses
ammonium persulfate solution	20 % solution (w/v) (20 g per 100 mL water) 5% solution (w/v) (5 g per 100 mL water)	<ul style="list-style-type: none"> • preparation of copper and alloys for microscopic examination • etching of copper in PCB construction • preparation of tin coating on steel for microscopic examination
copper ammonium chloride solution	10% solution (w/v) (10 g per 100 mL water)	<ul style="list-style-type: none"> • preparation of steels for macroscopic examination
ferric chloride solution (iron III chloride)	20% solution (w/v) (20 g per 100 mL water)	<ul style="list-style-type: none"> • etching of copper in PCB construction • etching of aluminium, zinc and copper plates
nitric acid	25% solution (approx 4 M)	<ul style="list-style-type: none"> • etching of copper plates

table showing commonly used etchants

Etchant	Concentration	Uses
sodium hydroxide solution	1% solution (w/v) (1 g per 100 mL water)	<ul style="list-style-type: none">preparation of aluminium and alloys for microscopic examination

Any etching technique that uses ultraviolet (UV) light sources must be carried out using extreme caution and strict supervision of students. UV light sources can cause permanent eye damage. Using the sun or a 500-Watt light bulb, while still potentially dangerous, are safer alternatives.

Never dilute UV products with solvents. UV inks and varnishes tend to strip the skin of its protective fats. This makes it easier for the solvent to penetrate the skin.

Specimen preparation for examination

A variety of corrosive chemicals are cited for use as metal etchants in the preparation of specimens for macroscopic and microscopic examination.

Teachers should be aware that some substances previously used are no longer permitted for use with students. Many formulations may result in violent, unpredictable reactions. Before using any etchant or etchant formulation for the first time, refer to [Appendix D](#) and SDS to determine any restrictions on its use and the measures needed to control risks. If generic advice is not provided in [Appendix D](#) a site specific risk assessment must be carried out.

Printed circuit boards

Etching in electronics involves the removal of unwanted copper from a printed circuit board, leaving the remaining copper to form the tracks and component pads.

It is a good idea to use a commercial etching tank when etching printed circuit boards as this will help minimise the contact with corrosive chemicals.

The two most commonly used etchants in electronics are ferric chloride and ammonium persulfate.

Ferric chloride (iron (III) chloride) is a black-brown solid which is soluble in water and is corrosive to most metals and alloys.

For etching, ferric chloride should be prepared as a 20-25 % solution.

The risk of exposure for students may be reduced if the teacher prepares the required amount of ferric chloride solution prior to the lesson.

Ferric chloride can be difficult to work with because of its dirty nature and its ability to produce persistent stains on most materials. Because of these qualities it is not recommended by nor available from some supply companies.

Ammonium persulfate is used as an oxidiser for copper. It is not a true corrosive chemical but an oxidising agent. It is an odourless, white granular powder that is stable when dry and decomposes slowly, evolving oxygen and some ozone.

For etching, ammonium persulfate should be prepared as a 20-25 % solution with the temperature kept at approximately 80°C.

Pure ammonium persulfate is classified by the department as a TCH-category chemical while a 20% solution can be used by students (see [Appendix D](#)). Therefore, teachers will need to prepare the required quantity of ferric chloride solution for their students. It is recommended that this is done prior to their lesson so the risk of exposure for students is minimised.

Other chemicals used in the production of printed circuit boards include:

- developers, such as CRD30, used for reprographic processes
- strippers, such as CRS40, used to remove dry film photo resist from printed circuit boards
- etch resist, such as Riston or a resist pen, used to protect sections of a plate from etchant
- water dispersant (WD) sprays, used for lubrication and protection against corrosion.

If any chemical used in etching activities is hazardous and is not listed in [Appendix D](#), a site specific risk assessment must be carried out using label information, the suppliers instructions and SDS. All staff using the chemical must ensure that any controls determined by the risk assessment are applied whenever the chemical is used.

(h): Spray painting

Spray painting is used as a means of finishing projects in some TAS classes. It is carried out using aerosol spray cans, airless spray guns or with a hand gun and air compressor equipment.

Spray painting, carried out as part of programmed school activities, should only be done in an approved extraction and filtering device, e.g. a spray booth which complies with Australian Standards that has been inspected and is approved by SafeWork NSW. In addition to the advice regarding paints, and manufacturers' specific recommendations, a number of safety issues arise when finishes are applied using spraying devices.

The following precautions must also be taken.

