DEPARTMENT OF EDUCATION & TRAINING

STUDENT SAFETY GUIDELINES

Technology

Victoria
The Place To Be

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1 Introduction

Technology and its predecessors such as woodwork and metalwork have traditionally been integral parts of the school curriculum.

In secondary schools, technology classrooms are usually equipped with tools and equipment that present higher levels of risk than those in other areas of the curriculum.

Because the safety and welfare of students and staff are of paramount importance, school councils, principals and teachers must ensure that proper safety measures are identified and taken. The Occupational Health and Safety Act 1985 and, in particular, the Occupational Health and Safety (Plant) Regulations 1995 and the Occupational Health and Safety (Noise) Regulations 1992 directly concern the provision of technology in schools. It is therefore mandatory that schools know and abide by all relevant aspects of these legislative provisions.

Policy, guidelines and advice are available to schools through the following Department of Education & Training sources: the Victorian Government Schools Reference Guide website http://www.eduweb.vic.gov.au/referenceguide/, Occupational Health and Safety Support Material for Schools, the Departmental Occupational Health and Safety website http://www.eduweb.vic.gov.au/HRWeb/safetyhw/default.htm, and curriculum documents.

2 Safety in the Technology Key Learning Area

2.1 Legal liability

In addition to the professional obligation a teacher owes to students, there is a legal duty of care for principals and teachers to take such measures as are reasonable in the circumstances to protect a student in their care from risks of injury that the educator should have reasonably foreseen.

This duty of care has two main aspects. The first is to provide adequate supervision. This requires not only protection from known hazards, but also protection from those risks that could arise (that is, those that the teacher should reasonably have foreseen) and against which preventative measures could be taken. The second is to provide safe and suitable buildings or shelter, grounds and equipment.

In both aspects, the duty of the teacher is higher than that of the ordinary citizen in that a teacher is obliged to protect a student in their care from harm or to assist an injured student, while the ordinary citizen may choose to do nothing in a similar situation.

This legal duty is imposed on the individual teacher, the principal and other staff who have students in their care and varies according to the particular circumstances. For example, an individual teacher is under a duty of care in performing supervisory duties, and the principal is under a duty of care to provide the supervision roster and to ensure that it is implemented.

To minimise the risks of injury, principals should implement risk and safety management processes (see 2.3 *Risk management processes*, below) for identifying and controlling hazards and risks as well as ensuring that teachers have appropriate first aid training.

It is essential that principals and staff set up procedures for keeping and maintaining relevant safety, preparation and planning documentation. This documentation would include:

- records of regular safety inspections by staff
- evidence of maintenance
- evidence of staff training, experience and expertise
- evidence of student preparation, prerequisite skills and knowledge.

Principals must ensure that teachers have suitable qualifications, training and/or experience in the use of all machines, tools and equipment used by students in their classes.

To maintain the highest level of student safety, teachers' professional development should include activities that enhance their knowledge of safety issues (for example, safe use of machinery and equipment, risk management).

2.2. Occupational Health and Safety

The Occupational Health and Safety Act 1985 requires that the Department of Education & Training (DE&T) and its schools provide so far as is practicable an environment that is healthy and safe for all staff, students and other people who may be on school property.

A number of Regulations and Codes of Practice arise from this Act.

In relation to machinery, the Occupational Health and Safety (Plant) Regulations 1995 require employers to assess, eliminate and control risks associated with plant.

The Occupational Health and Safety (Noise) Regulations 1992 require employers to assess student and staff exposure to noise and to take measures to control noise to minimise any risk to health and safety.

The Occupational Health and Safety (Manual Handling) Regulations 1999 require employers to assess any manual handling tasks likely to be a risk and to implement control procedures for tasks assessed as being a risk. Generally manual handling is thought of as lifting heavy bags, boxes, cartons or other activities involving considerable effort. However, the regulations apply to any physical activity using force, whether it be typing, cleaning windows or wheeling a barrow.

Under the Occupational Health and Safety Act, severe penalties can be imposed where the Department of Education & Training or a school cannot show that all reasonable measures have been taken to ensure the safety of students, staff and others.

2.3 Risk management processes

Effective risk management processes require steps to ensure that all technology activities are planned and conducted safely. These processes involve a systematic analysis of the activity, the machinery, tools and equipment, the learning environment, and the students and the staff so that unacceptable risk factors can be removed or suitably controlled. The process includes:

- **identifying** hazards, safety issues and assessing potential risks
- **managing** hazards, risks and safety issues through the development of a safety management plan
- **avoiding** any hazards and risks that cannot be satisfactorily controlled.

Following the thorough assessment of potential risks, a decision can be made to avoid safety risk by not conducting the activity or part of the activity or that the activity can be satisfactorily managed to ensure that any risks are minimised.

2.4 Identifying hazards and assessing risks

According to the Occupational Health and Safety (Plant) Regulations 1995, a **hazard** is something that has 'the potential to cause injury or illness', and a **risk** is 'the likelihood of injury or illness arising from exposure to any hazard'.

Hazards commonly associated with technology areas include:

- moving machine parts that could cause laceration and crushing injuries
- flying objects (for example, wood, metal fragments) that could hit the operator or others nearby

- noise from machinery
- sharp edges on materials or machines that could cause laceration and bruising
- dust and fragments that could cause eye injury
- dust inhaled
- spillage of liquids, hazardous substances, dangerous goods
- combustion or explosion of materials
- burns and scalds
- toxicity from absorption, inhalation, or ingestion of hazardous substances such as fumes and dust
- contact with chemicals, hazardous substances or dangerous goods
- corrosion
- electrocution from appliances or faulty wiring
- food contamination
- excessive noise
- handling or lifting awkward or heavy items
- trips and slips
- arc flash from welders
- excessive vibration caused by machinery.

In a technology classroom, for example:

- A **hazard** is the grinding wheel on a grinder. It has the potential to cause injury if body parts touch the turning wheel or if metal particles fly into the operator's face.
- Without safety measures, there is a high **risk** of the operator being injured.
- The risk can be reduced by ensuring that the correct guard is fitted to the machine.
- The risk can be further reduced by ensuring that:
  - grinder is in good working condition
  - guard is correctly fitted and operational when the machine is used
  - measures have been taken to reduce noise levels when the machine is in use, the light is good enough to see clearly, and effective dust-extraction equipment is installed and in good working condition
  - teacher has knowledge and expertise to teach students how to use the machine correctly
  - students have suitable levels of skill and maturity to use the machine safely
  - students wear appropriate protective clothing such as goggles, dust mask and ear muffs
  - there is sufficient space for the student to use the machine correctly
  - organisation and class rules prevent other students from interfering with the student using the machine.

When identifying hazards and assessing risks in technology activities, it is important to consider:

- condition of machinery, tools and equipment and their suitability for the activity and use by students in a particular class
- learning environment safety concerns, such as layout, physical conditions, noise levels, lighting, and quality of air
- teacher's skill, experience and qualifications
- personal skill levels of students, as well as their knowledge of the activity and environment, their attitude, confidence and experience and any disabilities and special medication needs
- school records of previous incidents, accidents or near misses
- safety concerns related to the activity
- techniques to be used and their suitability for the activity and for use by students.

2.5 Managing hazards and risks

The safety *management* plan is developed in response to the assessment of risks. It sets out to reduce risks sufficiently for the activity to be safe. The plan should cover:

- design and use of machine guarding to ensure that, so far as practicable, access to the danger point or area of the plant is prevented
- machinery and equipment maintenance procedures and checks
- use of protective clothing and equipment according to recommended practices for the activity (for example, goggles when using machinery)
- arrangements for conducting the activity, including number of students, size of classroom, and space available for safe use of machines and equipment
- qualifications, training and experience of staff as they relate to the activity and the nature of the students
- preparation of participants, including sequential skill development, awareness of safety procedures, and thorough briefing before activities
- choice of activities, including their suitability for the age, maturity, physical stature and readiness of the students, and the relationship of the activities to the curriculum.

The basic rule is: where the risks to participants cannot be kept to an acceptable level, exclude the activity from the program.

2.6 Emergency management planning

All Victorian government schools are required to develop and maintain an Emergency Management Plan. This sets out actions to be taken during and following an emergency to ensure the safety of students, staff and others. Schools should ensure that staff and, where appropriate, students know what the plan contains. They should also provide training in what staff and students are required to do during an emergency. For information on this topic, see the Department publication *Managing School Emergencies* and the *Victorian Government Schools Reference Guide*, 6.15 Emergency and security management.

Schools' responsibility to plan for the safety of students and staff involved in school activities extends beyond events occurring under normal circumstances. It should cover excursions and school-based emergencies. All school activities, regardless of where they take place, must be planned to ensure the safety of students and staff, and that students are adequately supervised, even during an emergency. All accidents or incidents must be reported, recorded and investigated according to established protocols. See the *Victorian Government Schools Reference Guide*, 4.4.1.1 Reporting accidents.

Emergency management planning should include:

- range of emergencies covered
- site plan (where appropriate)
- general description of area and environment
- assessment of risks and hazards
- roles and responsibilities of staff and others
- procedures for reporting emergencies
- procedures to be followed by staff and students during an emergency
- alternative evacuation routes and assembly areas
- emergency services telephone numbers
- measures to prevent or reduce the impact of emergencies
- arrangements for recovery programs following emergencies
- endorsement, where appropriate, by emergency services that plan content is appropriate.

2.7 Use of emergency equipment

All practical areas should have ready access to suitable safety equipment such as fire blankets, first aid kits, and fire extinguishers. These should not be stored in places susceptible to fire. Teachers should be instructed on how and when to use this equipment in an emergency and should explain its correct use to students if warranted. Students should be instructed on how and when to use this equipment in an emergency. At no time should students put themselves at risk when using safety equipment. In the case of a fire, the prime objective is the safe evacuation of the school. Students and teachers should be familiar with the school's fire evacuation procedures. Fire blankets should be centrally located and easily accessible. Instructions for use should be displayed next to the fire blankets. Blankets can be used for personal fire protection as well as to smother some fires.

Fire extinguishers should be near exits and their type clearly labelled. It is recommended that technology areas have water, carbon dioxide and dry chemical extinguishers. Each type of extinguisher has a particular purpose. Colour-coded charts of extinguisher types and their applications should be displayed next to fire extinguishers. All fire extinguishers should have an intact maintenance tag and be regularly inspected under a maintenance plan. All equipment should conform to relevant Australian Standards specifications such as *AS 2444-1995/Amdt 2-1997*, Portable fire extinguishers and fire blankets – Selection and location.

Technology rooms that pose a risk of fire (for example where gas torches are used) may need a metal fire bucket holding dry sand. The sand can be used to reduce the spread of spilt flammable liquid by covering and absorbing it. It can then be swept up and disposed

of suitably. Sand can also be used to smother small fires. The bucket should be light enough to be lifted to spread the sand. A lid will deter students from using the bucket as a rubbish bin.

Suitable emergency evacuation routes should be clearly signposted and all students and staff should be aware of the emergency evacuation procedures.

2.8 Student medical information

Teachers must have adequate and up-to-date medical information about students to ensure student safety. Confidential medical information forms filled in by parents at the start of the year can be used for this purpose. It is recommended that schools develop policies for passing relevant information on to all teachers concerned.

Schools may wish to obtain more information from parents where medical conditions and medications could affect a student's safety in a technology class. In some circumstances teachers may exclude a student from a particular activity or modify an activity because they believe medication or other reasons will prevent the student from working safely.

Teachers should take precautions to ensure that the participation of students will not pose unacceptable risks to their health and safety. Concerns about students' health or medical conditions in relation to technology classes may require further information and advice from medical or other professionals. Schools need to ensure that teachers develop the knowledge and skills needed to manage the medical and first-aid needs of students in their classes.

Activities or the learning environment may need to be modified to maximise student participation. If safety cannot be assured, suitable alternative activities should be used.

2.9 First aid

Principals and teachers have a legal duty to assist students who are injured or ill, including the administration of suitable first aid when necessary. Teachers should be familiar with *Victorian Government Schools Reference Guide* 4.5 Student health which provides information on a range of first aid issues including cuts, abrasion and blood spills. Principals need to ensure that staff have first-aid training suited to the types of activities students undertake and are able to deal with a range of situations. Suitable first-aid kits must be available and regularly maintained.

Technology classrooms should have a first-aid kit suited to the types of activities taught. Teachers should assess the first-aid needs particular to the activity, the location, the student group and their own level of first-aid training to determine the composition of a first-aid kit. Where there is a risk of cuts occurring, paper towelling and adhesive first-aid strips should be accessible to students. Refer to 10.3 *Providers of professional development, training, certification/accreditation* for information on first-aid training.

A first-aid kit should be carried if travelling on an excursion or working on activities outside the classroom. A teacher or staff member should be responsible for maintaining the kit, ensuring that it is kept stocked and the items are not past their use-by date. Instructions on basic first aid should be kept in the kit. The Health and Safety Management team should support this teacher.

Students should be instructed on procedures in an emergency (refer to 2.6 *Emergency management planning*). Accidents should be treated suitably and recorded accurately. Serious injuries involving loss of consciousness, cessation of respiration or heartbeat, blood loss or burns should be assessed and managed by a qualified first-aid officer according to established first-aid procedures and medical assistance sought immediately.

References

Department of Education & Training

Victorian Government Schools Reference Guide

- 4.4.5.2 Safety in the curriculum: Technology
- 4.4.5.3 Safety in the curriculum: The Arts
- 4.5 Student health
- 6.14 Risk management
- 6.15 Emergency and security management
- 7.24.8.5 Fire protection and prevention

Department of Education, Employment and Training, *Managing School Emergencies. Minimising the Impact of Trauma on Staff and Students*

Department of Education, Employment and Training, *Risk Management (CAP)*

Department of Education & Training, *curriculum@work CD-ROM*

Australian Standards

AS 1485-1983 Safety and Health and Workrooms of Educational Establishments. 3.6 Fire precautions

AS 2444-1995 Portable fire extinguishers and fire blankets – Selection and location

AS 4024.1-1996 Safe guarding of machinery – General Principles

AS 4360 Risk Management

3 The Technology Key Learning Area

3.1 The Technology Key Learning Area

Technology education provides students with the knowledge and skills to enable them to produce products that solve a problem or meet a need. Students use a range of equipment, materials, energy, system components and data to design and produce their solutions. The tools, equipment, materials and chemicals that students use may be hazardous.

Schools are expected to include technology in their curriculum from Year Prep to Year Ten as part of the CSF. In the Victorian Certificate of Education (VCE), which covers Years 11 and 12, students can study a range of technology areas. Safety is highlighted in both the Technology CSF and VCE study designs in technology. Programs developed from these documents should include instruction in the correct, responsible and safe use of equipment and resources.

The nature of technology activities makes it important to include the safety aspect when planning curriculum programs. Technology programs should address safety explicitly in particular lessons and as an issue throughout the program. Teachers planning and teaching technology are expected to be aware of the potential dangers and risks students could face in the activities and to steps to minimise those risks. Students must be well supervised, informed about safety and not permitted to engage in destructive or unsafe behaviour (refer to 2.4 *Identifying hazards and assessing risks*).

3.2 The learning environment

Teachers are responsible for maintaining a safe learning environment. Tools, equipment and materials (including chemicals) must be safely stored. For information on maintaining a safe physical environment for schools, refer to the *Victorian Government Schools Reference Guide*, 7.24.11 Building services inspection and maintenance.

Primary and secondary technology activities can be conducted in locations such as purpose-built technology classrooms, general classrooms, computer laboratories, shared specialist areas (art or science rooms), outside areas, on excursions or on site visits. Each location should be considered in terms of its suitability and any potential risks it may pose. Size and storage areas should be adequate for the activities and number and age of students. The location should enable proper levels of supervision at all times.

Eating and drinking should be forbidden in purpose-built technology classrooms and anywhere else technology is taught due to the risk of contamination by hazardous substances. Airborne particles or fumes can contaminate food. In primary schools, this may mean packing up the activity and cleaning up before students eat in the classroom. Proper cleaning procedures must be followed before allowing food to be prepared or consumed.

In primary classrooms, any activity that creates dust or fumes should be done in a well-ventilated area or outside or in specialist classrooms or wet areas.

Some activities require ready access to water. In primary schools, this may mean working in wet areas, art rooms or outside areas. In some cases, access to both hot and cold water will be required.

3.2.1 Site visits and excursions

Technology activities may be carried out in places other than the school that often do not have the safety mechanisms usually found in school settings. Each environment's own potential risk must be considered, including:

- traffic
- strangers
- unsupervised waterways
- exposure to sun
- steep areas
- uneven surfaces
- tripping hazard
- hazardous materials
- animals and insects that may bite, sting or carry disease
- toxic plant material
- machinery.

Before visits, teachers should contact a site's designated Safety Officer, who will provide safety guidelines for visitors. Inquiries to the Safety Officer should cover:

- provision of personal protective equipment that conforms to the Australian Standard
- chemical, biological or physical hazards
- environmental issues such as weather conditions, location, terrain, geographical features
- individual medical conditions that might restrict access or participation
- procedures to be followed in an emergency.

Where possible the teacher should inspect the site before the visit and analyse the proposed activities. The program may need to be modified to cover all safety issues. The teacher should ensure before the start of the excursion that everyone involved understands the roles and responsibilities of staff, students, volunteers, and on-site personnel. Close supervision is required to ensure that students are safe and accounted for at all times.

Equipment should suit the proposed activity, and conform to the relevant Australian Standards specification. Particular clothing or accessories may be required (long sleeves, sturdy shoes). Students may be required to wear protective equipment while on site (safety footwear, eye protection, ear protection, head protection or additional protective clothing).

3.2.2 Classroom organisation

Decisions about safe class sizes are made by the school and are ultimately the responsibility of the principal. Optimum class sizes will vary according to the size of the classroom, the type of activity, and the age and size of students. A room suitable for Year 7 students may

not be adequate to teach the same number of Year 10 students. When determining optimum class sizes for technology activities, teachers and school administrators should consider:

- nature of key learning area
- nature of activities
- age of students and level of experience with tools and equipment
- needs of students with disabilities
- size and layout of learning environment
- access to power and water
- provision of safety facilities and protective equipment
- numbers of tools, equipment and resources available.

Rooms used for technology activities and for storage should be arranged to allow safe movement of students. Students must be able to move freely between work areas and have easy access to exits. Students should be warned that running is dangerous and that pushing and shoving to get equipment will cause accidents. In general classrooms, furniture may need to be rearranged to suit the activity and to improve safety. The layout of furniture and equipment should prevent overcrowding, which can cause safety problems. Rooms should provide enough space to allow all students and the group as a whole to work safely and perform activities satisfactorily. One way of reducing risk is to rotate activities so that only small numbers are engaged in any activity at one time.

3.2.3 Storage and access

The technology learning environment must provide accessible, safe and secure storage for tools, equipment and materials. Safe storage should be provided for student work. Access to some storage areas or areas containing hazardous equipment or materials, for example, oxyacetylene equipment, chemicals or wood preparation equipment may need to be prohibited. Restricted or prohibited areas must be clearly marked and students instructed on the rules relating to them. In some cases, students will have access under teacher supervision to storage areas to collect work, tools, equipment or materials. In other situations, access may be restricted to particular students (senior students, for example).

It is essential to have procedures to prevent the unauthorised use of machines. These could include:

- removal and locking away of essential parts such as belts or chuck keys
- restricting power supply to machines
- covering machine to prevent access.

These procedures should be documented and a system designed to make all relevant staff aware of them.

3.2.4 Work areas

Teachers must have a clear view of all work areas and have ready access to them. The whole class should be visible at all times. Both permanently fixed and portable equipment should only be used where there is adequate space for students to work safely. The floor space around equipment should be restricted to operators and clearly defined by such methods as lines painted on the floor. Lines are usually painted in yellow, signifying caution. When using equipment in general classrooms, masking tape on the floor can identify restricted areas.

Work areas can use colour schemes recommended in *AS 1318-1985*, SAA Industrial Safety Colour Code. The colour of machinery should contrast with hazard markings. Red signifies danger and is used for stop buttons. Teachers could use red for hazardous equipment used on a one-to-one basis. Yellow signifies caution and is used for machine guards. Yellow could signify equipment used only under close supervision. Green signifies safety and is used for start buttons and for first-aid equipment. Teachers can use green to signify equipment used freely under general supervision. Blue signifies information and is used for signs. It could be used for safety information or directions around the room.

In purpose-built classrooms, work areas or tables can be permanently designated for particular activities. For example, electric soldering takes place at a work bench with access to power, sawing is done at a table set up with vices, bench hooks and clamps, and an overlocker is set up in one area of the room.

When working in primary classrooms, workstations can be designated for particular activities (such as using scissors, gluing, or sawing). Workstations can be colour-coded to identify the level of risk in the activity or in using the tools and equipment. Using workstations avoids the need to move tools and equipment around the classroom. Workstations and colour-coding can warn students to keep the space around a table clear, to be aware of which tables to move round carefully and which safety rules apply to equipment. Tools and equipment can be colour coded to identify the level of hazard they pose.

Clear signs should be displayed to indicate potential hazards to students. Clause 14 *Hearing protection signs* of the Occupational Health and Safety (Noise) Regulations 1992 requires signs, labelling of machines or other suitable means when and where hearing protection devices should be worn. Signs will relate to behaviour while engaging in technology activities, instructions for the safe use of equipment, including personal protective clothing, emergency equipment and general information. In primary schools, signs and posters should be suitable for the age of students.

Secondary schools should use standard recognised symbols. Symbols are recognised before colours or text and are a simple way of conveying safety information. Safety signs should be clearly readable and carefully positioned. They should be at eye level and visible while working at machines to which they relate. Do not have too many signs. Signs should not create a hazard themselves. They should be securely fixed to walls and not to any moving machinery.

3.2.5 Work surfaces

Surfaces used for technology activities should be kept clean and free from dust. They should be resistant to the materials used. Where surfaces are not resistant, they should be protected with materials that can be discarded safely after the activity. Take care to avoid thermally or electrically conductive surfaces for activities involving heating or electricity.

Work surfaces should be:

- easily cleaned
- water-resistant
- durable
- non-toxic
- smooth
- corrosion-resistant
- free of sharp edges
- fireproof if adjacent to flames or heated materials.

3.2.6 Furniture

Educational furniture is now covered by Australian Standards. Schools can now expect high-quality durable furniture designed for education. The standards clearly outline the need for designs to encourage good posture and maximise safety. The main aim of the standard is to create practical, safe and ergonomically optimal working environments in educational institutions. Its focus on encouraging good posture seeks to ensure that students can develop freely in an environment sensitive to biomechanical needs.

Students spend many hours at school during the key developmental years when postural damage can occur. It is important that school furniture caters for the sizes and needs of students in the tasks they undertake.

Constant use of unsuitable school furniture (too large, too small, of poor ergonomic design) can lead to permanently damaged posture. Where students are required to work for long periods in one position, teachers explain how to sit or work with correct posture. Consideration for students' postural health needs to be part of school planning.

The range of chair sizes available means that schools can buy different sizes to cater for individual students.

Furniture and equipment should be positioned to avoid overcrowding and tripping hazards. Teachers can refer to the principles in *Officewise* from the Victorian WorkCover Authority for advice on office layout, workstations and equipment.

When buying furniture, suppliers should be required to provide a written guarantee that the furniture meets the relevant and current Australian Standards.

3.2.7 Floors

Where practicable, a technology classroom floor should be at one level and non slip. Existing floors can be made slip-resistant by applying paint or other preparations containing abrasive particles or by using slip-resistant strips. Floors in welding areas must be of a non-combustible material.

Rubbish must be placed in bins, and school bags should not be left in work areas. Ideally, school bags should not be brought into technology rooms as they pose a tripping hazard.

Spills must be cleaned up and classrooms should have materials suited to a range of cleaning tasks. If a hazardous substance has been spilt, the teacher must be notified immediately and appropriate action taken (refer to 7.3 *Safe handling and storage of chemicals*). Classrooms where hazardous substances are used should have a spill kit with barriers for containment of hazardous spills.

Some materials, such as wood chips and sawdust, can become a slipping hazard, particularly on wooden floors. Floors should be swept regularly and may need to be swept during practical sessions. In dusty conditions, floors should be kept clean by wet mopping or wet vacuuming. Well designed and suitably applied dust-extraction systems can help greatly in keeping floor and tables dust-free.

3.2.8 Ventilation

It is essential that ventilation be considered when planning technology activities involving gases, fumes, and dust. Ventilation is the process by which indoor air is exhausted to the outside and fresh air drawn in. All practical areas should have suitable ventilation for the activity being undertaken. There are different kinds of ventilation. Natural ventilation depends on natural air movement (an open window). Because it can depend on the wind or

differences in temperature between one area and another to move air through a building, it is unpredictable and unreliable.

Mechanical ventilation is moving air by mechanical means (for example, a wall fan). There are two kinds of mechanical ventilation: general ventilation and local exhaust ventilation. General ventilation, also known as dilution ventilation, is the mechanical removal of contaminated air from an area and the bringing in of clean air. This dilutes the amount of contaminant in the work area. Dilution ventilation is usually suggested for non-hazardous materials. It is not effective for large quantities of fumes.

Local exhaust ventilation is the removal of contaminated air directly at its source. It is recommended for equipment or processes that create hazardous airborne materials. Because it does not allow the material to enter the work environment it can help reduce exposure to airborne materials more effectively than general ventilation. Local exhaust ventilation uses fume hoods or spray booths to capture the contaminants where they are generated and before they spread.

A local exhaust system usually includes a hood or enclosure, ductwork leading to an exhaust fan, and a collection unit or air cleaning device. It is important that these systems are cleaned and maintained as part of the school's maintenance schedule to ensure efficient operation. The air velocity through ductwork must be high enough to cause contaminated air to flow into the hood. The minimum velocity is typically 18 to 20 metres per second. (Refer also to 8.1.10 *Wood*.)

Normal classroom ventilation should not be regarded as an alternative to fume or dust extraction for individual machines and equipment used in secondary technology rooms. These need suitable exhaust ventilation systems. Exhaust outlets should be positioned so as to prevent the re-entry of exhaust gases, dust, fumes or vapours into the building. Respirators may need to be worn for certain activities (refer 3.5 *Personal protective clothing and equipment*).

Primary classrooms must have adequate ventilation for activities that create fumes or dust (such as gluing or sawing). This may be achieved by opening doors and windows or working outside. Open doors and windows will allow fresh air into the room but will not necessarily extract harmful airborne particles or fumes. Certain substances, such as solvents, should not be used in primary schools (refer to 7 *Safe use of materials: chemicals* and 8 *Safe use of materials: general* for details). Children's bodies metabolise more quickly than those of adults. They inhale more air in relation to body weight, which makes them vulnerable to inhalation hazards.

Schools may decide to set up special ventilation arrangements for particular types of work (welding, spray painting, heating plastic, degreasing). These include fume cupboards, spray booths, welding bays, and forges. Portable extraction systems are available that can be moved to the source of dust and fumes. These ventilation arrangements must meet Australian Standards.

3.2.8.1 Fume cupboards

A fume cupboard isolates hazardous gases and vapours and disperses them into the atmosphere. Mechanical fume cupboards have an extraction fan mounted in the flue to exhaust gases and fumes into the atmosphere. These should be serviced regularly to check for corrosion of the electric motor or fan.

Fume cupboards should be positioned so that they do not block exits if an emergency occurs. Adequate natural lighting should be available. If lighting is installed, it should be placed so that it does not create an ignition hazard or become corroded by fumes. Fume cupboards

should be made of easy to clean materials. They should not contain electrical outlets as these can create an ignition source and are susceptible to corrosion.

Acids used to clean or etch metals must be used in a fume cupboard. Fume cupboards should only contain the chemicals required for activities. They should not be used to store chemicals. Students must be reminded to turn on the fan when using the fume cupboard.

3.2.8.2 Welding bays

Electric arc welding requires a special area that protects students not welding from the welding process. This must conform to *AS 1485-1983*, 12.5 Electric Welding. *The walls of the welding compartment should be non-reflecting or be finished with a non-reflective surface. Where portable screens are used, they should be durable and stable and made of fire-resistant material*. Floors must be of a non-combustible material. Ventilation must remove fumes and disperse them to the outside atmosphere.

3.2.8.3 Spray booths

Spray painting should be done in a spray booth unless it involves minor touch-ups. Spray booths should be made of metal or an approved non-combustible material. The booth floor and surrounding floor within one metre of the booth entrance must be of impervious non-combustible material. Booths must be equipped to effectively control air movement inside.

The exhaust ventilation system should remove all spray-laden or contaminated air from the booth and discharge it in open air outside. Hazardous spark-generating operations such as welding or grinding should not be allowed near the spray booth. Exits near a spray booth should be kept clear and free from obstructions at all times. If spray painting is done outside a spray booth, there should be no source of ignition or engine present within 6 (six) metres of the operator. (Refer to 6.10.2 *Compressed air equipment,* Spray gun for information on related hazards.)

3.2.8.4 Forges

A forge is a furnace used to heat metal to high temperatures to soften it so that it can be shaped. Some schools may still have a forge or be able to use a local blacksmith's forge. The floor around the forge work area should be of fire-resistant material and kept free of slipping or tripping hazards. Electrical switches and controls should be positioned so that students do not have to reach across the hearth to operate them.

Fumes must be conducted to the outside atmosphere through a flue. Make sure the anvil is securely mounted and its face in good condition. The quenching tank should be close to the forge to avoid moving hot materials and tools any distance.

Students must wear protective clothing and equipment when using a forge and forge tools. They need eye protection, leather aprons, substantial footwear, and hand guards. Safety footwear is recommended if students work at the forge for a length of time.

3.2.9 Lighting

All places where students work or walk should have adequate natural or artificial lighting of good quality and free from glare. *AS 1680.2.3 1994* Interior lighting – Educational and training facilities requires an illuminance level of 320 lux in technical studies areas. In addition, it suggests that task lighting be considered. Ensure that all of the learning environment is well lit. Students must be able to move around freely without the risk of tripping because of poor lighting.

Task lighting may be needed at individual machines so that students can see their work and the machine clearly. Practical activities requiring close or detailed work may require extra lighting to avoid eyestrain.

When designing technology rooms, maximum use should be made of natural lighting, supplemented by electric lighting. Electric lighting should not be the major source of light.

Control of glare is important when working with computers. The placement and shielding of equipment should prevent glare and reflections (refer to 9.2.2 *Lighting for learning technologies*, and 9.3.5 *Eyestrain*).

The exclusive use of fluorescent tube lighting in work areas without natural light where rotating or cyclic motion equipment (such as drills and lathes) is used is prohibited by the VWA Plant regulations. The strobe effect can cause rotating equipment to appear stationary or to be moving at a slower rate. In these situations, extra non-cyclic incandescent lighting should be provided.

Flickering fluorescent lighting can cause headaches, dizziness and loss of concentration and should be replaced. A flickering effect can be caused when fluorescent lighting is used in conjunction with ceiling fans.

3.2.10 Noise

Noise levels in technology classrooms must be monitored and controlled in accordance with Occupational Health and Safety (Noise) Regulations 1992. Ensure that suitable protection is provided for students and staff.

Loudness of noise is measured in units of decibels (dB). As the noise level increases, the safe exposure time to that sound decreases. For example, a noise of 90 dB can be tolerated for about 475 minutes (8 hours), but this exposure time drops to 250 minutes (4 hours) for a noise of 93 dB, and 30 minutes for a noise of 110 dB.

General estimates for noise levels are:

0	–	threshold of hearing
60	–	normal conversation/dishwasher rinsing
80	–	telephone ringing
88	–	food blender
90	–	hairdryer/power lawn mower
93	–	belt sander
98	–	hand drill
105	–	spray painter
110	–	grinder
120	–	ambulance

Areas where hazardous noise may be present include:

- wood machining areas with band saws, planers, routers and other powered machinery
- electronics, engineering and other classes where band saws are used to cut plastic
- trade areas where compressors are used.

Under the Occupational Health and Safety (Noise) Regulations 1992, student or staff exposure to noise must be assessed if exposure may exceed the exposure standard of:

- 85 dB for continuous exposure, or
- 140 dB for peak levels of exposure.

Where the exposure might exceed the standard, the assessment must be undertaken by a person who has the appropriate training and experience to correctly perform the assessment.

Where noise levels exceed the exposure standard, measures must be taken to minimise the risk to students and staff. Where practicable, the following types of controls should be used:

- engineering controls—any procedure that reduces the sound level at the noise source or in its transmission
- administrative controls—organisational arrangements that substantially reduce the noise or exposure time
- hearing protection devices—hearing protection worn over or in the ears of students or staff.

Where engineering and administrative controls do not reduce exposure to below the required standard (85 dB for continuous exposure or 140 dB for peak level exposure), students and staff must wear suitable hearing protection. In such cases, clear signs should be displayed, machines labelled or other suitable means used to ensure that hearing protection is used.

Although technology classrooms may have noise levels below the required standard, teachers may still decide to require students to wear hearing protection. This will help them develop good practices in home workshops and other non-school environments.

3.2.11 Power supply

Electrical equipment and machines must be maintained in safe and good condition. Before use, teachers should see that equipment is free from external damage and check for damage to connectors, plugs, outlet sockets or accessories.

Machines must have suitable isolation switches such as a mushroom switch, key isolator or circuit breaker.

A qualified electrician should check equipment. Unqualified people should not interfere with or alter any electrical installations.

Teachers and other staff using technology rooms for any purpose should be familiar with the position and use of master isolation taps or switches for electricity. Any malfunction with the mains-operated (240v, 50Hz) equipment must be promptly rectified by a qualified electrician.

3.2.12 Manual handling

The Occupational Health and Safety (Manual Handling) Regulations 1999 define manual handling as '*any activity requiring the use of force extended by a person to lift, push, pull, carry or otherwise move, hold or restrain any object*'.

Tasks undertaken by students or staff should be assessed to identify if they involve 'hazardous manual handling'.

In technology classes, hazardous manual handling tasks are those involving repetitive or sustained movement, awkward posture or application of force, exposure to sustained vibration or tasks that involve unstable or unbalanced loads or loads difficult to grasp or hold. Large products constructed by students can be awkward to work on and heavy to move. They can also limit space and restrict movement within classrooms or storage areas.

Where such hazardous manual handling tasks are identified, the risk of musculoskeletal injury to students or staff should be assessed. If risks are found:

- the risk should be eliminated by changing the environment or the task, or
- if it is not practical to eliminate the risk, it should be minimised through training students in correct manual handling techniques.

Students should not be expected to lift weights that may cause them an injury or awkward objects that will cause excess strain or difficulty in manoeuvring. Students' size and age should be considered when requesting them to lift items. They should be taught safe

methods of carrying and lifting to avoid back and other injuries. This is particularly important in the technology curriculum where students may lift and move heavy items.

Students must wear suitable footwear when moving heavy loads. For handling items with sharp edges, gloves should be worn. Safe lifting calls for an evaluating the load's circumstances, position and movement. Students should be trained to judge whether it is safe to manually handle a load.

Before moving the load, students should take up a balanced position with feet slightly apart, bend their knees, and keep the body's centre of gravity close to the load. Ideally, hands are placed diagonally across the load and the palm and base of fingers and thumb used to grip. Students should be shown how to lift with a straight back. Leg muscles are used to provide the strength to lift. Looking up when beginning the lift helps keep a straight back. If possible, the whole body and the load should face the direction of travel to avoid twisting.

Weight of item should be considered when deciding at what level to store them. Heavy items should be stored at mid or waist level. Medium-weight items can be stored at low or floor level, and light items can be stored high or at chest level. If using a ladder to move materials, this should be secured to storage racks or stable objects. Do not stand on chairs, especially those with castors, to reach or move high items.

Teachers should monitor the transport of tools, equipment and materials in the room. Movement should be minimised to reduce hazards. At no time should students transport hot materials across the room.

Vibration from equipment or hand tools can have a variety of ill effects (for example, loss of coordination and nausea). Hand-arm vibration caused by the excessive use of power tools such as drills, sanders, lawn mowers and brush cutters can cause numbness and poor circulation. Over-use of such equipment should be avoided. Vibrations can be reduced by using better designed equipment, regular maintenance, use of shock absorbing mounting materials, and training in the correct way to hold equipment.

Manual handling is also referred in 4.3.3 *Manual handling of tools and equipment*, *8 Safe use of materials: general,* Manual handling of materials and 9.3.1 *Manual handling of learning technologies equipment*.

3.2.13 Waste

Schools must provide an efficient and hygienic means of disposing of waste from technology classrooms. Much waste can be recycled and bins will be needed for this. Students approaching activities should be aware of the environmental implications.

Students must not handle waste containing hazardous substances. Teachers or waste companies registered by the Environmental Protection Authority (EPA) must dispose of this waste properly. Regularly review chemicals in storage and correctly dispose of those no longer required. Unwanted and waste chemical disposal must follow current environmental protection regulations. Contact the local water authority and municipal authority for advice on waste disposal. If unsure, contact the EPA for advice on clean up and disposal of chemicals (refer to 7.3.3 *Disposal of chemicals* and *DE&T, Guidelines for the Storage of Science Chemicals* at http://www.eduweb.vic.gov.au/hrweb/ohs/worken/chem.htm).

Food wastes may pose a hazard if pests such as flies, other insects or rodents gain access (refer to 8.1.3 *Materials list, Foods*). One solution is to introduce a recycling program in which items are placed in separate receptacles. Waste will need to be sorted so that foods can be used in compost.

- Remove garbage and refuse from food-handling areas after each practical session and store in containers that are easily cleaned, durable, fly-proof, and rodent-proof and with tight-fitting lids.
- Ensure garbage and refuse containers are in good repair and cleaned regularly.
- Keep bins away from food areas.

3.3 Planning and teaching technology

Advice about safety when developing and planning technology programs is included in the *curriculum@work* CD-ROM. Primary teachers can also refer to the STEPS Program Teachers' notes, which include Safety notes. Examples and activities suggested in the Technology Teacher Support Materials, textbooks or other resources may involve risks. It should not be assumed that because an activity is found in such documents means that it is without risk. Activities should be examined to assess potential hazards and risks. It is important that teachers are confident that they have the skills and knowledge needed to safely teach the activity.

Learning safety procedures is an integral part of the processes and practices undertaken in technology classes. Students should be assisted to develop safe work practices and to learn procedures to follow in an emergency. They should be made aware of rules and instructions before practical activities and these must be clearly displayed in rooms. They cover:

- activity
- use and transport of tools and equipment
- use and transport of materials and chemicals
- student movement
- personal protective equipment (PPE)
- suitable clothing
- manual handling.

Rules and instructions need to be presented in ways that all students can understand. This calls for a range of presentation strategies, including demonstrations, posters, videos, and written and verbal instruction. Rules and instructions can take two forms. They can be a formal part of a safety program where regulations and procedures are emphasised. They can be an informal and a pervasive part of the processes and practices in class. Teachers should develop particular safety rules for each activity, as well as reinforcing the general safety rules for technology.

Rules and procedures may need to be communicated in the languages used by ESL students to ensure that they understand them.

Before an activity starts, teachers should be confident that students understand the implications of all rules and instructions. Students can be asked to demonstrate procedures, explain rules and instructions verbally, record safety rules, complete a test on safety or produce a safety poster.

Instructions on safety procedures should be included when introducing a new topic or technique. Students should be given a detailed introduction to the activity, including the safe use of tools, equipment and materials. Introductions should:

- suit the age group of the students
- be in a suitable format (written, verbal, visual)
- include an explanation of safety procedures
- include practical demonstrations.

Tools, equipment and materials for activities should suit the skills, knowledge and understanding of students. Students should progressively and sequentially develop skills in using equipment, tools and materials. As skills develop lessons can become more complex, but they should still be safe and within the capability of all students.

Under no circumstances should students be allowed to do practical work in the classroom without direct supervision by a teacher who is competent in the learning area and the practical activity. Students should not be allowed into a classroom without a teacher present.

When lesson plans are being recorded, safety aspects to be covered in class should be noted. Notes should be kept on each lesson and any safety issues or near misses or accidents recorded. Strategies and ideas for the improving the safety of the lesson should be recorded. Safety issues and incidents can then be addressed in the next lesson.

3.4 Preparation for technology activities

Students should be prepared for technology activities. Before beginning an activity, students should be introduced to the particular requirements, potential hazards and risks, safety arrangements and procedures to be followed in an emergency. Risks in practical activities are sharply reduced when students know about potential dangers and have been given suitable information and training. (*AS 1485-1983*, 2.1 Introduction, 2.2 Safety instruction, 3.3 Working methods and instruction)

It is important that teachers document the safety instruction they give students. Teachers must ensure that students understand the instructions. Where particular skills and knowledge are a prerequisite for safe participation, evidence that students possess the skills and knowledge should be recorded. Documentation and records should include teachers' plans on safety in technology programs for the term, semester or year, the results of student tests on safety rules, and records of student demonstrations of knowledge and skills.

Teachers can use a variety of means to present safety procedures. They include lessons on safety, safety demonstrations, written and pictorial safety rules and instructions, revision of safety rules, tests, posters, and videos. Teachers could require students to earn a certificate or license before using equipment. Where hazards are present, hazard identification and safe practices should be part of lesson plans and learning activities.

Activities should correspond with students' capabilities. Teachers should determine a student's ability to engage in an activity according to age, skill levels, knowledge and understanding. Equipment and facilities should be suitable for the activity and the capabilities of the student. Planning process should include review of real or potential hazards and plans for eliminating or minimising risks.

3.4.1 Student responsibility

Students are expected to show responsibility for their own and others' safety by following all safety rules and instructions. They should be encouraged to see the importance of ensuring their own and others' health and safety during practical activities. Students' knowledge of safety issues and their skills in working safely should be developed. They should be encouraged to take an active part in ensuring the safety of their learning environment. Students can:

- check equipment to ensure it is safe and report equipment faults to teachers
- research safety issues involved in using particular equipment

- conduct a safety audit of the activity they are undertaking
- conduct a class discussion on safety issues and rules
- devise safety rules and create visual materials on safety.

3.5 Personal protective clothing and equipment

Teachers must ensure that students use protective clothing and equipment at all times when exposed to hazards. Students without this protection must not be permitted to participate in the activity.

Personal protective clothing and equipment includes safety glasses, welding goggles, earmuffs, dust masks, gloves, and protective coats or aprons.

Personal protective clothing and equipment should not be used to compensate for an unsafe environment. They are used in addition to other methods of managing hazards and risks. Due to the nature of the activities in technology, personal protective equipment will often be used. Equipment should comply with Australian Standards *AS/NZS 1716-1994/Amdt 1-1996* Respiratory protective devices, *AS/NZS 1270:1999* Acoustics – Hearing protectors and *AS/NZS 1337-1992/Amdt 1-1994* Eye protectors for industrial applications.

Personal protective clothing and equipment should be stored so that it remains in good condition and can be easily accessed when needed. Teachers should ensure that students know how to use or wear personal protective clothing and equipment correctly and understand its purpose. Small sized equipment is available from major safety equipment distributors.

Some personal protective equipment such as protective aprons, dustcoats, smocks, and sturdy shoes is considered standard when students are involved in technology activities. Rules should be made clear to students before they take part in activities. Schools may require that students have their own equipment to be brought to class or stored securely in the classroom.

If students' hair is long enough to cause a hazard (get caught in a machine, catch fire, or contaminate foods), it should be covered or confined to eliminate the hazard. Hygiene should be considered when students wear hair protection.

When working with machines, loose items such as jewellery or clothing must be secured or removed. Aprons and dustcoats must be securely done up.

Gloves should be worn to protect skin against sharp objects, rough surfaces, heat, chemical absorption, and to protect foods from skin contact. A variety of gloves will be used in technology – rubber, cotton, heatproof, welding and disposable food-handling gloves. Gloves should be suited to the task. To protect against chemical contact, refer to manufacturer's specifications.

Where an activity carries the danger of injury to eyes, protection must be worn – safety glasses, goggles, face shields, welding facemasks, or welding goggles. They must be suited to the activity, in good condition and comply with Australian Standards *AS/NZS 1336-1982* Recommended practices for eye protection in the industrial environment, *1337-1992/Amdt 1-1994* Eye protectors for industrial applications and *1338.1-1992/Amdt 1-1994* Filters for protection against radiation generated in welding and allied operations. To ward against the danger of substances being splashed into students' eyes, close-fitting goggles (not safety glasses) should be worn.

Teachers may decide to have all students wear safety glasses where there is a general hazard of eye injury through things such as airborne particles. At times, students will wear face shields or welding helmets to protect their faces.

Situations producing dust or harmful fumes may be hazardous for wearers of contact lenses. Contact lenses may become scratched by foreign particles, which can also become trapped behind lenses. They may be damaged or dislodged through the effects of chemical fumes. It is recommended that students who wear contact lenses wear safety goggles in these situations.

Where dust or fumes cannot be eliminated by control at source or by extraction, protection must be worn to prevent inhalation of hazardous substances. Dust masks are suitable for large airborne particles, but finer dusts or fumes require the wearing of a specialised respirator. These protect from particulate contaminants such as dusts, mists or metal fumes. Before using a dust mask or respirator, hazards should be reduced by increasing ventilation, using non-toxic or less toxic substitutes or modifying processes. (Refer to 7 *The safe use of chemicals* and 8 *The safe use of materials: general* for details.)

No respirator suits all applications. The type of filter must be carefully selected to suit the hazard (dust, fumes, gases or vapours). Canister and cartridge respirators contain chemicals designed to absorb particular vapours or fumes. To be effective, respirators must be carefully selected and properly fitted, which requires training. Some safety equipment distributors and manufacturers provide training. Students should be shown the correct way to wear respirators and how to check them before use. Respirators should be cleaned and sanitised after use and kept in a sealed container to prolong cartridge life. Follow manufacturer's instructions on the correct use of the respirator and when to replace filters.

Where noise levels cannot be effectively and reasonably reduced, ear protection must be worn when students or staff are exposed to excessive noise levels (noise exceeding the exposure standard of 85 dB for continuous exposure or 140 dB for peak levels of exposure). Ear protection includes full earmuffs or disposable, mouldable earplugs. Students must be shown how to fit these properly. Earplugs should not be shared between students. (See also 4.3.1 *Noise when using tools and equipment*)

Footwear must be sturdy, fully enclosed, non-porous and non-slip. Footwear that may cause a safety hazard must not be worn.

Students not close to the activity will not need to wear personal protective gear – for example, if involved in another activity at a safe distance away or watching from a safe distance. In a classroom where noise is an unconfined hazard, all students should wear hearing protection.

Students not suitably dressed or adequately prepared to participate safely in an activity should not be permitted to be involved in any aspect of it that could jeopardise their safety or health.

Classrooms should display signs saying when and what personal protective clothing and equipment should be worn. These will remind students when they use equipment in the room and when they perform procedures that require personal protective clothing and equipment. Occupational Health and Safety (Noise) Regulations require hearing protection signs in all identified hazardous noise areas.

The use of personal protective equipment is discussed in 4 *Safe use of tools and equipment*, 7 *Safe use of materials: chemicals* and 8 *Safe use of materials: general* in this document.

3.6 Communication with parents

Due to the nature of technology, parents should be informed about the types of activities students will be involved in and the general safety requirements of technology. It is important that parents support the safety standards of the school. These will relate largely to students abiding by personal protection regulations such as wearing correct footwear and protective clothing in practical classes. Personal protective clothing and equipment that

students are required to buy will need to be included in booklists or in uniform policies. If parents have been notified in writing, this communication can be referred to where students are denied access to normal classroom activities due to non-compliance.