- The area where spraying is to be carried out should be clean and tidy and free of obstructions on the floor or around the project where the operator will be working.
- Oil, grease, paint and other spills should be cleaned up immediately to avoid slippery floors and/or the build up of fumes.
- Dirty rags and paper should be removed from the area and stored in a covered container. These materials usually contain significant amounts of flammable substances which could lead to spontaneous combustion. They must be properly disposed of at the conclusion of work.
- Proper ventilation should be provided to allow fumes to escape. It is better to work in an open area with good ventilation than in a closed-in workshop, even when using aerosol cans.
- Where there is no approved spray booth, spray painting should be carried out in an open area where exposure to fumes can be minimised.
- If working in an open area, minimise the number of people in the area where fumes might travel.
- Paints and solvents should not come into contact with the skin. Students should wear appropriate protective clothing at all times.
- First aid equipment and fire extinguishers should be readily available.
- Possible sources of ignition, such as static electricity, electrical appliances, naked flames or welding equipment should not be used in the vicinity of the spray-painting area.
- Students should wear safety equipment together with an approved filtered respirator.

- Respiratory equipment with the appropriate filters must be worn by all those working in the vicinity. **THIS IS A MANDATORY REQUIREMENT.** Spray painting produces very fine droplets of paint, not all of which reach the object being coated. Fumes in the form of vapour are also generated by solvents evaporating from the paint. Do not use dust masks for protection against fumes. The correct respirators are available on contract. For health reasons students should have their own mask or, where applicable, their own filter cartridge. Where a replaceable cartridge respirator is used it must be sterilised before and after each use by a student.
- Disposal of spray cans must be carried out by the teacher.

(i): Textile testing

The burning of textiles can be used to identify the type of fibre. This is a common practice in many textile and design classrooms. The tests require a visual examination of the ash left and the observation of the odour of the burning fibre.

Care must be taken to burn only a small sample, and the room must be well ventilated, as fumes may be toxic. This is the case when burning synthetics, particularly acrylic fibre and regenerated textile fibres.

Odour testing should not involve the direct inhalation of the burning fibre, particularly of non-natural fibres. Wafting the odour towards the nose is the preferred technique.

Tests on the effects of chemicals on fibres are also conducted mainly in senior textile and design courses.

Text books give examples of tests which utilise a wide range of chemicals. The following chemicals are commonly used to test fabrics:

- acetone
- bleach
- sodium hydroxide
- shirlastain A
- shirlastain E
- sulfuric acid
- titanium dioxide
- white spirit.

Before use check risk assessment and usage restrictions from SDS and [Appendix D](#).

The following chemicals are commonly used in mordant tests:

- alum
- copper sulfate
- ferrous sulphate
- potassium bichromate.

Before use check risk assessment and usage restrictions from SDS and [Appendix D](#).

Acetate can be reformed by using acetone and acetate fabric. The process involves dissolving the highly flammable acetate fabric in highly flammable acetone to form a dry spun acetate using a hairdryer. This activity should be attempted only as a demonstration in a well-ventilated space. The hairdryer should be set on cool only and provide a slight air stream to dry the extrusion.

(j): Using gas equipment

Cylinders of LPG, acetylene and oxygen must be protected from fire and from mechanical damage and should only be used in accordance with the supplier's instructions and relevant regulations. Cylinders are colour coded to minimise accidental misuse.

Gas cylinders can be very dangerous. A large amount of energy is stored in a highly compressed gas. Gas cylinders are heavy and can easily cause injury.

BOC, the supplier of most compressed gases, recommends that the valve seats of flammable gases be cleaned manually, and then remaining particles be removed with a jet of compressed air. BOC recommends that cylinders of non-toxic gases (air, nitrogen, helium, etc.) be "cracked" by quickly opening and closing the main valve to remove particles before use. This produces a loud noise which could be hazardous unless ear protection is worn. "Cracking" is not needed for oxygen and acetylene cylinders since the rubber o-ring seal in the regulator deforms so that it seals well even if irregularities or small amounts of particles are present. Over-tightening will damage the seals.

Cylinders containing flammable gases have a left-hand thread, so that they can never be connected accidentally to lines designed for oxidising gases (which have a normal right-hand thread). This can be confusing. Always screw regulators by hand first. Do not use excessive force.

Only use the correct key to open or close the main valve of gas cylinders. Do not use multigrips, pliers or any other tools; they are not strong enough and only damage the valve. Keep a properly-fitting key in the valve of any cylinder containing a toxic or flammable gas while the valve is open, so that you - or anyone else - can instantly turn it off in the event of a leak.

If an oxygen cylinder falls over, it may snap off the brass fitting on its top. The compressed gas will escape in a few seconds, shooting the steel cylinder around like a rocket. It would be extremely dangerous to be in the path of such a cylinder. For this reason, all gas cylinders must be chained at all times. Do not transport a gas cylinder with a regulator attached since this provides a lever for snapping the top off, if the cylinder is dropped, or the cylinder might be mistakenly transported with the main valve open.