References

Department of Education & Training

Victorian Government Schools Reference Guide

- 4.4.2 School excursions
- 4.4.6.1 Electrical equipment
- 6.15 Emergency and security management
- 7.21 Facilities overview
- 7.24.1 Energy management
- 7.24.1.1 Lighting
- 6.9.1.2.4 OHS (Noise) Regulations 1992
- 7.24.8.5 Fire protection and prevention

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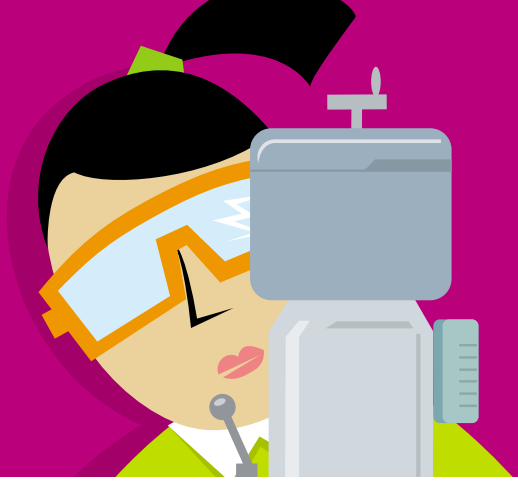
Australian Standards

- *AS 1485-1983 Safety and Health in Workrooms of Educational Establishments*
- *AS/NZS 3760: 2001 In-service safety inspection and testing of electrical equipment*
- *AS/NZS 1269.1:1998 Occupational noise management – Measurement and assessment of noise immission and exposure*
- *AS/NZS 4114.1:1995 Spray painting booths – Design, construction and testing*
- *AS/NZS 4114.2:1995 Spray painting booths – Selection, installation and maintenance*
- *AS/NZS 1715:1994 Selection, use and maintenance of respiratory protective devices*
- *AS/NZS 1716:1994 Respiratory protective devices*
- *AS/NZS 1801:1997 Occupational protective helmets*
- *AS/NZS 2161.2:1998 Occupational protective gloves – General requirements*
- *AS/NZS 2161.3:1998 Occupational protective gloves – Protection against mechanical risks*
- *AS/NZS 2161.4:1999 Occupational protective gloves – Protection against thermal risks (heat and fire)*
- *DR 99418 Furniture – School and educational – Part 1: Functional, dimensional and marking requirements*
- *AS/NZS 4610.2:1999 Furniture – School and educational – Chairs – Strength, durability and stability*
- *AS/NZS 4610.3:1999 Furniture – School and educational – Tables and storage furniture – Strength, durability and stability.*

Occupational Health and Safety Authority, *Personal Protective Clothing and Equipment*.

4 Safe use of tools and equipment



4.1 Introduction

This chapter includes general advice on the use of tools and equipment. The section on tools covers hand tools used in technology. The equipment section covers equipment used in technology, including portable power tools and equipment powered by electricity, gas or compressed air. Machines are covered in the section on equipment. Primary teachers will find the information in the tools section most relevant although their students may not use some equipment listed.

In Technology, students produce solutions to design problems by using tools and equipment to manipulate materials and components. A key responsibility of teachers of technology is to teach students how to use tools and equipment responsibly and safely. Many students have tools and equipment at home and hazardous tools and equipment can be bought everywhere. It is important to train students in the safe and correct use of tools and equipment within a safe learning environment. They should be taught the importance of transferring the skills of working safely at school to their homes, or other places where they use tools and equipment.

The induction and training of students and staff in the safe use of tools and equipment should be part of the school's overall risk management program. Teachers will decide when to introduce a particular piece of equipment or hand tool to their students. The decision will be part of the school risk-management program and will be based on students' experience, skill level, previous instructional experiences, maturity and behaviour. Teachers decide that:

- tools and equipment will be introduced at a particular year level
- a group or individual will not have access to certain tools and equipment
- only senior students may use particular equipment
- an individual student may use equipment barred to others.

Tools and equipment in both primary and secondary schools can be classified into four permitted-use groups as those students can:

- use independently under general supervision
- use after seeking permission and under general supervision
- use under close supervision
- use on a one-to-one basis under direct supervision.

This classification is not prescriptive and will be influenced by students' capabilities. If a teacher is not satisfied with a student's ability to safely use tools or equipment the student should not be allowed to use them. Only when the teacher is satisfied with the student's competence should use be permitted. Teachers may decide to exclude a student from an

activity if they believe medication or other substances taken may pose a risk. Teachers should warn students that some medications may cause drowsiness and that they should not use machines if they believe they are affected. Teachers may allow an individual student to use equipment on a one-to-one basis with the teacher or trained adult after thorough training.

As part of their risk management processes schools need to budget for the maintenance, repair and replacement of tools and equipment. A regular inspection and maintenance schedule should be followed on all tools, equipment and machines to ensure they are in a safe working condition. Machinery used in schools is not generally high-maintenance but regular checks should be made belts, electrical wiring, guards, blades, push sticks or similar equipment, on-off and emergency switches.

A qualified service person offering a certificate of safety for machines should perform safety inspections annually or as required on all equipment and machines used, including those privately owned. It is essential that machinery attachments and saws are kept sharp. Annual sharpening of machinery and saws by a reputable trades-person should be organised. An authorised mechanic who is prepared to offer a certificate of safety for machines should perform safety inspections annually or as required.

Machines must be isolated from power sources when being cleaned, maintained or repaired. Care should be taken with substances such as lubricants or coolants used to maintain equipment. Students must not handle hazardous substances without supervision and clear instructions (refer to *7 Safe use of materials: chemicals*).

Schools should have processes for managing faulty equipment to minimise the risk of injury. Machines must not be operated while in an unsafe condition. Faulty equipment should be labelled, isolated from power, identified with lock-out tags and removed from use (if appropriate). Any machinery in a dangerous condition should be reported. It is the principal's responsibility to ensure that all machinery is safe for students and staff to operate. When more than one teacher uses the tools and equipment, it is important to keep inspection and maintenance records. The Technology coordinator should take responsibility for coordinating records. Managing faulty equipment may also include notifying the bursar, maintenance personnel, or the occupational health and safety representative.

4.2 Using tools and equipment safely

Teachers should be experienced users of the tools and equipment they introduce to students. Inexperienced teachers must not be expected to teach secondary technology programs due to the inherent hazards. Teachers who have not used particular tools or equipment should seek training and advice from qualified teachers, parents or other skilled people. Teachers may decide to undertake professional development in using particular tools or equipment. Experts could be invited to class to show the safe use of tools and equipment to both teachers and students. In primary schools, qualified parents or adult helpers can help students to use tools. Primary students will not normally have access to most of the equipment listed in this chapter. Adults will use equipment for primary students when this is necessary to complete a product. Some senior primary students will use equipment such as microwaves, sewing machines, and scroll saws.

When introducing students to tools or equipment, teachers should discuss:

- hazards involved
- correct and safe way to use and adjust tool or equipment
- maintenance and storage procedures.

Teachers should ensure that tools and equipment are suitable for the work being done and for the students' age and physical and intellectual capabilities. The age at which individual students are ready to be introduced to different hand tools and equipment will vary.

All students must have adequate instruction before using tools or equipment independently. Teachers will decide on the best way to instruct students. This may be in a class group, small groups, individually, or by using experts. Students should demonstrate skills and their understanding of instructions before using tools or equipment. Teachers can issue certificates or licences that allow students to use equipment independently. They should keep records of student skill development and monitor the skills students have yet to develop.

Information about using tools and equipment safely should be presented in ways that suit students' age and ability. Guidelines for tool and equipment use and processes should be displayed in classrooms and discussed regularly with students. The safety aspects of tools, equipment and processes should be continually emphasised and referred to during lessons. When introducing them to tools and equipment, students should also be shown the personal protective clothing and equipment required. Display clear rules near equipment to remind students and reinforce the importance of using personal protective clothing and equipment. (Refer to 3.5 *Personal protective clothing and equipment*.)

Supervision of students should match the nature of the tools, equipment or process being used. Students should be closely supervised when using potentially hazardous tools or equipment.

4.3 General hazards

Many processes involving tools and equipment create noise, dust or manual handling hazards (refer to 3.2.8 *Ventilation*, 3.2.10 *Noise* and 3.2.12 *Manual handling*). These hazards should be considered when teachers:

- buy new tools and equipment
- do maintenance on tools, equipment or facilities
- introduce tools, equipment and processes to students.

4.3.1 Noise when using tools and equipment

Using hearing protection should be planned as part of a wider risk control process. Trained occupational hygienists can assess noise levels of particular machines or activities. Explain to students how to reduce the noise level of activities. A noise hazard can be created by the processes used and not the tools or equipment, requiring a modification of the process by:

- placing shock-absorbing material under work
- working on a surface that does not vibrate
- using different tools or processes
- changing the way a tool is used (for example, forcing a tool through materials often increases the noise level and reduces the tool's life.

Equipment noise levels can be reduced by regular maintenance. Preventative maintenance schedules can ensure equipment stays in good working condition, thus reducing noise. Vibration isolators (like shock absorbers) can be added to machinery. Methods that reduce equipment noise include:

- placing rubber material under machinery or on bench-tops
- applying rubber material to the tool rest of a pedestal grinder to reduce vibration

- stiffening or applying sound-deadening material to the inside of side panels can quieten machinery vibration
- enclosing equipment in a chipboard box lined with an acoustically absorbent material such as fibreglass insulation
- placing rubber mounting pads under machines to help prevent vibration transmission through wooden floors
- replacing noisy saw blades with newer quieter types
- replacing old, noisy machinery where possible with newer quieter models
- increasing the distance from equipment to ear without causing an operating hazard
- isolating machinery in an insulated area such as a machine room
- choosing suitable equipment for the task can reduce noise levels (a bench grinder may be quieter than an angle grinder, a handsaw may be better for small jobs)
- buying pre-cut materials can reduce noise by eliminating material preparation, and using softwoods which may create less noise when being processed than hardwoods
- dressing timber in smaller increments and allowing blades to cut at their own speed, buying machined timber where possible to cut machine use.

If noise cannot be reduced to a non-hazardous level below 85 dB(A), hearing protection is needed. It is good practice to wear hearing protection when using wood-cutting machinery and other noisy machines. Hearing protection should match the type of noise created. Some hearing protectors suit certain types of noise better than others (refer to *AS/NZS 1269.1:1998* Occupational noise management – Measurement and assessment of noise emission and exposure and *Victorian Government Schools Reference Guide* 6.9.1.2.4).

4.3.2 Dust and fumes

The establishment costs and energy efficiency implications of dust and fume extraction must be considered when buying new equipment. Equipment should be as close to dust extractors as possible to reduce ducting and energy required for each machine. In some cases, it is preferable to move existing equipment to reduce the amount of ducting required and to reduce noise and energy levels. The cost of relocating equipment could be offset by requiring less ducting.

Inefficiencies of single machines using a total extraction system can be overcome by using a stand-alone extractor attached to a machine. Roof level exhaust fans can remove airborne dust and fumes but they allow dust and fumes to pass the operator and expose them to harmful substances. Downdraft extraction reduces exposure to harmful substances by drawing dust downwards and is ideal for activities such as sanding and sawing.

Sweeping up dust creates an inhalation hazard. It is best to mop or vacuum up dust. Wood dust should be cleaned from around and inside machines to avoid fire hazards. Dust respirators and safety goggles may need to be worn where activities create substantial amounts of dust (refer to 3.5 *Personal protective clothing and equipment*).

4.3.3 Manual handling of tools and equipment

Students required to lift and move heavy tools, equipment, toolboxes or tool trolleys should be instructed in safe and correct lifting methods. Refer to 3.2.12 *Manual handling*. Both hands should be used and students should bend from the knees for correct balance and to avoid injuring their backs. They should not be required to lift, move or carry anything that could cause injury. Avoid unnecessary transport of tools and equipment around the room.

Storage racks should be used for neat storage of sheet materials and lengths of materials. Racks should not be shorter than the length of stored materials and long materials should not obstruct doorways or walkways.

Students should be shown the safe and correct way to carry and pass tools.

- Ensure that they carry sharp objects and tools with the points down.
- Warn students not to leave tools near the edge of tables or benches.
- Tell students not attempt to try to catch falling tools but to step clear.

Some tools pose no particular hazard in their use but require care when being transported. Stakes used for shaping and bending metals are heavy and pose a hazard when students move them in and out of holders or transport them. To avoid unnecessary movement, similar types of tools or processes should be used in one area.

Manual handling may be a hazard when using gardening tools for lifting, pushing, digging, restraining and similar tasks. The task should be designed to reduce risks. Students should be shown how to avoid injury while doing physically strenuous tasks. Choose gardening tools suited to students' size and strength.

Students coming in contact with farm stock must understand the manual handling hazards involved and must be instructed in suitable safety procedures. They should know the physical risks involved in close contact with large animals of unpredictable behaviour.

5 Tools

Most technology activities involve using hand tools. *It is essential that instructions regarding their safe use be clearly explained and understood by all students. Only the correct tools should be used for the job, and students should not be allowed either to improvise if the correct tool is not immediately available or to use a tool that is defective (AS 1485-1983*, 7.2.1 General).

Hand tools can pose safety hazards (outlined in *4 Safe use of tools and equipment*). Tools kept in good working order are more efficient and safe. For example, a sharp knife or saw blade will cut through materials with less effort than a blunt one.

Encourage students to respect the tools they use. Provide for all tools and see that they are stored when not in use. Packing up tools after practical sessions will account for all tools and help detect any faults. Develop routines for unpacking and packing up tools. Storage could be on tool trolleys, in toolboxes, on racks or shadow boards. These should be kept locked away. Avoid storing heavy items overhead. Tools can fall if not stored properly.

Students should check tools before use and report faulty tools to the teacher, who should take them out of action. Damaged and rusty tools should be discarded or, if possible, repaired. Teachers need to monitor rusting of tools and explain ways to prevent this. Students should be taught how to identify faults in the tools they use. Although students should learn how to maintain and store tools, this remains the teacher's responsibility.

A tool should suit the task and the materials, components and processes used. Smaller and lighter tools (available from educational distributors or hardware stores) will be easier for primary students to use. Students need to be exposed to a variety of tools from primary school onwards.

Some tools pose only a limited hazard to students. Others, such as nail punches, scoring tools or marking gauges, pose a hazard due to their sharpness. Students must protect their hands from the point of impact when using a hammer with tools. When using tools such as a rotary, perforation or wave cutters, a suitable surface (cutting mat, newspaper, cutting board, or vinyl floor tile) should be placed under the material being cut. To avoid injuring fingers, cutting tools should be used with a safety rule where possible. The tool is always used away from the body or hands.

Students should follow processes and use tools that make tasks safer. Tools that make working safer include clamps, vices, safety rules, tongs, mitre boxes and bench hooks. Students should learn how these help them work safely and more accurately.

Food preparation tools such as whisks, spatulas and tongs should be cleaned thoroughly and stored in clean areas such as drawers and cupboards. Care is needed with kitchen tools such as wooden spoons made of porous materials. These must be washed and dried thoroughly before storing. Split and stained wooden spoons will harbour bacteria and should be discarded. Porous tools can also carry lactose or gluten. Wooden spoons should only be used with one type of food (for example, spoons used for curry should not be used for egg and milk dishes).

5.1 Tool list

The following list of tools is not exhaustive. Students may use tools not on the list. When introducing any tool, teachers should follow the points outlined in 4.2 *Using tools and equipment safely*. For example, when introducing primary students to a manual stapler, the teacher must explain:

- hazards of using a stapler
- how to use a stapler correctly and safely (materials it can be used on, how to insert staples)
- how to care for and pack away a stapler.

5.2 Cutting tools

5.2.1 Scissors

Description and use

Students may use a range of different scissors in technology such (safety scissors, dress-making scissors, utility snips). They should be taught the safe use of scissors and correct cutting techniques. Teachers must supervise the giving out and use of scissors. They decide which scissors suit the age and skill of the student and advise on the most suitable scissors to cut different materials. Older primary students and secondary students are expected to choose the most suitable equipment to produce their designs. Primary students may find some cutting tasks difficult. They can seek help of the teacher or other adults. Primary students should not have access to sharp scissors.

Hazards	Precautions
Cuts to fingers or hands.	Show students how to keep fingers away from the scissor blade as they cut. Students should not be distracted when cutting. Allow only older students to use sharp scissors.
Cut to hands caused by open blade of scissors. Scissors can fall and injure students if not transported properly.	Do not hold scissor blades open to score through or pierce materials. Transport and pass scissors with care. The point should face down, with the hand positioned just below finger grips. (Refer to 4.3 *General hazards*, Manual handling.)
Scissors can stab fingers or hands if used to force holes in materials.	Place a cutting board or protective material beneath scissors if using them to puncture material. Internal cuts are best started off by the teacher for primary students.
Scissors can jar or pinch hands if used on difficult to cut materials.	Only use scissors with materials they are designed to cut. Choose correct cutting tool for materials.

It is important that scissors:

- suit the age and skill of the student
- suit both right and left-handed users
- have no indentations on the blade
- are sharp and tightened
- are clean.

Maintenance and storage

Scissors must be kept sharp and tightened. Store scissors in a safe place, pointing down, preferably in a scissors rack. Good quality scissors such as dress-making scissors can be sent away for sharpening. Damaged scissors should be discarded.

Students may need to clean scissors soiled with glue or other substances after use. Care should be taken when cleaning sharp scissors. Kitchen scissors must be cleaned thoroughly and stored hygienically.

5.2.2 Tin snips, aviation snips, shears

Description and use

These tools are used to cut tinplate, thin-gauge metals or thick plastic sheet. Most snips do not have the circular handles of scissors, so primary students may find them hard to use. One finger is kept between the handles to push them open after each cut. Do not close the blade completely, as this will distort the material being cut. When cutting to a set point, the tip of the snips should be lined up with the end of the cut so that they do not cut beyond it. The blade can be completely closed when making this final cut.

Hazards	Precautions
Cuts to fingers or hands.	Show students how to keep free hand away from the blade as they cut. Students should not be distracted while cutting.
Snips can fall and injure students if not transported properly.	Transport and pass snips with care. (Refer to 4.3 *General hazards*, Manual handling.)
Snips may jar or slip if used on thick materials.	Do not use snips to cut materials that require force. If cutting is difficult, one handle can be held in a vice to create greater cutting power.
Pieces may fly off if snips are used to cut wire or nails and the blade will be damaged.	Do not use snips. Use other tools such as hacksaws or pliers to cut wire or nails.
Cut edge left by snips can cause a cutting hazard.	Leather or sturdy cotton gloves should be worn to avoid injuries when handling materials with sharp edges.

Maintenance and storage

Do not allow students to cut wire or nails with snips, as this will damage the cutting edge. Tin snips are usually stored on a tool trolley or shadow board. They will need regular sharpening. Teachers should ensure they are tightened regularly and kept lubricated. Students should keep steel tools away from water to prevent rust.

5.2.3 Knives

Description and use

Students may use knives ranging from a simple bread-and-butter knife to a cook's knife. They should be taught the safe use of knives, including correct cutting techniques. Teachers should supervise the handling and use of knives. They should check the thickness of the materials, and advise students on the knife or cutting tool best suited to the task. Sharp knives must be stored away from student access. Teachers decide which knives suit the age and skill of the student. Older primary students and secondary students are expected to choose the most suitable equipment to produce their designs. Early years primary students should be guided by teachers. In primary schools sharp knives may need to be restricted to adult use.

Hazards	Precautions
Sharp knives can cause deep cuts.	Students must take care to protect free hand while using sharp knives. Use a firm grip to prevent slipping.
Knives can fall and injure students if not transported properly.	Transport and pass knives with care. (Refer to 4.3.3 *General hazards*, Manual handling of tools and equipment.)
Knives may slip if forced through materials.	Knives should be kept as sharp as needed to perform the task efficiently and safely. Knives should only be used with materials they are designed for. Avoid forcing knives through materials.
Knives may slip if used to cut items on an unstable surface.	Place items to be cut on suitable surface or cutting board (water resistant and non-absorbent). The item to be cut should be on a stable surface and held securely.
Knives can cause cross-contamination.	Always wash knives between uses when cutting different foods, particularly between raw meats and cooked foods.
Knives can cause a cutting hazard when being washed.	Wash sharp knives one at a time. Warn students not to leave sharp knives in washing-up water where they may become a cutting hazard to others.

It is important that knives are:

- suitable for age and skill of student
- have no indentations on the blade
- cleaned between uses if used in food preparation (especially between raw and cooked foods).

Some knives require particular techniques that may make them hazardous (for example, budding knives used in horticulture). When cutting bud grafts or cleft grafts, care must be taken to keep the free hand away from the knife blade and to avoid contacting the thumb of the cutting hand. Gardening gloves offer some protection.

Maintenance and storage

Sharp knives should be stored in a safe place with the blade pointing down, either in a knife rack or in a drawer in a knife protector. Kitchen knives should be washed well with detergent and stored hygienically.

5.2.4 Stanley knives/craft knives

Description and use

Stanley knives and craft knives have extremely sharp retractable blades. They are used for accurate cutting on thick materials such as cardboard. Teach students the safe use of and correct cutting techniques for knives with retractable blades. Teachers supervise the handling and use of Stanley knives or craft knives. They may decide not to allow primary age students to use Stanley knives. In this case, teachers or other adults can use Stanley knives to cut materials for students. The safe way to use them should still be discussed because students may have access to them at home. Older students must use a safety rule with Stanley knives or craft knives and be closely supervised.

Hazards	Precautions
Retractable blades can cause deep cuts due to the extreme sharpness and size of the blade.	Use a safety rule to cut straight lines in materials. This allows fingers to be kept away from the blade while cutting. Students should stand in a balanced position and cut away from themselves and others, using a smooth and even pressure.
Stanley knives and craft knives can slip if used on an unstable surface. Stanley knives and craft knives pose a cutting hazard if transported with blades extended.	Item being cut should be placed on a stable surface and clamped if necessary. Transport and pass knives with care. Warn students not to carry sharp objects such as knives or Stanley knives in their pockets unless in a scabbard or fully retracted.
Knives can fall and injure students if not transported properly.	Refer to 4.3.3 *General hazards*, Manual handling of tools and equipment.
Snap-off knife blades can pose an eye hazard.	Primary students should ask teachers to snap off blades. Secondary students can snap off blades at an area away from others, such as at the rubbish bin. Blades can be snapped off with a pair of pliers. Safety glasses or goggles should be worn as a precaution.

Maintenance and storage

Stanley knives should be stored with the blade retracted. Replacement blades must be stored away from student access. For safety reasons, teachers should replace blades unless convinced that students are responsible enough to change them safely.

5.2.5 Saws

Description and use

In technology, students use a range of saws (coping saws, tenon saws, piercing saws, handsaws, hacksaws) to cut timber and other materials to size. They may cut straight along the grain (ripping) or across the grain (cross cut), or cut curves. Students must be taught the safe use of saws and correct sawing techniques for each type of saw.

Hazards	Precautions
Saws pose a cutting hazard if students do not keep their hands clear of the saw blade.	When starting a cut, students should use a small block of wood and not their fingers to guide saw. Students should keep their free hand clear of cutting area.
Work can slip causing students to cut their hand.	Work should be clamped securely. Use mitre boxes, bench hooks or Lynx jointers attached securely to bench-tops. These secure materials and reduce the need to hold them by hand. Clamping materials enables students to cut material accurately and at an angle.
The arm action used for sawing can be a hazard to students nearby.	Area designated for sawing should be kept clear of other students.
Dust created by sawing can be hazardous if inhaled (refer to 8. 1 *Materials list, Metal*, *Plastic* and *Wood*).	Adequate ventilation must be provided if large amounts of dust are created. Students may need to wear respirators or dust masks. When sawing is minimal (for example, when only one student is sawing for a short time,) dust may not cause a hazard.
Dust particles are created when sawing. Metal fragments are particularly hazardous. Fine saw blades can snap, causing a hazard to eyes.	Students should wear safety glasses when there is any danger of dust or particles entering eyes. When work is finished, fragments should be carefully brushed off clothing and hands washed to avoid wiping dust into eyes. Warn students not to blow dust around. Cutting accurately will save time and effort later when students join materials and will avoid excessive filing or sanding (dust hazard).

Saw blades must be sharp, as it is much safer and easier to work with sharp blades. Soap can be run along the blade to minimise sticking. Warn students not to test the sharpness of the blades on fingers.

Ensure that students use the correct saw for the materials and the type of cut. Remove nails from wood before sawing. Students should be shown how to use the saw in the correct position. F-saws, tenon saws, dovetail saws and hacksaws are usually used in the horizontal position. Coping saws and piercing saws are used in the vertical position, with work secured on a bench hook or bench pin.

Show students that most saws cut on the push and not on the pull action. When cutting, remind them that extra pressure does not make sawing easier or cut materials faster. Show them how to stand in a balanced position with one foot slightly in front of the other to transfer weight from back foot to front foot when pushing the saw. Some saws, such as coping saws or piercing saws, can be used while seated. Long cutting strokes are more effective that short movements. Saws with handles further away from the saw/teeth are preferable for primary students.

Maintenance and storage

Show students how to insert new blades into saws with replaceable blades (hacksaws, coping saws and piercing saws). Ensure that they know which way the teeth should face. The teeth of piercing saws and coping saws face down towards the handle, while the teeth of F-saws or hacksaws face away from the handle. An experienced person should sharpen saws with permanent blades.

Saws should be stored over supports on a tool trolley or racks in such a way that the blades do not get damaged.

5.2.5.1 Coping saws

A coping saw is used to cut intricate or curved shapes in wood. The blade can be turned to cut in different directions. Internal shapes can be cut by drilling a hole, threading one end of the blade through it and reattaching the blade to the coping saw frame.

Work should be held securely while using a coping saw. If possible, clamp work so that student's free hand is away from cutting area. The teeth of the blade point downward and the coping saw is held at right angles to the material being cut. Coping saws are suitable for primary school students.

5.2.5.2 Dovetail saws (Gentleman's saw)

A dovetail saw, designed to cut dovetail joints, has a thin metal blade reinforced with a stiff band along the top. These saws are suitable for straight cuts. Greater control is achieved if the index finger is placed against the top band. Materials should be held securely with a bench hook or clamp. Dovetail saws are available in small sizes, making them suitable for primary school students.

5.2.5.3 F-saws

Description and use

An F-saw is a small framed, lightweight, robust saw with a closed handle that can be used by the youngest students. Blades are easily replaced when damaged or blunt. Both wood and metal cutting blades can be fitted. Teeth should point away from the handle.

5.2.5.4 Fret saws

Description and use

A fret saw does the same purpose as the coping saw but has a larger neck, allowing cuts to be made further into the wood. It has a fine blade, cutting curves in thin wood without leaving splinters.

5.2.5.5 Hacksaws

A hacksaw is used to cut metal bars, rods, tubes and sheet with a minimum of wastage and without distortion or bending. Incorrect use may cause the blade to snap. The blade must be kept tight and work held securely. Avoid twisting the blade by keeping the cut running straight. A wingnut on the saw frame is loosened to remove the blade. A new blade is hooked on at the handle and frame and the wingnut tightened. The blade teeth must point forward

so that the blade will cut on the forward stroke. Do not use a new blade in an old cut as the new blade will be wider than the old worn one.

Form small starting groove in work by drawing the blade back. Forward strokes are used to cut materials. The cut should be as close as possible to the vice or the clamp holding materials to avoid chattering and slipping. Encourage students to use the full length of the blade and to avoid forcing the saw through materials. Although the cut is limited to the depth of the hacksaw, the blade can be rotated to 90° to allow the frame to clear the metal in a long cut.

Junior hacksaws are designed for light-duty cutting of small diameter metal such as nails and wire. In some models, the frame creates tension for the blade. In others, the handle is loosened to release the blade. The replacement blade is inserted in the frame and handle and pulled tight by tightening the handle. The teeth should point away from the handle. Primary students can use hacksaws. Junior hacksaws are particularly suitable.

5.2.5.6 Panel saws

Description and use

A panel saw is a general-purpose saw useful for cutting large panels. It has pointed teeth similar to a cross-cut saw but smaller. It is used for sawing thin timber, generally across the grain and is useful for ripping tenons for joints. It will cut plywood without tearing the fibres if kept at a low angle to the surface.

5.2.5.7 Piercing saws (jeweller's saw)

A piercing saw is used to cut intricate curved or straight lines in thin metal or plastic. It is mainly used for fine work. Internal shapes can be cut by drilling a hole, threading one end of the blade through it, and reattaching the blade to the piercing saw frame.

The blades, which are extremely fine and break easily, should be inserted into the frame with the teeth facing downwards. When one end has been inserted, the frame must be put under tension by pushing it in against a work bench. Then insert and tighten the blade in the other end.

Work should be held securely while using a piercing saw. Work can be clamped or held by hand on a vee-shaped bench peg. Students should take care while cutting to keep the hand holding the work away from the cutting area. The piercing saw is held at right angles to the material being cut (usually vertical). The expense and fragility of the blades make piercing saws of limited use in primary schools.

5.2.5.8 Tenon saws

Description and use

A tenon saw is a small cross-cut saw (for cutting across the grain). The steel band running along the top keeps it straight and its enclosed handle makes it easy to use it in a horizontal position. The small teeth make it suitable for cutting small pieces of wood and for accurate joint construction. Saw with firm even strokes, using the full length of the blade. Store on a hook.

5.2.6 Planes

Description and use

A plane is used to smooth and straighten timber by removing material. Two handles are used to guide it along the timber surface. An adjustable blade beneath the plane shaves off layers of timber.

Hazards	Precautions
A plane can cause cuts if the blade contacts skin.	Store the plane with the blade drawn back.
The plane may slip if work is not secured.	Work should be clamped or held securely in a vice or against a bench pin and planed in the direction of the rising grain.

Both hands should be on the plane when using it. The handle is held by the preferred hand, with the thumb and closest finger guiding it. The other fingers hold the handle. The opposite hand holds the plane knob. Older primary students may be able to use a plane safely.

Maintenance and storage

Plane blades should be kept sharp and correctly adjusted. The handle should be kept tight at all times. A plane should be stored with the blade drawn back unless adequate protection is otherwise provided (AS 1485-1983, 7.2.4 Plane).

Care is needed when changing and sharpening blades. An experienced person should do the sharpening. To maintain blade sharpness, place the plane on its side when not in use. Check the wood to be planed for nails. The plane can be store suspended from its handle.

5.2.7 Spokeshaves

Description and use

A spokeshave is used to smooth and shape curved surfaces. It is similar to a plane but is smaller, making it easier to use on curves. It has a metal stock, two handles, a cutting iron and an iron cap. There are two types – flat-faced used for smoothing, convex edges and narrow surfaces and a round-faced for smoothing concave edges and compound curves (S shaped).

Hazards	Precautions
A spokeshave can cause cuts if the blade contacts skin.	Store the plane with the blade drawn back.
The spokeshave may slip if work is not secured.	Work should be clamped or held securely in a vice or against a bench pin and planed in the direction of the rising grain.

Maintenance and storage

Spokeshaves are maintained and sharpened in the same way as planes. Care is needed when changing and sharpening blades. An experienced person should do the sharpening. To maintain blade sharpness, prevent the cutting edge of the blade touching the benchtop.

5.2.8 Router planes (hand routers)

Description and use

A router plane is used to remove waste and level the bottom of trenches in timber. It has two handles, a metal stock, and an adjustable blade that protrudes below the base.

Hazards	Precautions
A router plane can cause cuts if the blade contacts skin.	Store the plane with the blade drawn back.
The router plane may slip if work is not secured.	Work should be clamped or held securely in a vice or against a bench pin.

Maintenance and storage

Check cutter profiles. Remove cutters when storing. Keep the tools clean and free from dust and store in a holder.

5.2.9 Metal-cutting chisels (cold chisels)

Description and use

A metal-cutting chisel is used to remove waste metal when a smooth finish is not required or to cut bars and rods or sheet metal too thick for tinsnips. The chisel is used with a hammer. Primary students are unlikely to use a metal-cutting chisel as other tools are more suitable.

Hazards	Precautions
Metal-cutting chisels may slip and injure hands.	Work must be secured in a vice and not held with hands. Students should always work away from the body.
Hands may be injured if struck with the hammer while trying to strike the chisel.	The chisel should be held close to its head to reduce risk of injuring hands and to provide stability. Leather gloves may provide some protection. Keep chisels and hammers free of oil and grease.
A chisel with a cracked or a mushroom head could cause miss-hits, cuts or other injuries.	A cracked or mushroom head chisel must be discarded.
Small particles of cut metal may fly off work while it is being chiselled.	Safety glasses must be worn. Warn other students to keep clear of the area or to wear safety glasses. Protective screens or shields protect students working nearby.
Chisels can fall and injure students if not transported properly.	Transport and pass chisels with care, with the blade facing down. (Refer to 4.3 *General hazards*, Manual handling.)
Metal-cutting chisels may also pose a noise hazard when the hammer hits the chisel head.	Teachers should monitor noise levels and have students wear ear protection if necessary.

Maintenance and storage

Do not carry chisels around the room unless they are in a suitable container such as a portable rack, toolbox or tool trolley. Store them with the cutting edge protected. *The head of the chisel should be dressed by grinding at the first sign of mushrooming. In the re-dressing of the head of a chisel, a small radius should be ground at the outer edge of the head. AS 1485-1983*, 7.2.

5.2.10 Wood chisels and gouges

Description and use

A wood chisel consists of a handle and a steel blade with a tang. It is used to cut and shape wood, remove waste and finish up joints. Gouges are similar to chisels, but are curved for work on curved surfaces. Older primary students can use wood chisels under supervision. Refer to 6.6.1.4 *Wood turning lathes* for information on wood turning tools.

Hazards	Precautions
Chisels and gouges pose a cutting hazard due to the sharpness of blades.	Work should be clamped to avoid the need to hold it with hands. Students should cut away from themselves.
Chisels can fall if not used or carried properly.	Transport and pass chisels with care with the blade facing down. (Refer to 4.3.3 *General hazards*, Manual handling of tools and equipment.)
Handles will be damaged if hit with a hammer.	Use mallets not hammers to hit chisels. Mallets are used with firmer chisels that have furrels. Paring chisels and gouges are not struck with mallets but are used by hand. Show students how avoid hitting their hands while using a mallet.
Poor quality chisel handles may shatter on impact.	Buy good quality tools that have a longer lifespan. Replace worn or loose handles.
Small particles of wood can fly off work while it is being chiselled.	Safety glasses must be worn. Warn other students to keep clear of the area or to wear safety glasses.
Chiselling wood can create dust.	Students should avoid inhaling dust, especially that from hardwoods (refer to 8.1.10 Wood). If dust is a problem adequate ventilation must be provided.

Maintenance and storage

Woodwork chisels and gouges should be stored in a suitable container that enables them to be safely transported. If stored on a trolley or shadow board, they must be securely held. If kept in a toolbox, blades must be protected to keep them sharp. Handles should be checked regularly and loose ones replaced.

5.2.11 Hand drills

Description and use

A hand drill is a small hand-operated drill used to bore holes in materials (refer to 6.5.2 *Portable drills* and 6.6.1.8 *Bench drilling machines*). The handle operates a gear mechanism that turns a drill bit. Hand drills are safe enough for primary students to use if the follow safety procedures.

Hazards	Precautions
Hair and clothing can become caught in the drill.	Safety precautions such as keeping loose clothing and hair secured should be observed.
Dust and particles can enter eyes while drilling.	If there is a risk of dust or particles getting into eyes, students should wear safety glasses or goggles.
Work can injure hands if it catches in the drill and spins.	Always secure the material to be drilled to the workbench using clamps or a vice. Place scrap wood underneath the material so the drill can pass through without damaging the work surface.

Hazards	Precautions
The drill bit can snap due to excessive force.	Warn students not to force the drill bit. They should drill at a speed suited to the materials and the size of the drill. Smaller drills can be rotated at a faster speed. The drill bit should be sharp.
The drill bit and work being drilled will become hot.	Allow time for the drill bit to cool between uses.
Shavings from drilling metal can cut hands.	Warn students not to handle the metal shavings and to use a dustpan and broom to clean up.

Secure suitable drill bit in the chuck of the drill and tighten chuck securely. Rotating the handle in an anti-clockwise direction loosens the chuck. The handle of the drill should be rotated to test that the drill is running straight.

Mark all drill holes with a pencil and use a centre punch to make an indentation in the material to be drilled. If drilling a large hole, drill a smaller one first as a guide hole. Stands can be used to hold hand drills in a vertical position. A small bench-mounted drill stand will enable younger students to guide the drill more easily.

Maintenance and storage

Drill bits last well if used carefully and on suitable materials. Students must be shown the correct way to insert and tighten a drill bit and to ensure that it is running straight to prevent drill bits breaking. They should be stored in a wooden block or tray designed to hold different-sized bits. Sharp drill bits will work more efficiently. They can be sharpened by an experienced person on a grinding wheel or with a file (refer to 6.5.8 *Portable grinders* and 6.6.2.1 *Bench grinders*).

5.2.12 Tap and dies

Description and use

Taps and dies are used to create a thread in metals.

Hazards	Precautions
Punching out a broken tap can cause fragments to be propelled into eyes.	Students must wear safety goggles or a face shield when punching out a broken tap.
Sharp threads and metal fragments can cut hands.	Students should avoid handling fragments and cut the thread slowly, reversing the action between each stage to allow waste to clear. Use a dust-pan and broom to clean up.

5.3 Forming and shaping tools

5.3.1 Pliers

Description and use

Pliers come in a variety of shapes and sizes, each with a different function. Their main purpose is to bend, hold or curve metal. They are also used to hold materials or components

while soldering or hammering and as a heat sink in electronics. Combination pliers have serrated jaws for gripping and a section that cuts. They are suitable for primary students to use.

Hazards	Precautions
The main hazard is pieces of wire shooting off when cut.	Students should wear safety glasses if the processes used could cause small pieces to be propelled into eyes.

5.3.2 Files

Description and use

Files are used to reduce uneven or rough surfaces left after sawing metal or plastic. They have different textures or shapes depending on the work they do. The correct type of file for the work should be selected. Tools such as rasps are used with wood. Do not use files on wood. Teachers will advise students on the most suitable files for different jobs and materials. Files are suitable for primary students to use.

Hazards	Precautions
The file tang can cause a serious injury if driven into the hand.	Files should have a smooth crack-free handle covering the tang. Advise students not to use a file without a handle and to check that handles are secure before use.
Files can slip and injure free hand.	Clamp work to be filed. This allows two hands to be placed on the file.
Burrs left after filing may cause a cutting injury.	Burrs should be removed from work after filing.
Metal or plastic dust created by filing is hazardous if inhaled (refer to 8.1 *Materials list*, 8.1.4 *Metals* and 8.1.8 *Plastics*).	Students should wear dust masks if there is a danger of dust being inhaled. Work should take place in a well-ventilated area regularly cleaned of dust.
Metal and plastic particles from filing can enter eyes.	Students should wear safety glasses if there is a danger of dust or particles entering eyes. When work is finished, fragments should be carefully brushed off clothing and hands.

Maintenance and storage

Particles can become firmly wedged in file teeth and damage work if not removed. Clean by brushing a file card in the direction in which the teeth are cut. Firmly wedged particles can be removed by running a scriber along the cut. Chalk rubbed into the file teeth will help prevent particles becoming wedged. Ensure that students do not clean files by striking them against a vice or other metal object.

5.3.3 Wooden mallets

Description and use

Egg shaped bossing mallets are used to shape metals. They form concave shapes in metals when used with curved wooden blocks or sandbags. A tinman's mallet is used for working on flat metal surfaces and for folding seams and edges. They are also used when shaping metals over stakes. Carpenter or joiner mallets are rectangular. They are used with wood

chisels or when adjusting joins in wood items. Both heads and handles of mallets are usually of wood, although some mallet heads are made from rubber or nylon. Wooden mallets are suitable for primary student use.

Hazards	Precautions
Mallet heads may fly off in use if loose.	Warn students not to use a mallet with a loose head. They should check mallets before use.
Mallets can cause injury if hands or fingers are hit.	Care should be taken to keep hands away from the point of impact while using mallets.
Mallets pose a noise hazard when they strike the handle of a chisel or when used to beat metals.	If the whole class is involved in beating metals, they must wear ear protection. Teachers should monitor noise levels at other times and have students wear ear protection if necessary.

Maintenance and storage

Mallets are usually hung from their handles on a tool trolley or shadow board. Their surfaces need to be smooth when working with metal. Mallets can be refaced by removing the face with a saw. Discard mallets once the face becomes split or damaged beyond repair.

5.4 Joining tools

5.4.1 Pins and needles

Description and use

Pins and needles are used to join fabrics.

Hazards	Precautions
Pins and needles can pose an injury hazard if left on floors or in sewn items.	Pins should go back into their container when removed from fabric. Students should use a pincushion or suitable container to store pins. Encourage them to pick up dropped pins immediately. Magnets could be used for this purpose. Allocating a set number of pins can assist younger students to keep track of them and to ensure they have not dropped any or accidentally left them in items.
Carpeted floors may pose a hazard if pins and needles become embedded in them becoming hard to see.	If possible, work on a smooth floor that can be swept.
Pins and needles can cause a choking hazard if students hold them their mouths.	Warn students not to hold pins, needles or any other sharp objects in their mouths.
Pins and needles can cause injuries or break off if excessive pressure is used to force them into materials.	Warn students about the problems of forcing pins and needles through thick materials. Thimbles can be used to protect fingers.

Maintenance and storage

Pins and needles should be stored in a container with a lid. They should be in good condition, straight and free from rust.

5.4.2 Screwdrivers

AS 1485-1983, 7.2.8 Screwdriver

Description and use

A screwdriver is used to tighten and loosen screws. There are two types – slotted head and Phillips head. Slotted head screwdrivers have a flat-edge blade that fits into the slot on a screw. Phillips head screwdrivers fit into the cross-shaped screw heads. Choice of screwdriver will depend on the screw. Young students can use screwdrivers with shorter handles and blades than those used by older students.

Hazards	Precautions
Screwdrivers can be hazardous if used for the wrong purpose.	Do not use a screwdriver as a cold chisel, punch or to pry open joints or lids of cans.
The point of a screwdriver can cause an injury if carried incorrectly.	Students should carry screwdrivers with the point facing down.
Screwdrivers can snap if used with force.	Do not use excessive force to turn a screw.
Screwdrivers can slip if used incorrectly.	When choosing a screwdriver, ensure the tip edges are square and fit neatly fit in the screw slot, or that the Phillips head is the right size for the screw. Magnetic screwdrivers are useful for small fiddly screws. Ensure the drill hole is a suitable size. Soap can be used to help the screw enter materials more easily. Students should keep their free hand away from the blade.
The metal of the screwdriver can conduct electricity, causing an electric shock if it contacts a live surface.	Insulated screwdrivers should be used in electronic activities.

Maintenance and storage

The blade and handle of a screwdriver should be kept in good condition. Screwdrivers should be stored in a rack that prevents the tips being damaged.

5.4.3 Rivet guns

Description and use

A rivet gun is used to join sheet metals by inserting pop rivets into holes. They are relatively easy to use. A pop rivet consists of a rivet with a mandrel or shaft through the centre. The end of the rivet is placed in the gun. The protruding rivet is inserted in the hole. Pressure is applied to the handles and the mandrel is forced through the rivet. This creates a bulge in the rivet that prevents it from falling out. The mandrel is released from the head of the rivet gun by upturning it and opening handles. Older primary students can use rivet guns under supervision.

Hazards	Precautions
The mandrel may become jammed in the rivet gun.	Ensure that the right size rivets are used for the head of the gun.
If the rivet stem is too thick, fingers can be jammed when force is applied.	Pop rivets come in a variety of sizes and materials. Students should be instructed on which are most suitable for their work.

Maintenance and storage

Lubricate moving parts as required. Ensure that students use and store the tool properly so that does not cause unnecessary wear.

5.4.4 Spanners and wrenches

Description and use

Spanners and wrenches are designed to provide leverage to turn different types of nuts and bolts and cylinders. Spanner generally refers to a tool that turns nuts and bolts, while wrench refers to a tool that grips cylindrical work. Ensure that students know how to choose suitable spanner for their task.

Hazards	Precautions
The spanner slipping can injure the student, or damage the nut or the spanner.	The spanner should fit the nut or bolt.firmly It is better to pull the spanner handle towards the operator. Pushing the spanner away may cause it to slip and injure the operator.
Spanners can snap and break if used with excessive force.	Do not allow students to strike a spanner with a hammer. Apply pressure by hand only.

Maintenance and storage

Pressure should only be applied by hand to spanners. Never use tubing or pipe to extend the length of the spanner handle, as this will damage the spanner or the work. *Spanners should be checked regularly. When a spanner has become cracked, worn or distorted, it should be destroyed and replaced* (*AS 1485-1983*, 7.2.7).

5.4.5 Hammers

Description and use

A variety of hammers are used in technology. Some are used with metal (ball peen), others with wood (claw). Hammers pose a number of hazards. Ensure that students use hammers suitable for their age group and the job. Small lightweight hammers are suitable for primary students, who are unlikely to be hammering hard materials.

Hazards	Precautions
Loose heads can fly off while in use.	Warn students never to use a hammer with a loose head and not to hit hammer faces together. They should check hammers before using them.
The item being hammered can chip and pieces fly off. Nails can fly out of materials when using a claw hammer to remove them.	Students should wear safety glasses when using hammers.

Hazards	Precautions
Hammers can fall if not used or carried properly.	Transport and pass knives with care. (Refer to 4.3.3 *General hazards*, Manual handling of tools and equipment.)
Hands can be injured if near the point of impact of the hammer.	Show students ways to hold materials to avoid placing hands where they may be hit. Secure work with a clamp or vice or have students hold the object with pliers. Blu-Tack or Plasticine can be used to hold a nail in place (avoid getting these on the hammer face). When using a hammer to shape materials, students should hold the material so that their free hand is well away from the point of impact.
Hammers pose a noise hazard when striking tools or materials.	If the whole class is involved in hammering, they should wear ear protection. Teachers should monitor noise levels at other times and have students wear ear protection if necessary.

Show students how to hold a hammer correctly. A hand painted on the handle in the correct position can be a help for primary students. When hammering a nail, tap lightly to set it in place, then hit it firmly to drive it through the material. Use a nail punch to set the nail below the surface of the wood if covering with putty or wood filler. Teach students techniques to prevent damage to materials when hammering – for example, drilling a hole before inserting a screw or nail to avoid splintering wood.

Maintenance and storage

The handles should fit the head of the hammer tightly and be correctly weighted. The face should be inspected regularly and any defects remedied; if this is not possible the hammer head should be replaced. A soft hammer should be used on hard or brittle metal (*AS 1485-1983*, 7.2.6).

Store hammers so that they do not damage each other. Hang them on a tool trolley, rack or shadow board to avoid faces contacting.

5.4.6 Soldering irons (not for electronics)

Description and use

A soldering iron has a pointed copper head attached to a steel rod with a wooden handle. It is used for soft soldering, a technique where soft solder is heated and used to join metals. Not all metals can be soft soldered. This process has been largely phased out in schools due to lead solder fumes.

Note: Lead-free solder can be used with electric soldering irons (refer to 6.12.2 *Electric soldering iron*). Although primary students may use electric soldering irons, it is not recommended that they use this type or soldering iron due to the lead solder fumes.

Hazards	Precautions
The heated soldering iron can cause burns or damage work surfaces.	Students should position hot soldering irons on a heatproof surface away from other students. Warn students not touch the soldering iron to see if it is hot.
Fluxes and solders can be hazardous. Solder and flux fumes may contain lead or other substances harmful if inhaled.	Soldering irons must be used in a well-ventilated area. Students should avoid skin contact with solders and fluxes and wash hands after use. Cotton gloves can be worn. Students should avoid skin contact with solders and fluxes.
Solder and flux fumes may contain lead or other substances that are harmful if inhaled	Soldering irons must be used in a well-ventilated area. Students should work under a local extraction fan or in a well-ventilated room. Teachers should refer to 7.6.10 *Chemicals used in Technology*, Solders and fluxes for precautions.
Lead in solder can be ingested.	Students should avoid skin contact with solder and wash their hands after using it. (Refer to 7.4 *Restricted chemicals*, Lead and 7.6.10 *Chemicals used in technology*, Solders and fluxes.)
Solder fumes can affect eyes and fluxes may sputter.	Students should wear safety glasses when using soldering irons.