If an acetylene or LPG cylinder is suddenly ruptured, there is little danger from the energy stored in the compressed gas, but could be a potential fire hazard.

A gas cylinder should never be used without a regulator recommended by the supplier of the cylinder. Before screwing on the regulator, check to see that the socket is clean and dry. Occasionally, cylinders are left out in the rain or damaged in some way. Carefully clean the socket using tissues. Examine the socket for damage or irregularities at the level where the regulator will make

the seal. Send back a cylinder (with a suitable comment) if there is any defect. Keep cylinders vertical at all times; never roll cylinders along the ground.

Gas cylinder colour codes:

- Hydrogen: Red
- Oxygen: Black
- Acetylene: Maroon
- Nitrogen: Grey
- Argon: Blue
- Nitrous Oxide: Dark Blue.

Gas cylinders should only be used after a complete risk assessment. This especially applies to cylinders of acetylene, hydrogen and oxygen.

Acetylene

Acetylene is a fuel gas which is highly explosive. It is dissolved in acetone and is supported on a porous medium inside the cylinder. Ensure that the bottle is always upright. Do not allow gas bottles to lie on their side. The acetone and acetylene may leak from the cylinder and this could result in an explosion.

As acetylene is a flammable gas, it must not be stored with oxygen. Ideally, acetylene and oxygen should be stored in separate locations outside and connected through pipes to the hand piece located with the regulators and taps.

Store only the minimum number of cylinders required to allow work to be performed. Do not stockpile cylinders. Gas suppliers are usually able to deliver at short notice.

Use an approved respirator to avoid breathing acetylene fumes or welding fumes.

Oxygen

Oxygen stored in cylinders for use with acetylene is not pure and should not be inhaled. Oxygen may cause irritations to the eyes with prolonged contact.

Breathing high concentrations of oxygen causes hyperoxia. The symptoms of hyperoxia include tightness in the chest, burning pain and coughing spasms. Irritation to the mucous membranes can occur when exposure to an oxygen-rich environment is prolonged.

Argon/argoshield mixtures

Argon-based shielding gases are used in MIG/TIG welding to exclude oxygen from the weld. They are non-toxic, non-flammable gases. However, they are stored under pressure and, if inhaled, are asphyxiants and may cause loss of consciousness.

Liquefied petroleum gas (LPG)

LPG is a colourless, non-corrosive, highly flammable gas that vaporises on release from the cylinder. Commercial gases may have a stenching agent added to give a warning odour. LPG is heavier than air and may displace air in the breathing zone, thereby acting as an asphyxiant. The gas is non-irritating to the eyes and skin but the vaporising liquid causes rapid cooling, and contact may cause burns and frostbite.

Gas stoves

Gas stoves and cooktops in kitchens have been converted to natural gas in many schools. The type of gas stove determines whether the conversion can be made. The supply of gas varies with the supply authority. Schools should contact the local supply authority or their District properties officer to clarify gas supply issues.

Where there is no automatic ignition mechanism for gas stoves, it is recommended that flint, piezo-electric or battery-operated lighters be used. Never use cigarette lighters to ignite gas stoves.

Most gas stoves in schools have an isolation switch on the stove. Gas stoves should be checked regularly by a qualified gasfitter for leaks and faulty ignition.

The griller section on gas stoves is often the most hazardous part. It is essential that, before the griller is lit, students check that all gas on the stove top is turned off or lit and that the griller itself has not been accidentally turned on. The griller can contain unlit gas and is a potential source of explosion.

All students working in food preparation areas should receive instruction and demonstrations regarding the safe use of gas ovens and cooktops.

3.3.4.3 Agricultural chemicals

A wide range of chemicals is used in the teaching of agriculture. Some of these chemicals are used in experiments whilst other chemicals are linked to the growth of plants and animals. Other chemicals are used in the maintenance and running of a farm.

The four most common types of agricultural chemicals are:

- fertilisers
- insecticides
- fungicides, and
- herbicides (or weedicides).

The latter three types are commonly known as *pesticides*.

(a): Legislation and the use of agricultural chemicals

Users of agricultural chemicals need to fully understand their obligations.

Legislation relating to the use of agricultural chemicals is listed below:

National controls:

- Agricultural and Veterinary Chemicals Code Act 1994
- Agricultural and Veterinary Chemicals Code Regulations 1995

State Controls:

- Pesticides Act 1999
- NSW Work Health and Safety Act 2011
- NSW Work Health and Safety Regulation 2017
- The Public Health Act 2010
- Poisons & Therapeutic Goods Act 1966
- NSW Protection of the Environment Operations Act 1997
- Food Act 2003
- Stock Medicines Act 1989
- Agricultural and Veterinary Chemicals (NSW) Act 1994.