The tip of the soldering iron is *tinned* with a thin layer of solder so it can pick up solder and transfer it to the metals being joined. The soldering iron is heated in a gas-fired soldering stove (tinman's oven). Students should stand to one side when lighting the stove. The gas is turned on slowly and lit with a flint gun. The flame is adjusted to confine the fire within the oven. When the gas flame is tinged green, the bit is hot. More than one soldering iron can be heated at a time, but take care not to overheat the bit or the tinning will be burnt off.

Maintenance and storage

The bit must be well shaped with a good point to allow it to get into corners. If it is rounded, support it in a vice and shape it with a file. Placing it in a dip pot after heating will clean the bit. Once it is tinned it should not oxidise for a long time provided it is not overheated.

Store the bit so as to prevent damage to the tip. Soldering irons may be hung from the handle.

5.5 Agriculture and horticulture tools

Agricultural and horticultural tools include simple gardening tools and some specialised tools. Buy the best quality tools possible. Spades, forks and secateurs of forged steel are stronger and more durable than of pressed steel. Buying reputable brands of tools assures quality. In agriculture classes, it may not be the tools that create the hazard. If students are working with animals, the particular hazards must be considered. (Refer to 4.3.3 *General hazards,* Manual handling of tools and equipment.)

5.5.1 Small gardening tools (hand forks and trowels)

Hazards	Precautions
Students can injure others if working too close together.	Ensure students have enough room when using gardening tools.
Tools with splits, cracks or other damage can cause hand injuries.	Ensure the working ends of gardening tools are in good condition. Handles should be checked for secure fit and splits, cracks and splinters. Damaged handles should be replaced immediately.

Maintenance and storage

Gardening tools should be tapped clean after use and stored in a dry area to prevent rusting. Sharp-edged tools should be stored so that edges do not touch other surfaces. Protective covers can be used to cover sharp edges.

5.5.2 Large digging tools

Hazards	Precautions
Students can injure others if conditions are crowded when working with large digging tools.	Ensure students have enough space around them when using large digging tools. It may be necessary to limit the number of students working in an area.
Large digging tools left on the ground can be stepped on, causing the handle to fly up. The risk is increased if tools are left in long grass or overgrown areas.	Students should place unused tools where they will not cause a hazard to others or themselves.
Foot injuries can be caused by large digging tools used carelessly.	Students must wear sturdy shoes when using large gardening tools and take care they do not work too close to others.
The ends of tools such as mattocks can work loose and fly off.	Check that too heads are secure.
Cultivators can be a manual handling hazard.	Large tools should not be raised above shoulder height as students may not have the strength to control them.

5.5.2.1 Shovels/spades

Description and use

(Spades are used to dig. Shovels are used to move materials.) There are many different types of both with different uses. The size should be suitable for the task and the strength of users. For primary students gardening, the size and weight of the spade is an important consideration. Small durable spades to suit primary students are available.

5.5.2.2 Digging forks

Description and use

Digging forks are used to break up soil, dig in heavy clay or rocks, and lift delicate plants where it is important not to damage roots.

5.5.2.3 Mattocks

Description and use

Mattocks are used to break up heavy clay soils, for levering up rocks, and for cutting lateral roots encountered when digging up a garden plot.

5.5.2.4 Rakes

Description and use

Rakes are used for raking leaves, garden debris or soil.

5.5.2.5 Cultivators

Description and use

Cultivators are used for weeding and breaking up hard soil around plants. They are mainly useful when cultivating among growing crops. Cultivators may be single-, double- or triple-pronged and care must be taken when using them.

5.5.3 Cutting tools

Hazards	Precautions
Cutting tools pose a hazard due the sharpness of their blades.	Hands must be kept clear of blade. Gardening gloves offer some protection when using cutting tools. Refer to 5.2 *Cutting tools*, 5.2.1 Scissors, 5.2.3 Knives and 5.2.5 Saws for precautions on cutting.
Pruning tools can be more hazardous than ordinary saws due to the awkward positions in which they are sometimes used.	Avoid using cutting tools in awkward positions. Where possible, reduce the stretching or leaning required to prune by using sturdy step-ladders to improve position.

5.5.3.1 Secateurs

Description and use

Secateurs are used for cutting small plant branches and stems. They should not be used for large pieces as they can damage them or cause injury.

Maintenance and storage

Tighten bolt as required and wipe with an oily cloth to minimise rust. Store and carry in a sheath.

5.5.3.2 Loppers

Description and use

Loppers are used to cut plant material up to 4 cm thick. The long handle gives more reach and leverage, resulting in greater cutting power. Some models have rubber shock absorbers to reduce jarring. Loppers are available in anvil or scissors styles and come in different lengths and weights to suit the user. For heavy pruning, double-lever loppers with greater cutting power are available.

Maintenance and storage

Keep shears at the right tension and oil joints regularly.

5.5.3.3 Pruning saws

Description and use

Pruning saws are used for heavier work and larger wood. They have cutting teeth on a curved blade that allows work in confined spaces. The main cutting action is on the pull rather than on the push stroke, which makes it easier for overhead work. Some models have safety locks and can be folded for convenient storage.

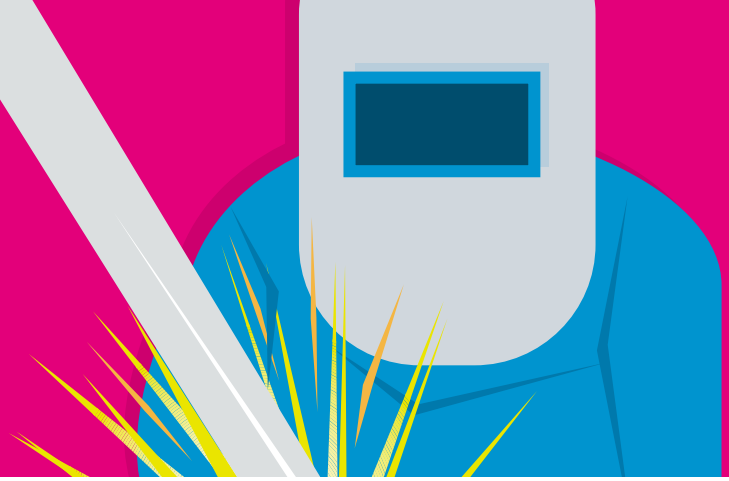
Maintenance and storage

Remove any soil or resins from the blade and wash after use. Wipe with an oily rag and store away.

5.5.3.4 Slashers

Slashers are not recommended for use by students in schools.

6 Equipment



The equipment and machinery used in technology should suit the activity and conform to the relevant Australian Standards. It is important that teachers understand equipment and machinery capabilities and ensure that they are not used for unsuitable purposes. The Standards Australia site http://www.standards.com.au/ provides information about standards and teachers can buy from this site. Check labels on equipment for information on compliance with standards. Teachers should be familiar with the Australian Standard *AS 1485-1983, Safety and Health in Workrooms of Educational Establishments* and *Occupational Health and Safety (Plant) Regulations*.

Equipment and machinery should be kept in serviceable condition. Some older items may not be safe and have inadequate guarding compared with newer models. Every effort should be made to ensure the older machine meets today's standards. Ensure older equipment is guarded appropriately and upgraded where possible. Decisions about using particular equipment are part of the school risk-management program.

Equipment used in technology can pose a range of hazards (outlined in 6.4 *Equipment list*). All users, staff and students, should be given adequate instruction in the safe operation of equipment and on safety issues. Manufacturer's guidelines are the principal document to refer to and should be available to all users. Teachers may need to develop guidelines for hazardous equipment that can be understood by students and displayed with the equipment. Students must show that they understand and can competently apply operational and safety procedures before being allowed to use equipment. Operational and safety procedures include:

- method of starting and stopping equipment
- hazards in using and maintaining equipment
- practices to be avoided
- use of guards and other safety devices
- recognising equipment faults
- compulsory protective equipment
- how to maintain work areas.

Areas in which only operators are permitted should be marked on the floor or otherwise clearly defined. Ensure that all permanently fixed equipment or equipment set up for student use is positioned so that it has adequate space for operation (refer to 3.2 *The Learning environment*, 3.2.4 *Work areas* and 3.2.7 *Floors*). *No traversing part of any machine and no material carried on any moving part of any machine shall be allowed to travel within a distance of 0.6 m from any fixed structure or other machine* (*AS 1485-1983*, 5.2.3 Clearance of moving parts).

The instructor should be provided with a clear view of all machines and have ready and rapid access to them. The machines should be arranged so as to eliminate risks to others from flying particles, tools or work which may be ejected. Where screens are used, they should not block the instructor's view (AS 1485-1983, 5.2.4 Arrangement of machines).

The general safety procedures that apply to all machines and equipment should be taught to students. These should always be followed along with the guidelines for the use of specific equipment. Students should:

- follow all instructions provided by the teacher for operating the machine, including wearing of protective equipment
- stand to one side when starting the machine and make sure other students are well away
- operate the machine on their own, keeping other students clear unless assisting the operator
- use mechanical feeding where possible
- work in a clear area without tripping hazards and maintain their balance
- turn off power after finishing work and stay with the machine until it has stopped
- make adjustments only after the machine has stopped and is disconnected from power
- make sure timber is free from checks, loose knots, unidentified surface treatments or other defects
- make sure all glued work is properly glued and dry.

6.1 Equipment controls

Teachers should know where to find the master isolation switches for the gas and electricity supply in all areas where technology classes are run.

Equipment should have push-button start-stop controls positioned so that they cannot be operated by accident. Start buttons should be coloured green, be shrouded or recessed, and have the word Start on or near them. All equipment must have a stop control that disconnects power and which is easily reached by students when working at the machine.

Students should be taught how to activate the emergency stop button. They should know to step away from the machine immediately if equipment fails.

Stop buttons should be coloured red, be protruding, and be clearly marked with the word Stop. Machines that require both hands to operate should have an extra stop button that can be activated with foot or knee. Mushroom-head type emergency stop buttons that immediately operate the circuit breaker and disconnect power to equipment should be installed in suitable positions. A master or isolating switch capable of being locked in the 'off' position should be provided to cut all power from the machine. Some machines are isolated with a key isolator or circuit breaker. The emergency stop buttons and on/off switches on machines should be checked regularly and a maintenance record kept.

Teachers must ensure that all machines are safe while they are not in the room. Students must not operate equipment and power should be disconnected if the teacher is not present. Machinery not in use should be isolated at the main switch and not just at the machine itself. Essential parts of machines such as belts, chuck keys, and oxyacetylene plant keys should be locked away to prevent unauthorised use.

6.2 Guarding

Access to dangerous moving parts (gears, belts, pulleys, shafts, flywheels) or other reciprocating or rotating parts (cutting edges, revolving cutters) must be prevented by suitable guarding or by enclosure within the equipment. All guarding must be in place when students use equipment.

Guarding on machines must be kept permanently in position unless the machine is being serviced or the teacher needs to make adjustments. Some guards, such as those on a bench drilling machine or bench grinder, are moved out of the way then back into place when students operate the machine. Show students how guards operate and how to ensure they are in the correct position before starting equipment.

Guarding should not be 'home-made' but must conform to the manufacturer's specifications. Teachers may consider making equipment inoperative if a guard is not in position.

6.3 Restricted Machinery: Variation to the Policy on Student Use of Machines

For many years, Department of Education & Training policy has prevented students from using the following items of technology machinery: rip saw, band saw, buzzer, thicknesser, guillotine, spindle moulder, docking saw and power wood shaper.

This policy has now been varied so that students may use the previously banned items of machinery if the school has been issued with certification from Noel Arnold and Associates. The requirements related to the certification process are outlined in *Executive Memorandum No. 2000/015 Student safety in wood and metal technology.* The certification process will review the school's level of compliance with the legislative requirements for the safe use of the particular machine. Note that the ban on student use of the specified machines still applies unless safety certification is obtained. Noel Arnold and Associates can be contacted on 9890 8811.

Teachers may use these machines if they have been properly trained. They should model safe practices when doing so. Teachers should never use hazardous equipment if they have not had adequate training.

6.3.1 Rip saws

Description and use

A rip saw is a highly hazardous machine designed to cut down the grain of timber. It is recommended that the saw should be used in the 'in-rip' position wherever possible.

Hazards	Precautions
Rip saws pose a cutting hazard to the operator.	Never use a rip saw in a position that brings the operator close to the blade or limits control. Use push-sticks and wood springs (featherboards) to avoid having fingers within 250 mm of the blade. The top hood guard should be positioned as close to the timber being cut as possible.

Hazards	Precautions
Timber can kick back into the operator.	The operator should stand to the left of the line of the saw blade at all times. Ensure that the pressure foot and the anti-kickback device are correctly adjusted before starting the machine.
The kerf can bind on the saw, causing timber to be thrown up.	Use splits or improvised riving knives to prevent the kerf binding on the saw. Never rip thin stock unless an elevating block is used. The riving knife should be thinner than the kerf and thicker than the body of the blade.
Particles of wood can enter eyes when using a rip saw.	Eye protection must be worn.
Rip saws generate large amounts of sawdust.	Avoid inhalation of dust. Operators should wear dust masks. Machines should have dust extraction attached.
A rip saw poses a noise hazard.	Ear protection must be worn. (Refer to 4.3.1 *General hazards*, Noise when using tools and equipment.)

Maintenance

The saw must be unplugged before attaching or adjusting ripguide. Only use saws in good working condition with working guards and an electric brake.

6.3.2 Bandsaws

Description and use

Bandsaws are used to cut timber, soft metal and plastics with a good degree of accuracy. A bandsaw can cut very large pieces of wood, cross cut, rip and cut curves. It consists of a large loop blade with teeth on one edge that runs on two or three large pulley wheels.

Hazards	Precautions
The bandsaw poses a cutting hazard to the operator. Timber may slip and can jump if it has imperfections, causing hands to come close to the blade.	Never push timber with hands directly in line with the blade. Hands should be placed either side of material and at least 75 mm away from the blade. Do not reach past the blade on either side. Use push sticks to clear chips away and help guide small material into the blade.
Blades can snap if used incorrectly or when cutting curves.	Work should be planned so that there will be a maximum of forward feed with a minimum of backing out of cuts. Avoid twisting the saw blade when cutting curves. Avoid backing out of curved cuts. Allow the machine to come to a complete stop before backing saw blade out of a long cut.
Round material may roll when being cut, causing teeth to jam and the blade to break.	Use a vee block to hold round stock while it is being cut.

Hazards	Precautions
If guides are not correctly positioned, blades can become unstable, be pushed off the wheel and hands will be able to come in contact with the blade.	The guide on the adjustable guard should be no more than 5 mm above the thickness of the work. They should not be left up. They provide support to the blade, keeping it stable. Operators should step away immediately if the blade breaks or comes off.
The noise levels when using a bandsaw can exceed can exceed 90 dB (A).	Hearing protectors must be worn when cutting wood on machines. The bandsaw is generally a quiet machine and should be used in preference to other power tools such as jigsaws and circular saws. The band saw may be so quiet that it is difficult to tell it is on. (Refer to 4.3.1 *General hazards*, Noise when using tools and equipment.)
Particles of wood can enter eyes when using a bandsaw.	Eye protection must be worn.
Sawdust poses an inhalation hazard.	Avoid inhalation of dust. Operators should wear dust masks. Machines should have dust extraction attached.
A bandsaw poses a noise hazard.	Ear protection must be worn.

Bandsaws can be modified to limit the size and type of materials that can be cut. A stop pin can be fixed in the vertical column so that the blade guard cannot be raised higher than the limits set. Cutting small items can bring operator's fingers too close to the blade. A clear poly-carbonate disc can be fitted to act as a safety shield to the blade guide block. A 100mm disc will limit the size of materials to be cut to not smaller than 75mm.

Operators should turn off the machine when work is finished and stand by the machine until it is stopped. The blade continues running for some time after turning off.

Maintenance

The bandsaw is not a high maintenance machine, however regular maintenance is important. The maximum and minimum blade length must appear on the inside of the top wheel cover. If it is not already there, it must be marked with a permanent medium. This information is required when broken blades are to be joined. When ordering new blades, give the maximum length, gauge, width and number of teeth. The smaller the teeth, the finer the cut. Blunt blades cause accidents because they require greater force to cut. They can also burn work.

Make sure the blade is running freely between the guide rollers. Check the rollers for lubrication and wear. Blades should be tensioned in accordance with the manufacturer's instructions.

The belt covers to the flywheel should be adequately secure and vibrations dampened.

6.3.3 Guillotines

Description and use

A guillotine is used to cut sheet metals. Although some guillotines are electric, most are operated by a foot pedal. Guards should be in place to prevent the operator from contacting the blade. Only one person at a time should operate the machine.

Hazards	Precautions
Guillotines pose a cutting hazard to fingers.	Do not remove guards. The guard should be set so that it prevents fingers from contacting the knife from the front or rear.
The cut edges of metals and waste pose a cutting hazard to hands.	Students should wear leather or sturdy gloves when handling large sheets of metal or guillotined metal. Waste should be place in a container.

Maintenance

The blade edges should be maintained in good condition and not be used if damaged or distorted. Lubricate the blade mechanism occasionally to prevent it from jamming.

6.3.4 Spindle moulders/shapers

Description and use

A spindle moulder is used to machine a single face or to form a profile or edge on previously planed timber. It has a blade similar to a router that protrudes through a hole in a table and can be wound up or down. It is easier to use than a router on irregular shapes. The wood is held on the table and moved around. This machine is considered highly hazardous and the operator must be fully qualified to cut curved work.

Hazards	Precautions
Spindle moulders cutters are highly hazardous. The cutter can come loose and be propelled out of the machine at high speed.	Correct assembly of the cutting head and the setting up of the machine is basic to safe working. The consequences of a mistake are so serious that operators should have their setting up checked by a competent person. Use the correct cutter for the job. Only cutters with chip-limit devices should be used. The nut holding the collars on cutter heads should be provided with a second nut for locking purposes.
Spindle moulders pose a cutting hazard to hands.	Cutting injuries can be avoided by securely guarding the cutter wherever possible. A well-constructed jig fitted with secure handholds will also do much to eliminate the danger of hands contacting the cutter. When the machine is not in use, the exposed portion of the cutters should be covered with a temporary guard. This is particularly important when cleaning down. The machine must be stopped when it is being adjusted.
The cutter can cut into the metal fence of the spindle moulder, damaging the fence and blade.	It is essential that a false fence is fitted as a safety precaution.

Hazards	Precautions
Particles of wood can enter eyes when using a spindle moulder.	Eye protection must be worn.
Saw dust poses an inhalation hazard.	Avoid inhalation of dust. Operators should wear dust masks. Machines should have dust extraction attached.

Maintenance

The spindle moulder should be maintained according the manufacturer's instructions. Cutters should be kept sharp. Make sure they are secure in the cutting head. Belts need to be checked and adjusted if necessary. Guards should be checked.

6.3.5 Docking saws (cross cut saws or radial arm saws)

Description and use

A docking saw is a stationary electrical saw that slides above the material to be cut, running along a metal arm. It is used for rapid docking of timber to size, cutting across the grain. Make sure the material is flat on the saw bench and hard up against the saw guide when cutting. A combination saw, which is adequately guarded, has a similar function but also allows for cuts at angles in two planes (compound angles). It is recommended that this machine not be used for ripping timber when a circular saw should be used.

Hazards	Precautions
Docking saws pose a cutting hazard to hands and body.	Do not allow hands to get close to blade. Do not dock pieces of timber shorter than 150 mm. Do not put fingers behind fence on table where accidental contact can be made with the blade. Keep hands at least 200mm clear of the blade and wait until the saw stops before removing offcuts and work. Allow the saw to automatically return to the back of the table before removing cut timber. Only draw the saw out far enough to separate the piece of timber. Most recent models will not allow the blade to be drawn past the end of the table.
The docking saw blade can grip into the cut and climb towards the operator if the correct blade is not fitted.	Combination blades are not safe for cross cutting. Fit blades with a negative rake (cross cut blades).
Wood can jam, allowing pieces to fly off if not held securely.	Hold the timber down and against the fence with the left hand while operating the saw with the right. Do not place a finger between the timber and the fence when cross cutting.

Hazards	Precautions
Radial arm saws are capable of producing noise levels in excess of 100 dB(A).	Good hearing protection must be worn. Use gentle pressure and allow the blade more time to cut. The bandsaw may be a less noisy alternative. Refer to 4.3.1 *General hazards*, Noise when using tools and equipment.
Particles of wood can enter eyes when using a docking saw.	Eye protection must be worn.
Sawdust poses an inhalation hazard.	Avoid inhalation of dust. Operators should wear dust masks. Machines should have dust extraction attached.

Operate the saw with a drawing action (climb cut), using a stiff arm. Ensure that the teeth of the saw are 1–2 mm below the surface of the table. Turn off the power and stand by until the machine has stopped as the blade keeps running for some time after turning off.

Maintenance

Ensure blades are sharpened regularly. Blade guards can become loose and rattle. Stop machine before making any adjustments and disconnect power if necessary. Keep the machine clear of dust.

6.3.6 Buzzers (handfed surface planing machines, hand planing and jointing machines)

Description and use

A buzzer can create a perfectly square edge both on the width and the thickness of the timber board. The planed surface and edge provide the base from which the opposite sites are planed true and parallel on a thicknesser. A spring-mounted guard moves out of the way when wood is pushed against the blade and springs back later. It must be in place and free to move to cover the cutting edge.

Hazards	Precautions
The buzzer poses a cutting hazard to hands.	Keep hands a safe distance from the revolving head. Make sure the guard is in place over the cutting knives. Do not plane stock less than 250mm long and less than 9mm thick. Use a pushstick or pushblock whenever possible to prevent fingers coming within 100mm of the cutting edge. Never allow fingers to be above the knives even if the guard is in place. Push the material far enough past the knives so that the guard will return before removing the material from the table.
Buzzer blades are extremely dangerous not properly fitted and sharpened.	Knives must be checked before use to ensure they are tight. Blades must be in good condition.

Hazards	Precautions
Particles of wood can enter eyes when using a buzzer.	Eye protection must be worn.
Sawdust poses an inhalation hazard.	Avoid inhalation of dust. Operators should wear dust masks. Machines should have dust extraction attached.
A buzzer poses a noise hazard.	Hearing protection should be worn when using a buzzer. (Refer to 4.3.1 *General hazards*, Noise when using tools and equipment.)

Adjust the front table only for the depth of the cut. Clamp fence firmly in position. Stand to one side when switching on the machine. Feed the wood slowly and evenly over the cutter, taking account of the grain. Turn off the machine when work is finished and stay with it until it has come to a complete stop. Disconnect power supply before making any adjustments.

Maintenance

Blades should be sharpened by a trained service person as required. The blades require honing with an oilstone slip before use and at regular intervals, depending the use the machine has had. Eliminate rattles by making sure the dust extractor heads are firmly attached to the buzzer.

6.3.7 Thicknessers (planing machines)

Description and use

A thicknesser is used to produce a parallel edge on the timer face after it has been planed on a buzzer. It can plane wider pieces than the buzzer. The planed surface and edge provide the base from which the undressed surfaces are planed true and parallel. It generally reduces the timber to the thickness required.

Hazards	Precautions
The thicknesser poses a cutting hazard.	Cutting heads should be guarded to prevent contact with the front or rear of the cutting knives. Do not machine pieces equal to or shorter than the distance between the centres of the feed rollers. Keep hands away from feed rolls and away from the board already gripped by the feed rolls.
Timber can kick back towards the operator.	Power-feed rollers should be provided with anti-kickback devices placed in front of the feed rollers. Stand to one side when turning on the power and remain at one side while the machine is in operation. Do not try to feed over-thick material through. Guards should be set to prevent overthick material being inserted. Allow the timber to travel completely through the thicknesser before making any depth of cut adjustments.

Hazards	Precautions
Thin material can be damaged or thrown back by the machine.	Run thin material through a thicknesser on top of a thick board.
The thicknesser is a noise hazard.	Hearing protection should be worn. Consider enclosing the machine to reduce noise.
Particles of wood can enter eyes when using a thicknesser.	Eye protection must be worn. (Refer to 4.3.1 *General hazards*, Noise when using tools and equipment.)
Sawdust poses an inhalation hazard.	Avoid inhalation of dust. Operators should wear dust masks. Machines should have dust extraction attached.