The *Pesticides Act* 1999 requires that a person using a registered pesticide must read the instructions on the label, or have the instructions read to them by

another person, before preparing or using a pesticide. The instructions covering the concentration of the mixture and the application must be followed, unless there is a permit to do otherwise. Each pesticide registered for sale has been approved for use under the conditions specified on the label. These conditions should be considered when estimating and controlling risk.

Agricultural production covers a diverse range of enterprises and activities and there is a vast array of chemicals available for use to increase productivity or for maintenance.

Further information sources include:

- retailers of agricultural chemicals, who are obliged to provide Safety Data Sheets (SDS)
- NSW Department of Primary Industries (formerly Department of Agriculture)
- the publication PESKEM (The University of Queensland, Gatton College), which provides a comprehensive list of agricultural chemicals.

The National Farm Chemical User Program is a nationally accredited program aimed at increasing awareness about the safe use of agricultural chemicals. Teachers trained in the Rural Industries Content Endorsed Courses (CEC) are qualified instructors of the course, which is also available through TAFE colleges.

(b): Integrated pest management (IPM)

IPM is a process of selecting a range of control strategies and using them jointly in the removal of agricultural pests, or in reducing their presence to an acceptable level.

- Pest control methods that do not rely on the use of chemicals include:
- physical or mechanical control, e.g. hand picking, fly swats, mouse traps, fly screens, using light traps, using ultrasound, the hand chipping of weeds
- cultural or managerial control, e.g. farm hygiene, crop rotation, companion planting, adjusting the time of planting and harvest, the use of sealed storage containers
- genetic control, e.g. the use of plants that are resistant to the pest
- exclusion, e.g. the erection of fences to keep out rabbits, the isolation of sick animals from a healthy herd or flock, the careful inspection of animals prior to allowing them entry to a school farm
- biological control, i.e. the use of other living organisms to minimise the activities of pests, e.g. the control of the cabbage white butterfly with the bacterium *bacillus thuringiensis*.

It is recommended that all teachers and head teachers adopt an IPM approach to the control of pests on school farms.

(c): Using agricultural chemicals in the schools

The use of agricultural chemicals in schools can be classified according to **administrative** or **curriculum** purposes.

Administrative purposes relate to the use of chemicals to develop and maintain the resources of the school. These relate to such activities as the maintenance of tools and equipment, the growth of crops, the control of pests or veterinary care of farm animals.

Curriculum purposes relate to the use of chemicals as a teaching-learning resource. Chemicals such as fertilisers or pesticides will be used in experiments and trials so that their effects can be investigated by students.

Administrative chemicals should only be used by teachers, SASS and contracted staff (see [Appendix D](#) for operational guidelines).

(d): Labelling of manufactured and decanted agricultural chemicals

Some products, like pesticides, are labelled in accordance with other legislation, such as, the Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP) and the Agricultural and Veterinary Chemicals Act 1994 (C'th). Such products are regarded as being appropriately labelled under the Code of practice of workplace substances and separate labelling is not required.

Agricultural and veterinary chemicals must have a label in English that complies with the requirements of the Agricultural and Veterinary Chemicals Code Act 1994 and also includes the following:

- any hazard statement that is consistent with the correct classification of the chemical, and
- any precautionary statement that is consistent with the correct classification of the chemical.

'Agricultural or veterinary chemical' refers to any agricultural chemical product or veterinary chemical product as defined in the Agricultural and Veterinary Chemicals Code Act 1994 (Cth).

The Australian Pesticides and Veterinary Medicines Authority (APVMA) labelling codes for agricultural and veterinary chemical products are the Ag Labelling Code and the Veterinary Labelling Code, respectively. You may omit the hazard pictogram and signal word from the labels of these chemicals. However, the label must contain hazard statements and precautionary statements for all of the intrinsic hazards of the product.

GHS statements are not required where the agvet chemical label already contains content that is the same, or substantially the same, as the GHS statements.

Decanting of hazardous agricultural substances should be avoided unless used immediately because of the difficulty of maintaining identification of the decanted contents in a new container. 'Immediate use' covers such situations as the transfers of some pesticide into a spraying device so the chemical can be effectively applied.

Labelling of a decanted chemical is not required if it is for immediate use, it will be controlled by the person doing the decanting and there is a low risk of any other person misusing it.

If the hazardous agricultural chemical has been decanted into a container and is not used immediately, it should be labelled with the product identifier and hazard pictogram or hazard statement consistent with the correct classification of the chemical as a minimum.

Other than for immediate use, a chemical must not be transferred from one container to another unless both containers are properly labelled. Never decant a hazardous substance into a food or drink container.