Adjust cut to measurements taken on the thickest part of the board. Limit cuts to 1.5mm at a time. Stay with machine until it comes to a complete stop. Turn off power if any irregularity in operation happens.

Maintenance

Ensure blades are sharpened regularly. Ensure dust extractor heads are firmly connected to the thicknesser to avoid rattles. Oil machine frequently at lubrication points according to manufacturer's recommendations.

6.3.8 Power wood shapers

Unlike the other banned equipment, the powered wood shaper is not a fixed machine. It is a blade that is attached to an angle grinder to shape timber and used instead of gouges and chisels. Guards can be bought for the blades and an adjusting clamping screw can control the depth of cuts. Teachers should refer to 6.5.8 *Portable grinders (angle grinder)* and 6.5.1 *Portable circular saws* for related safety information.

Hazards	Precautions
The power shaper blades operate at high speeds and pose a cutting hazard.	Only use the power shaper with a properly fitted guard. Work should be clamped to avoid the need to have hands near the blade.
Because the grinder is moveable, the blade and cut materials may be close to face and eyes.	Safety goggles or a full-face shield should be worn. Work should be clamped so that the machine is used at a safe distance from the face.
The power shaper may be a noise hazard.	Monitor or test noise levels. Hearing protection should be worn if this is over the recommended level.
Particles of wood can enter eyes when using cutting machines.	Eye protection must be worn.
Saw-dust poses an inhalation hazard.	Avoid inhalation of dust. Operators should wear dust masks.

6.4 Equipment list

Students may use equipment not featured in the Equipment list. When introducing equipment for the first time, teachers should follow the points outlined in 4.2 *Using tools and equipment safely*.

6.4.1 Electrical equipment

Electrical equipment and apparatus shall be designed and constructed so as to prevent danger from shock and fire, and should always be maintained in safe and good condition. It shall comply with the relevant requirements of AS 3000 and the requirements of the Competent Authority (AS 1485-1983, 5.5 Electrical Installation).

The Australian Standard *AS/NZS 3000:2000* Electrical installations sets out requirements for the selection and installation of electrical equipment and design and testing of electrical installations. Teachers should refer to 3.2.11 *The learning environment, Power supply*, for information on electrical equipment.

All electrical equipment is potentially lethal if mishandled or tampered with by an unqualified person. It is recommended that mains-operated hand tools and equipment are connected to power points through a core-balance leakage device. (This may already be built into the school's electrical switchboard.) It is a protective system that operates by detecting differences in the current entering and leaving a circuit and will switch off mains electricity. Safety devices that plug into power points can be used with appliances. These will cut power supply if a fault is detected. Buy only safe, reputable and tested safety devices.

Appliances' flexible cords should be in good condition, free from cuts and breaks. The cord sheathing should be held firmly at the tool end and wires must not be exposed. The plugs and extension sockets should be free from cuts or damage. Any defects must be repaired by a licensed electrical repair person.

Electrical equipment should be inspected and tested annually for electrical safety and should have a current electrical test certification. Electrical equipment must be tested and tagged in compliance with the Electrical Safety Standard *AS 3760:2001 In-service safety inspection and testing of electrical equipment*. Teachers should ensure that all mains-operated equipment is properly connected and correctly operated. When new equipment is installed, teachers should ensure they obtain complete instructions on its safe use and maintenance information. As a supplement to regular audits, teachers are responsible for checking plugs and cords and components of electrical equipment before student use. Students should be told to notify teachers if appliances do not work properly. Faulty electrical equipment should be removed from use and clearly identified with lock-out tags for repair by a qualified electrical service person. If repair is not practicable, plugs should be removed before disposal.

Ensure power is switched off before plugging in or unplugging electrical appliances. When using mains or low voltage equipment, ensure that the rated voltage of the device is not exceeded by that of the power supply or battery. Where practicable, students should use low voltage equipment such as 2 – 12 volt DC/AC transformers or 1.5 volt – 6 volt batteries. Never allow students to use mains electricity for experiments.

Electrical appliances, power leads, power boards, adaptors and extensions leads should conform to *AS 3760: 2001 In-service safety inspection and testing of electrical equipment*. Avoid the use of extension cords. If they must be used, ensure they are out of the way and taped down with masking tape to avoid tripping. The number of power points in the classroom should be adequate to avoid the use of electric extension cords or double adaptors. Do not overload electrical circuits. Two or more adaptors used at one point are dangerous.

Students may tinker with disused electrical or electronic products to find out how they work as part of their technology activities. It is important that students do not tinker with any item that is marked tamperproof or is sealed to avoid tampering. Electrical tinkering items must have their electrical cords removed before they are disassembled. Tinkering should be done in a constructive way with the aim of learning how products function.

Primary students will only use electrical appliances under strict supervision. Because students use electrical equipment at home does not mean that they know the correct and safe way to use it. Teachers are responsible for explaining safety procedures for all equipment used by students. Stress the danger of allowing water to contact with electrical appliances or power points. Showerproof plugs can be installed and labels warning students about having wet hands when turning power on and off should be placed above power points. Electrical equipment should not come in contact with water or be used near water taps or sinks

Small electrical appliances are generally portable, which means students may need to unpack and pack them up at the end of lessons. Care must be taken when transporting appliances that they are not dropped or damaged. Avoid winding cords tightly when storing appliances as this may damage the cords.

Electrical equipment should be switched off and unplugged when not in use. Equipment should be kept in storage areas clean and dust free.

Miscellaneous electrical equipment

6.4.1.1 Glue guns

Description and use

Glue guns hold a cylindrical glue stick that is heated in the gun barrel. Pushing a trigger extrudes the glue. Students should be taught the safe use of glue guns and correct joining techniques.

Hazards	Precautions
Glue guns pose a burning hazard. The metal tip of the glue gun can become very hot, causing deep burns and damaging work surfaces.	It is recommended that only low-melt glue guns be used (the glue stick melts at a lower temperature). Keep glue guns in a stand that prevents contact with the tip when not in use.
Molten glue can cause burns if it touches the skin.	Show students how to use glue guns without coming in contact with melted glue. Show students how to use the gun so that drips are avoided. They can wipe the nozzle on scraps of wood or other suitable material. Turn off the glue gun when not in use as it will continue to melt glue while on. Students can wear cotton gloves to prevent contact with skin. Gloves need to be replaced regularly as they become coated with glue, making them difficult to work in.
Glue guns pose an electrical hazard if the metal tip of the glue gun melts plastic-coated electrical cords.	Keep cords out of the way of the tip of the glue to prevent damaging them. Turn off glue guns when not in use and store in a stand.

Various methods can be used to store the glue gun while it is on and in use. The stands attached to glue guns are often unstable and do not hold the glue gun off the work surface.

A wooden box with slots cut in each side can be used to hold the glue guns. Drips are caught in the bottom of the box. Alternatively, stand glue guns on a tray or board to prevent glue dripping on work surfaces.

Encourage students to have surfaces to be joined ready for gluing before applying the glue, which sets quickly. Primary students may need to work with a helper. Light clamping may be needed to hold surfaces together while the glue sets.

Maintenance and storage

Refilling the glue gun with glue sticks is simple and most primary students can be shown how to do this. Do not extract the glue stick from the rear of the gun.

The glue gun must be cool before being packed away. In some classrooms, the glue guns will be left out in work areas but stored in such a way that cords are clear and they are switched off at the power point.

6.4.1.2 Hairdryers

Description and use

Hairdryers are sometimes used to dry paint on textile fabrics or to heat or soften materials. They can generate a large amount of heat.

Hazards	Precautions
Hairdryers can cause electrocution if used near water.	Ensure that the hairdryer is not used where it can come in contact with water.
Hairdryers can overheat if used for extended periods.	Avoid using hairdryers for extended periods as this may cause them to overheat and the motor to seize.
Hair can become caught in the fan.	Take care that hair and other materials are kept away from the filter end of the hairdryer.
Heat from hairdryers can damage some surfaces and materials.	Do not be use hairdryers on surfaces that can be damaged by heat.

Maintenance and storage

Wind cord loosely and store hairdryer in a dry storage area. Ensure the filter is kept free of dust and fluff build-up.

6.4.2 Food preparation equipment

Description and use

Food preparation equipment includes items such as saucepans, baking trays, mixing bowls, chopping board or strainers. Teachers should refer to the Department of Human Services Food Safety Unit website *Food Safety Victoria* at http://www.foodsafety.vic.gov.au for information on handling equipment hygienically. The section Keeping Food Safe is a good starting point.

Hazards	Precautions
Food cooked at high temperatures (such as boiling water, oil, toffee or jam) can cause serious burns.	Protective equipment such as oven mitts and tongs should be used when handling hot foods and cooking utensils. Do not allow students to carry hot foods across the room. Primary students should not handle hot liquids or foods. Parents, kitchen assistants and teachers must supervise.

Hazards	Precautions
Hot liquids such as oil or fat can ignite if overheated.	Students should be instructed on how to determine the correct temperature of fat for frying to prevent ignition. It is recommended that only senior students use deep-frying methods.
Handles of equipment such as saucepans can become hot and cause burns.	Saucepan handles should be of a heat-resistant material to prevent burns. Handles should be turned in (not over another hot plate) and pushed back as far as possible from the edge of the hot plates or gas burners.
Scalds can be caused by steam if lids are lifted incorrectly.	Saucepan lids should be lifted carefully and away from the body to prevent scalding.
Chopping boards can harbour bacteria if not in good condition and have deep cuts.	Use chopping boards made of a material easily cleaned and kept hygienic. Chopping boards should be in good condition and replaced when worn and difficult to clean. Use separate chopping boards for meat, fish, vegetables and fruit, as well as raw, cooked or processed meats.
Cross-contamination can occur if the same equipment is used for different foods (raw, cooked, meat, fruit).	Avoid cross-contamination by ensuring all equipment is cleaned thoroughly after use.
Blades and sharp attachments can be a cutting hazard during washing up.	The power must be turned off before blades and sharp attachments are removed and washed. They should be washed separately in hot soapy water, rinsed, dried and returned to the appliance. Due to their sharpness, they should not be placed in the sink with other utensils.

Maintenance and storage

Food preparation equipment must be hygienically maintained and stored. It should be checked after each practical session to ensure that it is accounted for, clean, and in good working condition. Storage of cooking equipment will depend on facilities available, such as drawers, cupboards, shelves, storage spaces, and storage rooms. In primary schools, some equipment will be stored in a central area in the general classroom or staffroom. Wherever equipment is stored, it is important that storage areas are free from dust, vermin or other pests. Equipment used with food must not be stored with cleaning materials or food.

Teachers should check that cooking equipment is in good condition. Handles on saucepans and frying pans should be firmly fixed and all screws regularly tightened. Chipped crockery and glassware and damaged or faulty equipment should be discarded and replaced.

Electrical equipment should be stored either in a cupboard or on a shelf for easy access. Attachments to small machines should be in a container near the appliance, with sharp blades or edges protected from damage.

The bodies of electrical equipment can be cleaned with a damp kitchen cloth, taking care not to immerse the appliance or the power plug in water. Take care to clean grooves in the accessories as these may contain food particles. Store in the stand or in a clean storage cupboard with the cord loosely wound.

6.4.2.1 Food processors and blenders

Description and use

Food processors and blenders are used to blend or chop foods to a fine consistency. They spin at high speeds and have sharp attachments. Students should be taught the safe use of food processors and blenders.

Hazards	Precautions
Fingers can be cut if they come in contact with blades.	When using food processors or blenders it is essential that students do not attempt to push food down with fingers. They should be instructed to use the food pusher or a scraper. Blenders should be turned off to scrape down the sides of the processor or blender.
Handling sharp attachments can cause cuts.	The power must be turned off before removing the blades of food processors and blenders. Take care when sharp attachments are being removed and cleaned. Students can wear rubber gloves to do this.

6.4.2.2 Hand held food processors

Description and use

Handheld food processors are used to blend or chop foods to a fine consistency. They can be used to process foods in small containers. The attachment is exposed and is easily touched. Most of these appliances come with a stand that will prevent it falling from the bench.

Hazards	Precautions
The unguarded blades spin at high speeds. Loose clothing or items can be caught in the machine.	The machine should only be operated while it is in food and turned off when it is removed. The power must be turned off pulling the operator into the blades when attachments are being removed.
The blades pose a cutting hazard if the appliance is not handled correctly.	Care must be taken when removing blades from the machine. If the power is disconnected, a cloth can be placed over the attachment to remove it.
The quick on-off action of the switch means that the appliance can be inadvertently switched on while cleaning or removing blades.	The appliance must be turned off at the power point to clean or remove accessories.

6.4.2.3 Kitchen mixers

Description and use

Kitchen mixers are used to mix foods together quickly and efficiently. They consist of a mixing bowl, attachments, and a motor with controls. Some kitchen mixers are capable of producing a noise level of 90 dB(A). As they are used in short bursts, exposure levels are not usually exceeded. Worn bearings and gears will cause older mixers to be more noisy. A washable rubber pad can be placed under the mixer to stop vibration. Run the mixer at the minimum speed needed to perform the task. Do not scrape down the sides of the bowl when operating.

6.4.2.4 Electric beaters

Description and use

Electric beaters are hand-held beaters or small mixers placed on a bench. Students should be taught the safe use of electric beaters. Avoid hitting the sides of the bowl with the blades.

Hazards	Precautions
Because they rotate at high speed, loose clothing, items or hair can get caught in the beaters.	Long hair and loose clothing must be secured.
Items can get caught in beaters when scraping down or removing them.	Do not scrape down the sides of the bowl when operating. The appliance must be turned off at the power point to clean or remove beaters.

6.4.2.5 Electric knives

Description and use

Electric knives have vibrating blades. They are used to cut foods such roast meats or breads or when cutting for a long period. Students should be taught the safe use of electric knives and correct cutting techniques (refer to 5.2.3 *Cutting tools*, Knives). Restrict the use of electric knives to students who can safely and competently use them. These will generally be Year 11 and 12 students.

Hazards	Precautions
The sharp blade can cause a cutting hazard.	Students should keep their free hand away from the blade by using tools to hold food. Place food to be cut on a stable surface and secure with a carving fork or tongs. A spiked cutting board can be useful for holding food while cutting.
The knife may be inadvertently switched on while not in use.	The knife should be switched off at the power point when not in use.

6.4.2.6 Pressure cookers

Description and use

A pressure cooker has a securely fitting lid with a pressure valve. It can be electric or heated on a hot plate. It cooks foods under high pressure, speeding up the cooking process. Steam heated to about 120C° is used to cook the food. The super-heated steam cooks foods quickly and evenly.

It is essential that students are taught the safe use of pressure cookers and the correct cooking techniques. Safer cooking methods should be preferred. Only senior secondary students will use a pressure cooker. As instructions for each brand vary, it is important that the manufacturer's printed instructions are followed. These can be copied and laminated for student use.

Hazards	Precautions
Scalding can occur if pressurised steam is released suddenly.	At the end of cooking time, the pressure cooker can be allowed to cool naturally or cooled immediately by pouring cold water over it. At no time should the cooker be opened while still under pressure. An oven glove should always be worn when releasing the valve.
Pressure cookers can overheat and become very hazardous if not used correctly.	Adequate amounts of water should be added in relation to cooking time. The pressure cooker must not be allowed to overheat and boil dry.

The pressure regulator controls and maintains pressure inside the cooker and indicates when the ideal cooking pressure is reached. The pressure regulator fits on the vent pipe and allows excess pressure to be released. Pressure is completely reduced when the air vent/cover lock has dropped. Remove the pressure regulator, then remove pressure cooker cover.

Maintenance and storage

If the vent pipe becomes clogged, pressure cannot be released normally. Hold cover up to light and look through the vent pipe to make sure it is clear.

After cooling, the pressure cooker should be washed in warm, soapy water, then rinsed and dried thoroughly before storing. The valve must be cleaned of food particles. Rubber seals in the lid require lubricating. Rubber seals and safety valves should be replaced periodically (1–2 years) as the rubber perishes and becomes brittle.

6.4.2.7 Cappucino machines

Description and use

Cappucino machines use high pressure steam to froth milk. They are also used to grind coffee beans and produce the coffee base for coffee drinks.

Hazards	Precautions
Steam under pressure can cause burns.	Ensure students avoid skin contact with steam when frothing milk.
Hot components can cause burns.	Turn water outlets off after use to prevent burns if the machine is accidentally turned on.
Milk can breed bacteria if it is not cleaned from nozzle.	Clean nozzle with a clean disposable cloth between uses.

Maintenance and storage

Back flush at the end of the day to clean out water inlets. Remove drip tray and wash with detergent. Turn off all control points and ensure nozzle is cleaned.

6.4.2.8 Deep fat fryers

Description and use

Deep fat fryers are used to deep fry foods.

Hazards	Precautions
The oil in deep fryers may catch fire.	Do not leave oil unattended. If fat reaches smoking point, turn off and allow to cool.
Hot oil can cause serious burns.	Warn students not to drop food into oil. Ensure foods to be deep fried are dry to avoid spattering.

Maintenance and storage

Allow oil to cool. Clean the deep fryer by straining oil to remove food particles. Change oil regularly if a permanent deep fryer is used. If a domestic deep fryer is used, wash with hot soapy water after removing oil for storage.

6.4.2.9 Electric frying pans

Description and use

Electric frying pans provide a convenient and portable method of cooking. They are generally larger than the average frying pan. The temperature is controlled with a thermostat. They are used to fry foods or melt substances such as chocolate or wax. Many primary schools use electric frying pans.

Hazards	Precautions
The electric frying pan surface can cause burns.	Warn students that the surface of the frying pan can get very hot. Tell them to use protective equipment such as oven mitts when cooking food. Place frying pan on a stable heatproof surface. Ensure it is pushed back on the bench top and does not touch surfaces damaged by heat.
Electric frying pan can be knocked or pulled off the bench.	Keep cord positioned so the electric frying pan cannot be pulled off bench. Ensure handle is turned in.
Food cooked at high temperatures (water, oil, toffee or jam) can cause serious burns.	Protective equipment such as oven mitts and tongs should be used when handling hot foods and cooking utensils. Do not allow students to carry hot foods across room. Primary students should not handle hot liquids or foods. Parents, kitchen assistants and teachers must supervise.
Steam can cause scalding if lids are lifted incorrectly.	Lid should be lifted carefully and away from the body to prevent scalding.

Hazards	Precautions
Hot liquids such as oil or wax can ignite if overheated.	Students should be instructed on how to determine the correct temperature of fat for trying to prevent ignition. Monitor wax so that it remains melted but does not overheat.

6.4.2.10 Microwave ovens

Description and use

Microwave ovens produce and control microwave energy for heating and cooking. They heat and cook foods more quickly than conventional ways of cooking. Teachers need to be familiar with the manufacturer's instructions before operating them. Brands vary and the wattage will determine how long food is cooked. They should be placed on a flat, even surface. Students should be taught the safe use of microwave ovens and correct cooking techniques.

Microwaves are generally located in a staff room, food preparation rooms, or general classrooms. A microwave oven may sometimes be the only means of cooking or reheating food, particularly in a primary school. Primary students should be supervised when using microwave ovens.

Microwave can be used to dry flowers, paper and wood. If this is done, obtain instructions from a reputable source. Monitor materials to avoid overheating. Microwave ovens used for this purpose should not be used for cooking due to the possibility of fumes or poisons in organic materials. Instructions for safe drying of flowers and wood can be found on the Internet.

Hazards	Precautions
Foods can be heated to high temperatures in a short time in a microwave oven.	Students should avoid scalds from steam by covering food before placing it in the microwave oven, and by removing containers with an oven mitt. Take care when lifting lids.
Some foods can overheat rapidly or explode in a microwave oven. They may also continue to cook after being removed.	Take care not to overheat foods such as • oil or fat • eggs in the shell • foods for preserving • bacon • jams. Warn students that these foods may continue to cook after being removed from the oven. When the food is ready, take it out of the oven and leave it to stand for 2–3 minutes. Take great care when taste tasting these foods.
Unsuitable microwave oven containers may melt or spark.	Suitable microwave-proof cookware should be used for best results. It is essential to make students made aware of the dangers of placing metal or gold-decorated items in some microwave ovens.

Hazards	Precautions
Microwaves can leak microwave radiation.	It is extremely rare for microwave oven leakage levels to exceed the recommended levels. An oven in good condition and used correctly is safe. Simple precautions should be followed: • Stand at least an arm's length away from an operating microwave oven. • Do not attempt to operate the oven with the door open. Safety locks prevent microwave ovens being operated with the door open. • Do not use the microwave if the door does not close properly or is damaged. • Only operate a microwave when it contains food or liquids or the magnetron will be damaged.

Maintenance and storage

A damaged oven (broken or loose hinges, latches, door seals and sealing surfaces, bent doors) should be repaired by a qualified service person or replaced. Most microwave oven repair shops will test ovens for leakage at a reasonable cost.

Microwave ovens should be wiped clean inside and out after use. Plastic spatter protectors can be placed over foods to prevent walls being soiled. Protectors can then be removed and washed. Absorbent paper towelling placed under dishes will prevent soiling of the microwave base and avoid impacts between hard surfaces. The base, usually toughened glass, must be removed carefully to avoid breaking it. It will generally be wiped clean and not removed.

The way a microwave oven operates means very high DC voltages are present in the internal circuitry. These voltages can remain even when the oven has been disconnected from the mains supply for some time.

6.4.2.11 Electric ovens

Description and use

Students should be taught the safe use of ovens and correct cooking techniques. In primary schools, teachers or adult helpers will remove hot items from the oven. Some equipment, such as commercial cooking appliances, will only be used by senior students.

Hazards	Precautions
The main hazards in using an electric oven are burns or scalds when foods are checked or removed.	Students must use suitable protective equipment such as good-quality oven mits. Never use a damp cloth to remove hot items from the oven or when handling hot appliances as the steam created can scald and burn.
Heavy items may be awkward to insert and remove from the oven.	Show students the safe way to remove items from the oven. Students should bend from the knees for correct balance and to avoid back injuries.

Hazards	Precautions
The oven glass may cause burns if touched.	Warn students that the oven exterior can cause burns although it may not be visibly hot.
Hot items removed from the oven may damage surfaces.	The oven must be close to a heatproof surface where hot items can be placed.
Domestic ovens have sometimes been used to heat sheet plastics. When heated plastic emits toxic vapours that tend to line the oven walls. If the oven is then used to cook foods, these can be contaminated and poisoning may occur.	It is recommended that domestic ovens are not used to heat plastics.

Maintenance and storage

Ovens should be wiped clean after use. In some cases, they will need to be thoroughly cleaned. This is the teacher's responsibility and suitable cleaning substances should be used. Trays are removed for cleaning.

6.4.2.12 Electric hot plates

Description and use

Electric hot plates are used to cook foods in containers such as saucepans and frying pans. In some cases, students may cook on a barbecue hot plate (wood, gas, and electricity). Students should be taught the safe use of hot plates and correct cooking techniques. Primary students should be encouraged to prepare food and cook. However, only older primary students will use hot plates and then under close supervision. It is not recommended they handle or cook extremely hot foods. Younger primary students can enlist the aid of adults.

Hazards	Precautions
The main hazards are burns, fires or scalds caused by direct contact with the hot plate.	Tea towels and similar items should never be placed on hot plates. Care must be taken when using oven mitts to remove lids or cooking equipment from hot plates. Emergency equipment such as fire extinguishers and fire blankets should be easy to get at and not in an area likely to catch fire. Make sure that students know that the hot plate may hot without looking hot.
Overcrowding can lead to accidents.	No more than three students should be assigned to work at each stove-top to allow enough room for safe movement.
Portable electric hot plates can be an electrical hazard.	Ensure that portable electric hot plates and plugs are positioned away from sources of water.
Portable electric hot plates can fall off benches.	Position portable electric hot plates at a safe working height. Do not allow cords to be where they can be tripped over or accidentally pulled out.

Maintenance and storage

Cooking surfaces should be wiped clean after each use. Some hot plates can be removed for cleaning. Use suitable cleaning substances.

6.4.2.13 Gas cooking appliances

Students may use gas ovens or hot plates when preparing food. The hazards involved in using these appliances are generally the same as for electric ovens and hot plates but an extra hazard is the naked flame when cooking.