Figure 3.3-6: Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP)

The labelling of poisons used in agriculture is in accordance with the Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP), also known as the poisons schedule. SUSDP is the recommendation of the National Health and Medical Research Council of Australia (NHMRC) regarding classification of drugs and poisons into schedules for inclusion in the relevant legislation of the States and Territories. It also includes provisions about containers and labels for scheduled poisons.

Commercially available pesticide products will have appropriate signal words and phrases, warning statements, safety directions and first-aid instructions on their labels.

table showing poison signal words and phrases

Schedule	Signal words to identify poisons
S2	PHARMACY MEDICINE
S3	PHARMACIST ONLY MEDICINE
S4	PRESCRIPTION ONLY MEDICINE, or PRESCRIPTION ANIMAL REMEDY
S5	CAUTION
S6	POISON

table showing poison signal words and phrases

Schedule	Signal words to identify poisons
S7	DANGEROUS POISON
S8	CONTROLLED DRUG POSSESSION WITHOUT AUTHORITY ILLEGAL

Poisons for therapeutic use (drugs) are included in Schedules 2, 3, 4 and 8 with progression through these schedules signifying increasingly strict controls.

For agricultural, domestic and industrial poisons Schedules 5, 6 and 7 represent increasingly strict container and labelling requirements with special regulatory controls over the availability of the poisons listed in Schedule 7.

Another schedule, Schedule 9, contains substances that should be available only to medical or scientific research including clinical trials conducted with the approval of Commonwealth and/or State/Territory Health Authorities.

(e): Risk assessment of agricultural chemicals

General principles

A SDS must be kept for each hazardous chemical used at the school. For agriculture, pesticides will be the most commonly used group of hazardous chemical.

The use of hazardous agricultural chemicals for curriculum purposes is restricted to department approved users under the department risk assessment protocol (DETRA protocol).

When used, these chemicals must be applied strictly in accordance with the manufacturer's instruction. Where more dilute mixtures are used the level of control must not be reduced.

Pesticides should be kept in their original containers as supplied from the manufacturer, except when decanted for immediate use.

Procedures for risk assessment

Before using a hazardous agricultural chemical for administrative or curriculum purposes staff must assess the risks and determine usage restrictions by:

- using the DETRA protocol. For pesticides, staff should refer in Appendix D to the generic listing "PESTICIDES", in which case they will be instructed to apply the chemical strictly in accordance with the manufacturer's instructions given on the label, product instruction sheet and the SDS
- using the results of a site-specific risk assessment where the use of the DETRA protocol is inappropriate.

Note: To provide schools with advice about the administrative use of pesticides the Department has developed a separate publication titled "Pesticide Use Notification Plan (updated April 2016)". This publication includes:

- suggested practices for integrated pest management
- information on pesticides, including their toxicity and safe use
- a list of pests and the pesticides which may be used against them
- a list of organisations which can be contacted for more information.

The document outlines the procedures to be adopted if school staff intend to treat pests. It also provides advice when a licensed pest control operator is to be contracted to treat pests.

(f): General precautions for using pesticides and fertilisers

- Transport and store chemicals in an approved manner (refer to requirements under the NSW WHS Regulations 2017 and GHS requirements, [Section 1.3](#)).
- Correctly identify a pest or problem before selecting a chemical solution.
- Select the most appropriate chemical to treat the problem or pest. Use safer alternatives where possible.
- The risk of using a product must be assessed (see [Section 1.5](#), [1.6](#)). Use the results of the assessment to ensure that risks are adequately controlled for yourself and others. Read, or have read to you, the manufacturer's instructions on the label and instruction sheet before use.
- Calibrate all application equipment correctly and avoid leftover chemical by effective calculation of the amount to be used.
- Take care when handling concentrates and powders, the time of greatest risk. Work in a well-ventilated area. Stand upwind while opening, pouring and mixing. Spills should be cleaned up immediately.
- Wash any empty pesticide containers immediately after measuring and mixing. All containers should be **triple rinsed**. The water used to rinse the containers should be added to the application container. Where the containers should not be reused, punch a hole to render them unusable.
- Follow the recommended safety precautions, especially the requirements for personal protective equipment.
- Apply chemicals only when:
 - using proper and well-maintained application equipment
 - others are at a safe distance
 - weather conditions are suitable.
- Avoid contact with the skin, eyes or mouth. Avoid inhalation of vapours or dust. If contamination occurs, wash the affected area immediately with copious amounts of water (if indicated by the label).
- NEVER blow or suck with your mouth to clear pipes or nozzles.
- Never eat or drink while preparation or spraying is in progress.
- Do not allow any product to be harvested or sold until the withholding period has passed.
- Thoroughly clean all equipment and clothing after use.

- Dispose of any leftover chemicals in an approved manner.
- Ensure that all people handling chemicals wash their hands thoroughly after use.
- In case of accidents, follow the first aid instructions on the label and seek appropriate medical treatment. Take the label and SDS of the product with you if going to hospital so that hospital staff and doctors can verify the product used.

NOTE: Triple rinsing

An effective manual rinsing procedure is:

1. On emptying the contents into the spray tank, drain the container for an extra thirty seconds after the flow has reduced to drops.
2. Fill the container with suitable solvent to about 20% to 25% of its capacity.
3. Replace the cap securely.
4. Shake, rotate, roll and/or invert the container to wash all of the inside with rinse.
5. Remove the cap and add rinsate from the container to the spray tank. Drain the contents for an extra thirty seconds after the flow has reduced to drops.
6. Repeat steps 1 to 5 two more times.
7. Check the container thread, cap and thread, and outside surfaces, and if contaminated, rinse with a hose or hand wash.
8. Let the container dry completely and replace the cap

(g): General advice on agricultural chemical groups

Any product specific advice contained in this section is intended to supplement, but not replace the information found on the label and in the SDS for the product. The advice is intended to assist staff to make decisions when completing risk assessments.

Insecticides

Most phosphate-based insecticides, e.g. Malathion and Dimethoate (Rogor), are insect nerve poisons, the insect equivalent of "nerve gases" used in human warfare. These insecticides have been chosen to have as low a toxicity to humans as possible, but it is not surprising that some of them are still powerful poisons. Some people with rare metabolic disorders are much more sensitive to them than the general population.

The following organochlorine compounds have been banned in Australia and must not be used in schools:

Aldrin Heptachlor
BHC Hexachlorophene
Chlordane Isodrin
DDT Lindane
Dieldrin Pentachlorophenol
Endrin 2,4,5-T.

Regard all insecticides as highly poisonous, avoid skin contact (especially the concentrated liquids), and take special care when spraying not to inhale droplets.

The types of insecticides available to the general public, and likely to be used in schools, are relatively safe if used according to instructions supplied on the product label. Check usage group restrictions for the use of pesticides in Appendix D, under the generic listing "PESTICIDES". Low toxicity organophosphate insecticides include Malathion and Dimethoate, which are the active ingredients of a number of commercial products with a variety of trade names. Low toxicity carbamate insecticides include Carbaryl and Bendiocarb, again supplied under various trade names.

Organophosphorus and carbamate insecticides are potentially toxic if misused. Inhalation of the spray of these chemicals can lead to nausea, cramps and headaches. These insecticides should not be sprayed on windy days, when the mist can carry on the wind, or indoors in the vicinity of food or drink. Insecticides should never be decanted into soft drink containers.

Note: Beware of ammonium nitrate fertiliser. It forms dangerously explosive mixtures with combustible materials.

Fungicides

There are a large variety of chemicals used as agricultural fungicides. They are supplied in the form of powders to be dissolved or mixed with water or as emulsions. Fungicides are usually less poisonous than insecticides. Most fungicides are safe if used carefully and the directions on the products are followed.

Sulfur is sometimes used as a fungicide and is usually harmless to humans, but may cause dermatitis. Some fungicides, e.g. those used in paints to prevent mould growth, contain organic mercury compounds which are toxic.

Treat fungicides with care. Avoid skin contact with them (especially the concentrated liquids), and take special care when spraying not to inhale spray droplets. Check the SDSs for fungicides and choose those that are least toxic.

Herbicides

The herbicide 2,4,5-T is a banned material and should not be used in schools. It is preferable to use current formulations of 2,4-D as they contain no significant level of dioxins. (Remember that trace quantities of dioxins can be found everywhere, and are even products of natural combustion processes.)

Regard all herbicides as poisonous, avoid skin contact with them (especially the concentrated liquids), and take special care when spraying them not to inhale droplets of herbicide solution. Wastes containing 2,4,5-T are Scheduled Chemical wastes which have special disposal requirements. The EPA must be consulted about the disposal of wastes containing 2,4,5-T.

The need to use chlorinated phenoxyacetic acid, its salts and its esters should be carefully assessed.

Veterinary chemicals

Veterinary chemicals are designed for use with animals, not with humans. The standard of testing is much lower than for chemicals designed for human use, higher levels of impurities are allowed, and packaging is not as well controlled.

Never allow veterinary chemicals to be used to treat humans.

Many veterinary chemicals can drastically disrupt human metabolism and are highly poisonous as a result.

It is particularly important that these substances are used strictly in accordance with the label instructions and are stored securely.

Note: Veterinary chemicals should be considered as poisons.

Fertilisers

Generally, fertilisers consist of a mixture of inorganic salts, the main constituents being nitrates, sulphates, phosphates together with trace amounts of other elements. Fertilisers are produced as both solid and liquid formulations.