Hazards	Precautions
Gas can combust suddenly if the cooking appliance is not lit correctly.	Students must be shown the correct way to light gas appliances. They should use an automatic lighter rather than matches. The gas should be turned down as low as possible to light. If using automatic lighters (battery powered), warn students to turn off gas if the appliance does not light quickly.
The open flame of gas cooking appliances increases the risk of loose items such as clothing or tea towels catching fire.	Care must be taken not to leave gas ovens or hot plates with the flame on. A low flame may not be easily visible.

Maintenance

Gas cooking appliances should be wiped clean after use. In some cases, they will need to be cleaned thoroughly. In secondary schools this is the responsibility of the kitchen assistants. In primary schools, cleaners or the teacher using the equipment may do this task. Suitable cleaning substances should be used as oven cleaners can be hazardous (refer to 7.6.4 *Chemicals used in technology*, Cleaners and disinfectants). Hot plates and trays must be removed for cleaning.

6.4.2.14 Refrigerators and freezers

Description and use

Refrigerators and freezers are used to store foods so that they do not deteriorate. Freezers are used to freeze and store foods.

Hazards	Precautions
Discarded refrigerators can be a suffocating hazard.	When discarding an old refrigerator, the door must be removed or made inoperable so that young children cannot become trapped.
CFCs are used in refrigeration as coolants and in the foaming agent in insulation foam.	To protect the environment, and in particular the ozone layer, both coolants and insulation foam must be disposed of suitably. Schools should contact their local council to dispose of unused refrigerators.

Maintenance and storage

Refrigerators should be kept clean and well maintained. Depending on the refrigerator's age, it may be an extra safeguard to have a temperature gauge fitted so that this can be

easily checked. The temperature should be below 5°C and this should be checked once a term with an accurate calibrated thermometer. Teachers should refer to the Keeping Food Safe section of the Food Safety Victoria website at http://www.foodsafety.vic.gov.au. It provides a downloadable Safe Food Storage and Display pamphlet.

Keep refrigerator doors closed tightly. Open when necessary and for short periods. Avoid building up ice in freezer sections. Allow cold air to circulate around the refrigerator. Do not overfill. Ensure that there is enough airflow around the refrigerator or freezer so that it does not overheat. Refrigerators and freezers must never be placed near equipment that generates heat, such as ovens.

6.4.3 Fabric preparation equipment

6.4.3.1 Electric irons

Description and use

Irons may be used to iron on transfers or computer-generated images, prepare fabrics for production or to finish a finished product. Students should be taught the safe use of irons. Only older primary students will use irons and this must be under close supervision and after thorough instruction.

Hazards	Precautions
The high temperature of electric irons means they are a burning hazard.	Students should keep away from the ironing area while others are ironing. Warn students to treat all irons as hot. Irons should be turned off as soon as ironing is finished and should not be left unattended. Students should know the type of fabric they are ironing and use the recommended setting to avoid fabric burns.
Irons can injure students or damage floors if dropped or cords tripped over.	Use a stand or a lock on the cord of the iron to avoid the iron falling. An iron that has been dropped may have to be discarded. Position cords so they cannot be tripped over. Wind the cord around the cold iron to store it away. Use a stable surface such as an ironing board or table with a suitable cover when using the iron.

Maintenance and storage

Irons must be cold, disconnected from the electricity, and emptied of water before storage. The iron plate must be kept clean by using a non-toxic iron cleaner occasionally to clean the surface. Ironing boards need to be checked for stability. Irons with frayed cords must not be used. The cords must be replaced.

6.4.3.2 Sewing machines

Description and use

Sewing machines are used for joining and decorating fabrics. Students should be taught the safe use of sewing machines and correct sewing techniques.

Only one student should be assigned to work at each sewing machine. This allows enough room for safe movement and operation as well as for proper supervision of the student. Do not more sewing machines to be used than can be adequately supervised.

In the primary classroom, adults can use the sewing machine for students. Older primary students may use sewing machines under supervision.

Hazards	Precautions
Fingers can be injured if accidentally placed under the sewing needle.	Students should be taught how to feed fabric through the machine with their fingers well away from the needle. When working on fine techniques, they should use basting or pinning to secure fabrics so fingers do not have to be close to the machine needle.

Maintenance and storage

Students using sewing machines independently need to be shown how to thread needles and fill bobbins. Turn off the machine when replacing needles and machine attachments. The teacher replaces sewing machine needles for primary students. Refer to manufacturer's instructions on oiling the sewing machine and use only sewing machine oil.

Sewing machines should have a cover to keep off dust when it is not in use. Sewing machine without covers should be stored in a clean safe place. Sewing machines should be serviced annually by a qualified service technician.

6.4.3.3 Overlockers

Description and use

Students should be taught the safe use of overlockers. As the threading of the overlocker is difficult, instruction in and supervision of the threading procedure is important.

Only secondary students should use the overlocker as operating the machine is difficult for primary students. The same safety procedures apply to the overlocker as to the sewing machine.

Maintenance and storage

Overlockers should have a cover to keep off dust when not in use. Sewing machine without covers should be stored in a clean safe place.

Overlockers should be serviced annually by a qualified service technician.

6.4.3.4 Electric presses

Description and use

An electric press is used to iron fabrics and clothing items. It is efficient because of the large pressing surface and adjustable pressure. Students should be taught the safe use of the electric press and correct pressing techniques. These machines will generally be kept in the textiles area. As with all other electrical appliances, the teacher should be familiar with the operating instructions and ensure that instructions on use and specific safety procedures are followed.

Maintenance and storage

If the electric press is not permanently set up, it should be stored so that the surfaces and cords are not damaged.

6.4.3.5 Electric cutters

Description and use

Electric cutters are used to cut quickly and easily through one or several layers of fabrics. A number of designs are available. Students should be taught the safe use of electric cutters and correct cutting techniques. When buying a cutter choose cordless designs with guarded blades. It is recommended that primary students do not use electric cutters.

Hazards	Precautions
Electric cutters can be a cutting hazard.	As blades are sharp, it is recommended that only students with well-developed manual skills use them. Show students how to use the cutter correctly. They must keep their free hand clear of blades. With scissor-action blades, the safety guidelines will be the same as for scissors (refer to 5.2.1 *Cutting tools*, Scissors). Care must be taken to prepare materials and clear the table of items that could be cut accidentally. Keep cord clear if the cutter is not cordless.

Maintenance and storage

Store cutters in suitable containers with blades guarded. Take care that power cords are kept in good condition.

6.4.3.6 Washing machines and tumble dryers

Description and use

Washing machines and dryers may be used when students work with fabrics. Students should be taught the safe use of washing machines and dryers. Washing machines that cut off power when the lid is lifted are safer because they prevent items being caught in the spinning propellers.

Maintenance and storage

Remove lint from dryers after use. The washing machines filters need to be cleaned regularly. Warn students about the dangers of water and electricity. The power point and switches should never be touched with wet hands.

6.5 Portable power tools

Portable power tools used in schools include low-risk tools such as engravers, pyrographs and cordless drills. The use of portable power tools in schools and the community in general has grown greatly. Portable power tools can however be a source of both mechanical and electrical hazard unless correctly maintained and used. They should be lubricated according to manufacturer's instruction. The type and size of power tools should suit the job and the capabilities of students.

It is the teacher's responsibility to know the equipment's safety features, applications and limitations set out in operating manuals. Ensure that students follow manufacturer's safety precautions. Instructions may need to be copied and laminated for student use.

Remind students to revise instructions before using the power tools. Work should be secured in a vice or clamp to keep hands free to operate tools. Students should stand in a balanced position when using power tools.

Do not use accessories or attachments unless the power tool manufacturer recommends their use on the product. Do not use anything requiring the removal of or defeating of any guards, barriers or other safety-related devices. Unplug tools before installing, adjusting and changing any accessory or attachment.

A powered hand tool should be of the single-purpose type, of robust construction, and used only for the purpose for which it was designed.

The tool should be placed in a suitable store when not in use after the serviceability of the tool has been at least checked visually for damage to parts and attachments (AS 1485-1983, 7.3.1 General requirements).

Portable electric power tools and extension leads should be checked periodically by a qualified electrician. The check should include an earth continuity test by a high current testing device (AS 1485-1983, 7.3.1 General requirements).

Power tools should have a non-detachable flexible cord that complies with *AS 3191* Approval and test specification – Electric flexible cords. The cord should be kept short to avoid tripping and damage and prevented from contacting sharp objects. If possible, rather than running power cables along the floor, they should be run at a high level and dropped down to the workstation. Where 240-volt portable power tools are used on a supply system not protected by core-balance earth leakage protection, each tool should be protected or double insulated. Double-insulated electric tools can help to reduce the chance of electric shock. Extra safety precautions are built into the power unit during manufacture. Power tools should never be carried by the cord.

Power tools must be turned off and unplugged before adjusting or working on them. Avoid dangerous environments such as damp, wet or explosive areas when using power tools.

The same care taken with power tool cords should be followed when recharging cordless power tools. The tools must only be recharged in their own specified charging unit. Ensure that students know that because a cordless tool does not need to be plugged into power to operate, it can function whenever the switch is inadvertently or deliberately turned on. Do not operate cordless tools near flammable liquids or in gaseous or explosive atmospheres. Motors in these tools normally spark, which may ignite fumes.

6.5.1 Portable circular saws

Description and use

Portable circular saws are used for rapid cutting of timber on site. They can cut along or across the grain depending on the blade used. They are considered high-risk machines and safety precautions must be carefully followed. Teachers must be familiar with the manufacturer' instructions on safe use. Only senior secondary students may use portable circular saws. These students must be fully instructed on the safety hazards involved, trained in the safe use of the machine, and closely supervised.

A portable circular saw shall be provided with guards incorporating fixed and automatically adjusting parts which when in use cover the saw blade teeth clear of the work, and when withdrawn from the work cover the teeth completely around the periphery of the saw blade. No device for locking the guard in the retracted position should be permitted or used.

The device provided on the saw for controlling power shall be such that power is cut off when the pressure ceases to be applied. AS 1485-1983, 7.3.3.

Hazards	Precautions
Serious injuries can occur if the free hand is close to the blade.	Hands must be well clear of the blade if holding work. Work should be clamped to avoid the need to hold it. Do not hold small pieces.
Power cords can be a tripping hazard. A jerk on the cord can cause loss of control of the saw.	Take care that the cord is not stood on or tripped over by others. For maximum control, hold the saw firmly with both hands after securing the work. Circular saws should not be too heavy for students to control.
Power cords can be an electrical hazard.	Before starting the saw, make sure the power cord is away from the blade path and long enough to complete the cut.
Unstable work can cause loss of control of the saw.	Check the work to make sure it is secure. Avoid cutting small pieces that cannot be clamped properly or materials on which the saw shoe cannot rest. Use safer methods to cut these materials.
Dust and particles can enter eyes.	Students should always wear safety goggles, safety glasses or a full-face shield when using portable circular saw.
The saw can kick back if the blade jams.	Release pressure on trigger and stop cutting if the blade jams. Do not force the saw through materials. Feed in wood gently, letting the blade cut at its own speed. Keep the bed of the saw flat against the wood and avoid twisting the blade. Ensure the blade is sharp and the correct type for the job.
Blades can break when making a partial cut or if power is interrupted.	Release the trigger immediately and don't remove the saw until the blade has come to a complete stop.
The noise levels produced by portable circular saws relate directly to the condition of the motor and blade. They pose a noise hazard that may increase depending on the materials being cut and can exceed 110 dB(A).	Students should wear ear protection while using a portable circular saw. Prevent extended exposure to the noise. Use the saw away from main work areas, or saw in an isolated room. Investigate quieter methods of working. Quieter saw blades can be bought. A band saw may be a suitable alternative or a sharp handsaw can be used on small work.

Maintenance and storage

It is good practice to allow the blade to reach full speed before contacting the work. Keep blades sharp and use the correct type of blade with teeth spacings to suit the task. Dull blades cause binding, stalling and possible kickback. They also waste power and reduce motor and switch life. Teachers should ensure that students fit the correct blade for the application. Unplug the saw before changing blades.

The blade guard must operate properly. It should be checked before each cut. Check that the guards return to their normal position quickly. Never defeat the guard to expose the blade.

Inspect and replace bearings and brushes, tighten loose parts such as blade covers. Roll up cord when not in use.

6.5.2 Portable drills

Description and use

A portable drill is a power version of a hand drill. The rotation of the drill bit is controlled by a trigger and powered by mains electricity or rechargeable batteries.

Hazards	Precautions
High speed rotation of portable drill poses a hazard to users' hair, clothing or jewellery.	Students must tie back long hair, secure loose clothing when using the drill. They must keep heads and hands clear of machine when in use.
Dust and particles can enter eyes when using the drill.	Students must wear eye protection such as goggles or safety glasses when using the drill.
Chuck key accidentally left in drill will become a dangerous projectile when drill is turned on.	Students must ensure that chuck key is removed after inserting a drill bit.
Hands can be injured if drill and/or work catches and spins.	Students should always secure material to be drilled. This may be to the workbench. Larger items being drilled should be secured to prevent the drill vibrating. Avoid drill designs that trap fingers.
Drill can be accidentally turned on while inserting drill bits.	Students must turn off the drill at the power point while changing drill bits to avoid injuries.
Drill bit and work can become hot. Build up of heat can damage the drill.	Lift drill out of the work occasionally. Small items should be clamped or secured and not held by hand. A suitable lubricant (such as soluble oil) can be used to prevent build up of heat.
Forcing of drill can overheat motor, drill bit can be damaged, and operator control reduced.	Students should not force the drill. If it slows, they should reduce pressure. If it jams, they should reverse direction as the drill itself may rotate and burn out the engine. Check the drill bit before proceeding.

Hazards	Precautions
When using drill to insert screws, it can catch and pull out of the hand of operator.	Use screwdriver only in cordless drills. These have less torque than other portable drills and gears can be set so that drill stops and spins when screw is fully tightened rather than trying to continue to spin the screw.
Metal shavings can cut fingers.	Warn students not to handle shavings. Remove chips and shavings from drill table with brush.
Depending on what is being drilled, drills can produce high noise levels. Hammer drills for masonry produce the highest noise levels.	Portable drills vary in noise output according to type. Better quality drills are quieter. Use pedestal or cordless drills where possible. If noise levels are high, ear protection should be worn. Use sharp drill bits. Blunt drill bits squeal and produce more noise. Use a suitable speed for the task. Do not force the drill by using excessive pressure. When drilling metal, ensure that it is firmly clamped near drilling area. Dampen sheet metal to prevent vibration. Small sandbags placed on large sheets or against metal boxes can reduce noise. Increase distance from tool to ear.

Students must be shown the correct way to insert and tighten a drill bit and to ensure that it is running straight to prevent it breaking. A suitable size drill bit needs to be secured in the drill chuck and the chuck tightened securely. The drill should be turned on to test that the drill bit is running straight. Students must mark the centre of the hole to be drilled with a centre punch to guide the point of the drill. Place scrap wood beneath the material being drilled so the drill can pass through without damaging other surfaces. Doweling jigs may be used to accurately guide drill accurately into end-grain of timbers.

Maintenance and storage

Bearings, bushing and brushes should be checked for wear. Regular maintenance both reduces noise and extends the tool life. Store in a dust-free, dry storage area with the cord loosely wound. If auxiliary handles are used, ensure they are securely installed.

6.5.3 Belt and orbital sanders

Description and use

Portable sanders usually have a sanding belt, pad or a disc. They are used to smooth timber surfaces quickly. The belt sander is used for rough sanding and usually has a small dust bag attached. The orbital sander is used for finer sanding. Using exhaust-type systems or bag collection is recommended.

Hazards	Precautions
Dust created by sanding is an inhalation hazard.	Students must be protected from dust by wearing a dust mask. Refer to 8.1.10 *Materials list,* Wood for information on avoiding inhalation of dust. Due to the large amount of dust created by sanders, students must wear respiratory protection such as a dust mask or a respirator. If possible, use an individual dust collector on the sander or work beneath a ventilation system or over a downdraft ventilation system.
Dust and particles can enter eyes.	Students should always wear safety goggles or safety glasses with side shields.
Portable sanders can injure fingers if they contact moving parts.	Make sure work is secured and keep hands and fingers away from moving parts and abrasives.
Heavy pressure can cause work to burn or gouge and overloads motor.	Use light pressure when sanding.
If switch locks are used, the machine can take off across the bench when turned on.	Ensure switch is off before connecting the sander to power. Discourage the use of switch locks.
Hand-held belt sanders range in noise level from 92–103 dB(A). The quality and condition of the tool directly affect noise levels. The free running noise of the belt sander is often higher than the working level.	Hearing protection should be worn. Clamp down work to a benchtop and if possible use a rubber mat under work to reduce vibration transmission. Switch on sander just before contacting the surface to avoid free-running the tool. Keep the sander at arm's length. Stand on steps or a footstool when sanding high work to avoid sander being at head height. A fixed sander/finisher is quieter than a portable sander. Hand sanding is quieter than machine sanding. Encourage students to work carefully with timber, thereby reducing the amount of sanding needed.

Use correct grade and type of abrasive. Excess glue should be scraped off before sanding as it can ruin the abrasive disk, pad or belt. Allow the tool to reach full speed before applying to the work. Portable sanders must be held with both hands, exerting an even pressure as it is worked across the wood surface. Too much pressure may dull the abrasive and cause clogging, glazing and stripping of the abrasive. Use whole surface of the abrasive to spread wear evenly.

Sand along the grain as cross-grain scratches show up under stains and clear finishes. Remove dust while sanding to prevent the abrasive becoming loaded or clogged with dust, which can burn the work. Removing dust enables faster sanding.

Maintenance and storage

Rub frequently with sponge rubber or foam plastic block to keep the abrasive clean. Disconnect machine from power to fit new abrasives and make adjustments. Remove dust from motor ventilation slots with a vacuum cleaner.

Replace worn sanding belts as they can tear and raise noise level. Replace rubber belts on orbital sanders when worn to prevent vibration transmission.

6.5.4 Routers

Description and use

A router is a high-speed cutting tool used to shape, mould, groove and rebate timber. Different cutters are fitted to produce decorative edges or cut trenches or grooves. Routers can be extremely hazardous machines. Only fully trained and supervised senior secondary students should use a router.

Hazards	Precautions
The high speed cutters of router can cause serious cutting injuries.	Make sure students know how to operate the router correctly and safely. They must keep hands and fingers and power leads away from router cutter.
Fixing router on a bench with cutter facing up transforms it into a fixed machine (spindle moulder), making it extremely hazardous.	This technique is not recommended in secondary schools. Special tables can be bought for this purpose, which reduces the hazard, but caution must still be exercised in using them.
Routers create large amounts of dust, posing an inhalation hazard.	Students must wear respiratory protection such as a dust mask or a respirator. They must also wear safety goggles or a face shield. Work should be done beneath a ventilation system or over a downdraft ventilation system.
High torque of the motor can twist the machine out of hand.	Hold router with both hands with cutter away from the work when it is switched on. In most cases, better control is obtained by pulling the router rather than pushing it.
A router placed on bench with its motor running can take off across the bench top, damage benches or cause a cutting hazard.	Always switch of the router when not in use.
Cutting grooves too deep will overload the motor.	Try not to exceed a 5mm cut. To avoid overheating the motor, cut wide grooves and trenches using a bit slightly wider than half the recess and making two passes. For deep grooves and mortises, adjust the cutter depth for about 8mm deep cut at each pass.

Hazards	Precautions
A slow feed can cause wood to burn and overheat the cutter.	Keep the base pressed flat on the surface of the work. Maintain a steady cutting pressure that does not slow the motor too much.
Routers can produce noise levels up to 101 dB(A). Forcing the router can increase noise levels above this, lessening recommended exposure time. Small routers tend to scream.	Use gentle pressure and don't hurry to cut timber. Do not force the tool through the timber. Quieter routers are available. Larger routers operate at lower RPM than small routers. The router can be mounted in a box lined with acoustically absorbing material to reduce noise levels.

Before starting work, make sure work is fixed securely to the bench. Start cutting when router has reached its full speed. The router is generally used with its base pressed down on a horizontal surface. A guide is needed to control movement. The cutter rotates in a clockwise direction.

The feed speed depends on hardness of the timber, power of the motor, and size of bit used. Switch off before lifting the router when making stopped trenches and grooves. When rebating and trenching, a piece of scrap wood clamped to the edges of work will prevent it chipping and splitting where the cutter breaks through.

When setting the router, select the correct cutters and matching guide pin, and check that eccentric cutters are balanced and securing screws are tight. Isolate the machine, then lock spindle, insert and tighten cutter securely, then unlock the spindle and check free rotation.

Set cutter depth and depth stops, insert guide pin, lock in position and check seating in template. Clear all tools from table, insert piece in jig, place jig over guide pin and adjust guard. Run through a complete cutting sequence without switching on the router to become familiar with the correct movements. Set correct cutting speed before turning on and carrying out the work. Switch off, using brake to stop cutter.

Maintenance and storage

Switch off and disconnect power when fitting cutting pieces to the router. Make sure nuts and screws securing them are properly tightened before use. Store cutters in container when not in use.

Ensure blades are sharpened regularly and that bearings and brushes are in good order. Forcing a blunt bit tends to stall the tool, burning the work.

6.5.5 Jigsaws

Description and use

A jigsaw is used to cut circles and irregular shapes and also for cross-cut sawing and ripping. The blade cuts on the upward stroke. Press the jigsaw firmly on the surface, keeping the sole plate flat.

Hazards	Precautions
Jigsaws can be a cutting hazard.	Hand should be kept on the handle and not holding the material being cut. Work should be securely clamped.
The jigsaw blade may snap if saw is not used correctly.	Choose correct type of blade and make sure it is sharp. Ensure that blade does not touch the bench, vice or other clamping devices. Hold work securely to prevent vibration or flutter. Do not force the blade through material. Do not lift the blade out of the cut while the saw is running.
Table-mounting of jigsaw turns it into a fixed machine and allows the blade to be exposed and unsupported, causing a greater cutting hazard.	This technique is not recommended in secondary schools. Special tables can be bought for this purpose, which reduces the hazard but caution must still be exercised in using them.

Maintenance and storage

Disconnect the jigsaw from the power source and store it in its holder. Keep clean and dust-free. Ensure blade is not clogged.

6.5.6 Biscuit jointers

Description and use

Biscuit jointers cut a semi-circular slot in board edges for accurate jointing of work. Plywood 'biscuits' allow a slight lateral movement, while maintaining perfect vertical alignment of work components. They are stronger and easier to align than doweled joints. The biscuits swell in contact with PVA or water-based adhesives to ensure a tight joint.

Biscuit jointers are permanently guarded. The blade is not exposed until it contacts the wood. Settings need to be tight.

6.5.7 Scroll saws

Description and use

A scroll saw uses a mechanical coping saw action and a fine blade to cut plywood and thin plastics. The plastic visor guard should be set close to work and the pressure should be adjusted to prevent the work from vibrating. When the blade is installed properly, the teeth face downwards. This machine may be suitable for older primary students to use under close supervision.

Hazards	Precautions
Dull blades or a speed too fast can burn wood and melt plastic.	If possible, slow speed of scroll saw. Candlewax can be dropped on difficult corners on work and will reduce friction and cools mechanical parts.

6.5.8 Portable grinders (angle grinder)

Description and use

Portable grinders are widely used to work with metals. Accessories include polishing pads, sanding discs and wire wheels. The machine requires close supervision as it can be extremely hazardous if used incorrectly.