Fertilisers are generally of low toxicity, but may be irritant to the skin if contact is prolonged. Fertilisers must never be decanted to or stored in unapproved containers such as soft drink bottles or food containers. When spraying fertilisers, care should be taken to avoid contact with the sprays since it can irritate the throat and lungs and affect the eyes.

Nitrate-based fertilisers can support combustion and pose a fire/explosion hazard if mixed with organic material. Fertilisers containing nitrate salts should not be stored in the vicinity of petroleum products. The most dangerous fertiliser is ammonium nitrate. Mixed with oil, it is used as an explosive! Avoid the use of ammonium nitrate as a fertiliser in a school. Use ammonium sulphate, which is harmless and non-explosive, instead.

(h): Other safety issues for practical agriculture

Hygiene

It is recommended that students wash their hands with soap or an alternative after all agricultural lessons where contact with chemicals has occurred.

Students should wash their hands after performing practical activities which involve touching, holding, leading, etc. of animals or when working in an enclosed environment where there is animal dust.

Students should wash their hands with soap or an alternative after performing practical activities which include working with soils, compost or potting mixes.

It is strongly recommended that vegetables and fruits grown on the school farm should be washed in clean water prior to being consumed or sold. This is especially important if the produce is eaten raw.

Chemical safety with seeds

Many purchased seeds are coated in fungicide. Not all fungicides can be easily detected. All seeds on the school farm should be treated as though they are coated with poison. Students must not be allowed to place the seeds in their mouths. Students must thoroughly wash their hands after handling seeds.

Quarantine areas

When pesticide is being applied students should be kept away from the area being treated. The actual quarantine distance will depend upon the toxicity of the chemical and the prevailing weather conditions. For low toxicity chemicals, applied on a day when there is no wind it is recommended that students stay a distance of five metres away.

Students with allergies

Some students have high levels of sensitivity to things such as bee stings, ant bites and plant chemicals. There is a strong possibility that some students in your classes are asthmatic as well. Teachers should be aware that certain medical conditions may impact on the ability of the student to participate.

Students who are highly sensitive to chemicals should be warned to stay away from dangerous areas of the farm, or should not participate in activities which threaten their health.

It may be necessary to alter learning activities to ensure that allergic students are not excluded unnecessarily from activities.

Dust

Dust can be a threat to all students, not just asthmatics. Students undertaking practical activities in a dusty environment or where dust is being created by the

activities, e.g. when cleaning out a broiler shed, should be supplied with an approved mask. Ensure that the dust mask is correctly fitted.

Nitrogenous fertilisers and fuels

Some nitrogenous fertilisers may form an explosive mixture when stored with fuels. This is especially so with ammonium nitrate and diesel fuel. It is important that nitrogenous fertilisers are stored separately from petroleum products.

Disposal of carcasses and offal

Animal carcasses and offal should be disposed of in an 'approved manner'. The manner varies between local government areas. Teachers should contact their local meat inspector or council health inspector to obtain accurate information on the correct disposal method for their area.

Disposal of sharp objects

It is recommended that all sharps be placed in a receptacle which is designed to hold used needles. The cap should be placed on the end of the needle to reduce the chance of needle stick injury. Sharps should not be placed in a garbage bin to which students may have access or if cleaning staff may be injured.

Disposal of chemical waste

Excess chemical should be disposed of in accordance with the information provided on labels or in SDS. Where other suitable disposal is not available for hazardous substances, wastes should be well labelled and securely stored pending collection by an approved waste contractor.

(i): Chemical records

A register must be kept of all chemicals used or produced on the school farm. Make sure that risk assessments are also completed and kept for all hazardous chemicals (see [Sections 1.5](#) and [1.6](#)). The teacher or farm assistant can use school records to research the effectiveness of previous chemical applications and calculate the amounts needed to be sprayed.

3.3.4.4 Test tubes and heating

Personal protective equipment

Whenever required by a risk assessment, teachers must ensure that students use appropriate personal safety equipment.

Teachers and SASS staff should act as role models for students by using personal protective items whenever necessary.

Note: See [Section 1.9](#)

(a): Eye protection

Eye protection devices are made in a range of styles to suit different purposes and the needs of the individual. A variety of eye and face protection equipment should be purchased and maintained. These include glasses, goggles and face shields.

(b): Gloves

Protective gloves are made from a variety of materials to cater for contact with the range of chemicals in use in schools. A range of sizes should be purchased and maintained for ready access when any type of chemical is being used.

(c): Respirators

Respirators are designed to protect employees and others undertaking work from airborne particles, gases and vapours. A wide variety is now available in both maintenance-free and reusable models.

Only respirators that meet Australian Standards should be used. Because each type of respirator is designed for specific applications and has specific limitations on its use, it is important to systematically select the appropriate respirator for each task.

(d): Footwear

Substantial footwear appropriate to a practical activity should be worn. Footwear such as thongs, open weave type shoes, or shoes with openings at toes or heels, platforms or high-heel shoes should not be worn in areas which present hazardous situations. Where indicated by a risk assessment, the wearing of safety footwear is mandatory.

(e): Aprons and protective clothing

Aprons or other protective clothing should be worn by all participants in practical activities to avoid splashes and spills when indicated by a risk assessment.

In some circumstances, such garments as overalls may be more appropriate. Disposable overalls are readily available from safety equipment suppliers and are particularly useful for activities like spray painting and agricultural spraying.

3.3.4.5 Other protective devices

A range of devices are available to reduce hazard levels in technology classes.

- Separate waste receptacles should be provided for general rubbish, glass and sharps.
- Fire extinguishers should be readily available and in good working order.
- Fire blankets should be readily available.
- Fume extraction fans/systems should be used.
- Dust extraction/collection systems are required.
- Drum pumps and funnels are to be utilised when decanting liquids.
- Access to water, safety shower and eye irrigation devices is needed.
- Hand trolleys should be used to move drums containing chemicals or gas bottles.
- Measuring equipment is needed to ensure that the correct quantities of chemicals are used.

3.3.4.6 Equipment in contact with chemicals

All equipment coming into contact with chemicals should be thoroughly cleaned or disposed of at the conclusion of the activity. This should be carried out using the appropriate cleaning agent and technique, or the correct disposal technique.

3.3.4.7 Disposal of chemicals

Appendix E in Volume 2 provides a comprehensive description of disposal methods for chemicals.

Technology staff are advised to consult this and the SDS for the chemical being used before proceeding with a planned activity. The Guidance notes in Appendix D direct the user to the appropriate disposal method for each chemical.

3.3.4.8 Immediate emergency procedures

The following generic advice is provided as an indication of the actions which may be required in response to an emergency situation. Specific advice for particular chemicals is given in SDS and [Appendix D](#) and should be followed where possible.

(a): Chemical splashes in the eye

Immediately wash the eye under running water from a tap or eye-wash bottle for at least 15 minutes. The flow should be slow and eyelids should be held back. During the first minute of washing ask if the casualty is wearing contact lenses. If so the contact lenses should be removed quickly to improve contact between water and eye. Medical advice should always be sought in all cases where eyes come in contact with a hazardous chemical.

(b): Chemical splashes on the skin

Wash the skin for 5 minutes or until all traces of the chemical have disappeared. Remove clothing as necessary. If chemical adheres to the skin, wash gently with soap.

(c): Chemical in the mouth

Do no more than wash out the casualty's mouth. If there is a possibility of poisoning contact the Poisons Information Centre by phoning **131 126**.

(d): Burns

The department [e-emergency care module](#) advises the following actions for emergency care procedures involving burns.

DO

- cool burns under cold, gently running water for at least 10 minutes
- remove jewellery
- cover burn with sterile non-stick dressing
- treat for shock

DO **NOT**

- break blisters
- apply lotions, ointments or creams
- apply ice
- remove clothing that sticks to burned area

N.B. Large burns must be left uncovered and medical help sought urgently.

(e): Inhalation of a toxic gas, vapour or fume

Sit the casualty down indoors in an area free from fumes. Keep the casualty warm and calm. If the casualty has been overcome, e.g. short of breath, dizzy, medical advice should be sought. In the interim the casualty should be constantly monitored by someone who is capable of providing CPR and offer first aid.

(f): Hair on fire

Smother by surrounding burning hair with a fire blanket (or non-flammable cloth if fire blanket is not close by).

(g): Clothing on fire

Push the casualty to the ground with the flames on top. Smother flames by covering with a fire blanket/thick cloth/non-flammable garment.

(h): Electric shock

Take care of your own safety if a person appears to have been electrocuted. Break contact by switching off the power or pulling out the plug. If it is necessary to move the casualty clear of the source of the electricity use a wooden broom handle or wear thick rubber gloves.

If the casualty is unconscious, check that the airways are clear.

If the patient is unconscious but breathing normally: lay patient on side, head to one side, mouth open, with head unsupported. To leave an unconscious person lying on his or her back may cause death. Never give anything by mouth to an unconscious person.

If breathing has stopped or is feeble: Start mouth-to-mouth resuscitation, continue until help arrives.

If breathing has stopped and no pulse can be detected: Start CPR immediately.

(i): Severe cuts or wounds

The immediate priority is to stop excessive blood loss by applying pressure to the wound e.g. by using a pad of cloth. Do not attempt to remove embedded bodies. Raise the wound as high as possible and, if the blood loss continues or the casualty feels faint, lower the patient to the floor. Protect yourself and others from contamination by blood.