Hazards	Precautions
Grinder's main hazard is particles thrown off the wheel into eyes.	Students should wear safety goggles or a facemask to avoid getting grit and dust in eyes while using a grinder.
Work can slip, causing loss of control of grinder.	Work should be secured with clamps or a vice before grinding.
Loose clothing, hair and other items can become caught in a grinder.	Students should secure loose items, clothing and hair.
Portable grinders can cause serious injuries if the grinding wheel (or attachments) contacts skin.	They can cut through clothing. Students must take care not to get exposed skin near the operating grinding wheel. Never use a grinder in an awkward position where it can contact the body (for example, do not use it between the legs while sitting on the floor).
Portable grinders pose a noise hazard that can increase depending on materials being ground. A worn or out of round disc produces more noise than a good disc.	Students must wear ear protection while using a portable grinder. Maintain an arm's length between grinder and ear. Dampen the material being ground or cut by clamping work as close as possible to the work area. If using the grinder in a grinding bay, line surfaces with acoustic absorption materials to reduce reflected sound. Mobile screens around the work area will reduce sound transmission.
A worn or out of round disc is unsafe.	Discard worn discs. A sound, undamaged wheel will have a clear metallic tone or ring when tapped gently with a light non-metallic instrument.
The disc can shatter at high speed.	Use correct disc for the material. Do not use undue pressure when using the grinder. Keep grinding disc at a 15 to 30 degree angle to work so that it is working on its edge. Never bump grinder on to the job, or let the disc hit any other object while grinding. Teachers should check that flange and locking nut are correct for the type of disc being used.

Hazards	Precautions
Too much pressure will cause the grinder to dig in and kick back.	Hold the grinder against work with minimum pressure.
Portable grinders can create sparks.	Students should wear skin protecting clothing and sturdy shoes. Ensure that no students are in the area where sparks will fall. Use mobile screens to contain sparks in one area. Grinders should not be used on containers that have held flammable materials or near substances that can be ignited with a sparks.

Students using the grinder should stand comfortably, feet apart and well balanced, and with a clear view of the job. It is good practice to allow the grinder to run up to operating speed before applying it to the job. Students should stop the grinder at regular intervals for a short break to rest their arms and hands. It is recommended to use only the grinders with automatic cut-off switches as part of the hand-grip. This cuts the power off as soon as finger pressure is released. Disconnect the power when not in use and when changing blades. Put the grinder on a bench with the disc facing upwards when not in use. Never put a grinder down until the disc stops rotating.

Maintenance and storage

The angle grinder should be checked for electrical safety before every use. Ensure that there are no cracks or other damage to the machine's casing, all screws are tight, brush caps are intact and firmly in position. The angle grinder should be inspected and tagged by an electrician at least once every 12 months.

6.6 Fixed electrical equipment for material preparation

Large fixed machines are in permanent positions, usually on the floor or a bench. They are usually heavy duty, able to process a wider range of materials than hand tools or portable power tools. The power must be disconnected if a teachers is not in the room or if an 'extra' is taken in the room.

6.6.1 Cutting equipment

6.6.1.1 Bench shears

Description and use

Bench shears can cut metal up to 5mm thick. They work on the same principle as tin snips. The metal to be cut rests on the lower cutting edge and the long handle, which creates greater leverage, is pulled down forcing the top cutting edge through the metal. Do not close the blade completely as this distorts the material being cut.

Hazards	Precautions
Bench shears can cut hands if used carelessly.	Only one student at a time should use the equipment. Fingers and hands must be kept clear of cutting mechanism.

Maintenance

Lubricate moving parts of bench shears as required. Blades may need sharpening over time.

6.6.1.2 Electric shears

Description and use

Electric shears are used instead of tin snips or aviation snips. They allow rapid cutting of sheet metal or thin flat bar. It is recommended that students do not use this machine in an inverted position.

Hazards	Precautions
Electric shears can be a cutting hazard.	Care must be taken to keep hands clear of the cutting edges. Ensure that handle lock-pin is inserted in the machine after use.
Work can become jammed in the blade if it is tilted by the cutting action of the blade.	Secure material being cut so that it does not tilt.
Noise levels exceed 90 dB(A).	Hearing protection should be worn. Small sandbags placed on large sheets can dampen vibration. Use in a machine room and away from other students. Cut close to the area being clamped and don't force tool through the work. Keep tool at maximum distance from the ear. Use hand shears for small jobs or a guillotine where possible.

Maintenance

Replace blunt blades or have them sharpened regularly. Replace worn bearings and bushings as these may contribute to tool noise. With some tools only the blades are replaceable. Have the brushes checked and replaced if worn. Excessive sparking from the motor normally indicates worn brushes, which can result in damage to the commutator.

6.6.1.3 Metal lathes (centre or engineer's lathes)

Description and use

A metal lathe holds and spins lengths of steel allowing them to be shaped with cutting tools. Instruct students in stages on the safe and correct way to use a metal lathe. Metal lathes will only be used in secondary schools and only after thorough instruction.

Hazards	Precautions
The spinning lathe means loose clothing, hair, jewellery and hands can become caught.	Students must tie back long hair and secure loose clothing and jewellery. Keep heads and hands clear of machine and material while lathe is operating. Never use cotton waste or rags near moving machines. Ensure guards on gear trains, back gears, pulleys and belts are in place. Ensure that the machine is turned off before making adjusting speed, work, tools, belts or taking measurements.

Hazards	Precautions
Dust and particles can enter eyes.	Students must wear eye protection. A face shield is recommended.
Metal shavings can be a cutting hazard.	A brush (and not hands) must be used to sweep away chips and shavings from machine and tray. A dustcoat will prevent shavings becoming embedded in students' clothing. Machines should be fitted with a splashback to prevent hot metals being propelled onto students working at an adjacent lathe.
The cutting tool can be propelled from the lathe.	Make sure the cutting tool is held securely and the cutting edge is sharp.
The chuck key can be propelled from the lathe at high speeds if not removed after use.	Make sure students learn the habit of removing the chuck key and placing it in the rack.

Set a sequence of tasks for students to perform under close supervision before allowing them to set up the lathe themselves. Provide a list for students to refer to before using machines. Before switching on the lathe, students must check that the:

- chuck is free to rotate by turning it by hand
- saddle is free on the bedways
- work is held securely in chuck
- key is removed and replaced in rack
- cutting tool is securely held and cutting edge is sharp
- guards and covers are in place
- tail stock is secure if working between centres.

The lathe speed will depend on the work being done and metal being cut. Students should learn to adjust the lathe speed to suit the procedures used. Use lower speeds where possible and balance offset work.

Maintenance

Oil and maintain gears regularly. Turn machine off when it is being cleaned and oiled. Frequently used cutters need regular regrinding. They must be kept in good condition.

6.6.1.4 Wood turning lathes

Description and use

A wood lathe holds and spins lengths of wood allowing them to be shaped with cutting tools. Instruct students in stages on the safe and correct way to use a wood lathe. Wood lathes will only be used in secondary schools and only after thorough instruction.

Hazards	Precautions
The spinning action means loose clothing, hair, jewellery and hands can become caught.	Students must tie back long hair, secure loose clothing and jewellery. Keep heads and hands clear of machine and material while lathe is operating. Never use cotton waste or rags near moving machines. Polish is applied with a pad of folded fabric. Ensure that all guards are in place.
The chuck key can be propelled from the lathe at high speeds if not removed after use.	Make sure students learn the habit of removing the chuck key and placing it in the rack.
Cutting tools can become jammed in wood being turned.	Ensure tools are sharp before starting work. Ensure tool rest is clamped tight and set as close as possible to the timber (2–3mm) to avoid leverage of the tool.
Wood being turned can break and fly off.	Ensure work is held securely. Set appropriate speed for diameter of wood.
Dust and particles can enter eyes.	Students must wear eye protection. A face shield is recommended.
Wood turning creates dust, which is an inhalation hazard.	Students should wear a dust mask or an appropriate respirator.

Set a sequence of tasks for students to perform under close supervision before allowing them to set up the lathe themselves. Provide a list for students to refer to before using machines. Before switching on the lathe students must check that:

- speed is checked and is suited to the diameter of the wood being turned
- the spindle is free to rotate by turning it by hand
- work is held securely in chuck
- tool rest is clamped tight and set as close as possible to timber (2-3mm)
- turning tools are sharp
- key is removed and replaced in rack
- all guards are in place
- tail stock is secure if working between centres
- tool rest is removed before sanding or finishing.

The lathe speed will depend on the diameter of wood being cut. Start lathe at the slowest speed when turning to create the general shape. Speed can be increased as wood is shaped. Students should learn to adjust the lathe speed to suit the procedures used. The machine must be stationary and switched off when speed is being adjusted. Stand to one side when the power is first turned on. Grasp the turning tool firmly with both hands, holding it firmly against the rest.

Maintenance

Maintenance bearings and belt drives regularly. Check fence nuts and bolts need to be checked and replaced if worn. Older lathes may need lubrication. Later models have sealed bearings.

6.6.1.5 Circular metal cutting saws (drop saws)

A circular metal-cutting saw is used for cutting off lengths of metal.

Hazards	Precautions
Circular metal-cutting saws pose a cutting hazard.	Clamp all work securely before cutting to avoid hands contacting the blade.
Blades can break if not used correctly.	Do not use excessive pressure when cutting. Allow more time and feed the blade into the cut. Clamp work securely.
Dust and particles can enter eyes.	Safety goggles or full face shield must be worn.
Circular metal-cutting saws are high-noise machines. Noise levels produced are in excess of 100 dB(A) at the operator's ear.	Good hearing protection is required. Keep work at arm's length from the body. The increased distance helps reduce noise at ear. Clamping all work before cutting helps reduce noise. A less noisy alternative is a power hacksaw.

Maintenance

Ensure coolant supply is full. Check the blade for security and the blade chamfer to avoid work jamming. Lubricate gearbox as required. Swarf screen should be kept clean.

6.6.1.6 Power hacksaws

Description and use

A power hacksaw is designed to cut sections of metal stock and thick sections of metal. It has an oscillating blade (moves back and forth) cooled with a jet of coolant. The metal stock must be firmly secured in the built-in vice before cutting. When cutting long lengths, both ends must be well supported. A power hacksaw is a less noisy alternative to a drop saw.

Hazards	Precautions
The blade can break or teeth can break off stock smaller than 13mm diameter is cut.	Do not cut stock smaller than 13mm diameter. Use alternative methods of cutting for these.

Maintenance

Lubricate the power hacksaw once a week when in regularly use. Make sure the cutting compound reservoir is kept filled.

6.6.1.7 Circular bench saws

Description and use

Circular saws are used for sizing timber before machining. A circular bench saw has a flat work surface through which the blade protrudes. It is fitted with fences and guides and a blade that can be raised and lowered. It is used primarily for ripping along the grain but

can also cut mitres, trenches, rebates and bevels. Circular bench saws are considered high-risk machines and safety precautions must be followed. Teachers must be familiar with the manufacturer' instructions on safe use. Only senior secondary students may use a circular bench saw and then only when they have been fully instructed in the safety hazards involved, fully trained in the safe use of the machine, and work under close supervision.

Hazards	Precautions
Circular saws spin at high speeds and can cause serious cuts to hands.	Keep fingers clear of the path of the blade. Use a push stick when ripping narrow pieces of timber and to clear scraps of wood. See that all guards and other safety devices are in the correct position. Use the ripping fence or crosscutting guide at all times. Where necessary use an assistant to tail out.
Circular saw blades can break if not in good condition or used correctly.	Make sure blade is sharp and free from any cracks or other blade defects. Ensure saw is firmly bolted in place and free from vibration.
The blade can overheat or jam and belts can break if timber is forced. Wood can burn if pressure is too great.	Apply moderate pressure and feed material only as fast as saw will freely cut.
Noise levels produced by fixed circular saws can be in excess of 100 dB(A) depending on the type of blade used and the hardness of material being cut.	Good hearing protection must be worn. Quieter saw blades can be bought. Feed in timber gently, allowing blade cut at its own speed. Keep timber flat against the bed of the saw and avoid twisting motions. Prefer a handsaw for small jobs.

Maintenance

Stop machine before making any adjustments and clearing wood and disconnect power if necessary. Do not allow removable guards to be removed. Long arm guards will allow larger pieces of material to be cut.

Teachers choose and mount the correct saw blade for ripping or cross cutting. Use the correct type of blade with teeth spacings to suit the task. Saw blades should be reconditioned as required by a trained service person. Most blades are now tungsten-tipped and require professional sharpening. Tighten any loose parts, such as belt and blade safety guards. Replace worn bearing and belts.

6.6.1.8 Bench drilling machines

Description and use

A bench drill performs the same functions as the hand drill and portable drill but it can drill through thicker and harder materials. A rotating handle lowers it into the work. Only secondary students will use the bench drilling machine.

Hazards	Precautions
Drill's speed of rotation poses a hazard if hair, clothing or jewellery caught in the drill.	Students must tie back long hair, secure loose clothing and jewellery and wear eye protection. They must keep heads and hands clear of the machine when it is running.
Drill bit and work being drilled can become extremely hot. The build-up of heat can damage the drill.	Drill should be lifted out of the work occasionally. Small items should be clamped or secured to avoid holding them by hand. Using a suitable lubricant such as soluble oil may also prevent build-up of heat.
A chuck key accidentally left in the drill will become a dangerous projectile when the drill is turned on.	Students must ensure that the chuck key is removed after inserting a drill bit.
Work can get caught or spin on drill causing a hazard to hands.	Teach students how to activate the emergency stop button. Teach students ways to hold work safely when drilling. A hand vice will hold small items securely. A machine vice can be bolted to the drill table to hold work being drilled. Do not allow students to hold materials in hands while drilling.
Bench drilling machine can pose a noise hazard depending on the materials being drilled.	Teachers monitor noise levels and advise students to wear ear protection when necessary.
Dust and particles can enter eyes.	Students must wear safety glasses or goggles while drilling. The drill must have a polycarbonate guard that is pulled down to shield the user from swathe flying off.
Drill can slip off work.	Students must use a centre punch to mark centre of hole to be drilled as guide for the point of the drill. When drilling large-diameter holes, a smaller sized hole should be used first to prevent large drill wandering across the work.
Shavings formed when drilling metals can cut fingers.	Warn students not to handle shavings. Remove chips and shavings from drill table with brush.

Check that the drill runs true and does not 'wobble' before drilling. Drill speed should be checked. Small drills are used at high speed while large drills should be slower to prevent drill damage. Wood being drilled should be rested on scrap to prevent the drill bit from reaching the drill table. Depth stop is used to drill holes of a set depth. A horizontal boring machine is used to drill holes into the board edges at a consistent distance from the face (used for dowelled joints).

Maintenance and storage

Turn off machine before belt speeds are changed. All guards must be in place before machine is started again. Keep floor around machine clear of shavings or chips. Stop machine before removing chips and shavings from the drill table with a brush. Return clean drill to a drill rack and clamping devices to their storage place.

6.6.1.9 Horizontal borers

Some schools may use a horizontal borer, a machine used to drills holes horizontally into timber and used for dowelled joints. It is similar to a drill in function and students must wear safety glasses to protect eyes from materials thrown off.

6.6.2 Shaping equipment

6.6.2.1 Bench grinders

Description and use

A bench grinder consists of a motor with a spindle on each side fitted with abrasive wheels. The grinder is a potentially dangerous machine and teachers must make students aware of the hazards involved in using it. Only students in the middle or upper years of secondary schools will learn to use the grinder.

Hazards	Precautions
The grinder's speed of rotation poses a hazard to hair, hands, clothing or jewellery, which may get caught.	Students must ensure that jewellery, hair and clothing are secured. Hands must be kept away from the wheel while it is in motion. Do not allow students to wear gloves or hold work with rags while using the grinder. These may get caught in the wheel and pull hands into the grinder. Avoid grinding small items. Students should not use pliers to hold small items. A hand vice or similar locking grip can be used. Small lathe tools are held in a tool holder. Bench grinders should be against a wall and students should never lean against the machine or stand behind it.
Flying sparks and grit may hit the operator.	Students must wear eye protection (safety goggles, glasses or full-face shields) to protect their eyes from grit and metal particles. Students should wear also protective clothing and sturdy shoes. Ensure safety shields are in place to protect operator from flying grit and sparks of hot metal. Wheel guards, which surround most of the wheel, provide further protection.

Hazards	Precautions
Grinders pose a noise hazard. Noise levels of bench and pedestal grinders vary with the work being done. Grinding large pieces of metal makes much more noise than touching up a drill bit.	Students must wear ear protection when using a grinder. Check that the grinder is firmly bolted to the bench and parts are not vibrating. Use contact adhesive to glue 6mm of sheet, such as rubber belting material, to the top of the tool rest. On top of this cement a new tool rest of metal plate or other durable material. A partial enclosure can be built to cover the machine. Avoid forcing the work against the grindstone. Hold the work firmly against the tool rest to avoid chattering against the grindstone. Fine grindstones produce less noise than rough ones. Encourage students to cut work accurately to minimise grinder use. Small work can be filed instead of shaped on the grinder.

Maintenance

Choose correct grinding wheel for the metal being ground. Students must ensure that all shields and guards are in good condition and in position before working. Tool rest must be set close to the grinding wheel (no more than 3mm away) and adjusted as the wheel wears down.

The abrasive wheel consists of grit that breaks down with use. Students should grind work evenly across the face of the wheel and never use the wheel side. The grinding wheel requires dressing with a wheel dresser when the surface layer of grit has become dulled or glazed. Truing squares the face of the wheel. Check that new grinding wheels are in good condition when changing them over.

6.6.2.2 Forge tools

Description and use

Forge tools include anvils, hammers, tongs, scale brushes, and tool rack.

Hazards	Precautions
Dust, scale, metal particles, hot sparks can enter eyes.	Eye protection must be worn while working at a forge. The heating medium should be stored dry and free of foreign bodies.
Burns can occur from hot metal, tools and furnace sparks, flames.	Students should wear leather gloves, leather aprons and sturdy shoes when handling hot metal and tools. Handle hot metal with correctly fitting tools.
Hammers may fall if not used or carried properly.	Care should be taken when transporting forge tools, which should be quenched and stored in a rack when not in use. (Refer to 4.3.3 *General hazards*, Manual handling of tools and equipment.)
Fumes from heated metals and heating medium can be hazardous if inhaled.	Fumes must be extracted through a flue directing them to the outside atmosphere.
Forge tools can pose a noise hazard when they impact on metals.	Monitor noise levels and have students wear ear protection when necessary.

6.6.2.3 Centrifugal casting units

Description and use

A centrifugal casting unit enables precise casting of metals such as silver and gold. It includes stainless steel casting flasks and a vibrating table. The unit has a casting arm on a central axis with counter-weights on one side and the crucible and flask on the other. A spring-activated device spins the arm at high speed, forcing the molten metal into the flask.

Hazards	Precautions
The flask containing the plaster mould and wax model is heated to extremely high temperatures in a kiln to melt the wax out of the cast. It can cause burns. (Refer 7.6.7 *Chemicals used in technology*, Dyeing, Wax.)	The flask must be removed using suitable tongs and fireproof gloves that fully protect hands and forearms. Never allow the flask to become cold as it cannot be reheated.
Molten metal splashes can occur if too much metal is poured into the cast, impurities are present in the metal or the sprue or mould are not designed to allow metal to flow freely.	A full-face mask is recommended to protect from molten metal splashes. Metal should be clean (free of solder and other particles). A magnet can be passed through it. Metal to be melted must be carefully weighed so that there is no excess. The sprue and jewellery design must allow metal to flow around the mould easily.

The actions needed for casting to be a success and the safety precautions involved should be clearly explained to students and kept on display. The casting unit arm must be balanced with the counter-weights. Crucible and flask must line up and their sizes must match. The metal in the crucible needs to be slightly molten before winding the arm around and locking with a safety catch. When the metal is molten, the safety catch is released. Make sure the torch has been moved away and that nothing stands in the way of the arm's arc.

When casting is complete, the flask is cooled by immersing in a container of water.

Maintenance

Keep crucibles in good condition and free from cracks. Check before use and replace if necessary. Keep machines clean and free of debris.

6.6.2.4 Bending machines

Description and use

Bending machines come in different types and can bend steel to almost any angle. Some are adjustable and allow for the bending of box shapes. Magnabenders use strong electro-magnets to hold the work rather than the adjustable fingers on the Pan Brake-style machine, which does not have guarding. The maximum thickness of metal that can be folded (the capacity) must be checked before bending metal.

Hazards	Precautions
Hands can become caught in the bending machine. Magnabenders can exert great pressure.	Students must keep hands clear of the folding mechanism. Only one person should operate the machine at a time to avoid hands being trapped.

Hazards	Precautions
Magnets in magnabenders may affect watches or pacemakers.	Remove watches. Warn students who have a pacemaker. Work can be done by another student or teacher.
The weight on the machine can injure students in its path.	The area where the weight moves should be kept clear of students.

Maintenance

Moving parts need occasional lubrication and maintenance. Individual fingers can be tightened and the width adjusted on some models.

6.6.2.5 Benders (tube benders, bar benders, mandrel benders)

Description and use

Most tube benders support the outside of the tube with a follower and a former supports the inside. Mandrel benders provide internal and external support for precise bends. Bar benders will bend strap metal. Metal needs to be annealed if sharp angles are required.

Hazards	Precautions
Tubing can require a lot of pressure to bend. The force required can cause a fall backwards if students lose their grip. Students need room to move when bending tubing.	A second student should assist. Students must make sure they have a good grip when preparing to bend.

Maintenance

Moving parts need occasional lubrication and maintenance.

6.6.2.6 Rolling machines

Description and use

A rolling machine forms sheet metal into cylindrical or conical shapes by feeding it over rollers. The capacity is 1.0mm material.

Hazards	Precautions
Hands can become caught in rollers.	Students must keep hands away from the rollers. Only one student should use the machine at a time.

Maintenance

Moving parts need occasional lubrication and maintenance.

6.6.2.7 Swaging machines

Description and use

A swaging machine bends or shapes cold metal using a stamp or die for marking or shaping metal with a hammer. It is considered a low-risk machine. Rotary swaging reduces the cross-sectional area or shape of bars, tubes or wires by repeated radial blows with one or more pairs of opposed dies. Cold swaging, done at room temperature, is effective for thin-walled materials and smaller reductions. Cold swaging can improve the strength of metal.

Hot swaging is done at precise temperatures, which allows for greater reductions on heavy-walled difficult alloys.

Maintenance

The swaging machine should be maintained to according the manufacturer's instructions. Mechanical parts must be lubricated as required.

6.6.2.8 Milling machines

Description and use

A milling machine uses a rotating cutter to shape, cut and profile metal. Reamers and slot drills are the cutting tools used. The work is fixed to a table that can be moved in relation to the cutter. It is considered a high-risk machine and used only by senior secondary students. Safety precautions must be carefully followed. Teachers must be familiar with the manufacturer's instructions on safe use. No students must use a milling machine unless fully instructed on the safety hazards involved, fully trained in the safe use of the machine, and closely supervised. Teachers should check set-ups before students begin work.

Hazards	Precautions
Milling machine's spinning action machine can cause operators to be pulled into it.	Ensure loose clothing, hair and jewellery are secured. Guarding must be in place.
Milling machine can cause serious cutting injuries.	Keep hands away from moving cutters. Machine must be stopped before adjusting or changing cutters.
Crush injuries can occur between the table and blade.	Do not lean against or rest hands on the moving table.
Work can be thrown from machine.	Ensure work is securely clamped before starting machine.
Steel shavings can injure eyes and hands.	Students must wear eye protection such as safety goggles or a face shield.
Metals can become extremely hot when being milled, causing blade to break.	Before beginning work, ensure coolant will make contact with metal.

Check depth stop is accurate and used. Speed to the feed has to be correct or the cutter can become clogged or blunt.

Maintenance

Keep table clear. Check condition of equipment parts (gears, spindles, and chucks) and remove attachments (vices, clamps and bolts) from the table when not in use. Ensure adequate coolant supply.

6.6.3 Finishing equipment

6.6.3.1 Polishing machines (buffing machines)

Description and use

A polishing machine, like the grinding machine, has two spindles that rotate at high speeds. Both spindles are fitted with brushes or mops used to polish or texture metal or plastic. Mops are made of cloth (linen or muslin) or swansdown (fluffy wool). Mops are coated with a buffing compound suited to the finish required and the metal or plastic being polished.

Hazards	Precautions
High speed rotation causes hazards of hair, clothing or jewellery being caught in the polishing machine.	Students must tie back long hair and secure loose clothing and jewellery when using polishing machine. They must keep heads clear of the machine when it is operating. Cloth or cotton waste must not be used to hold work. Polishing machines should be against a wall and students should never lean against the machine or stand behind it.
Students' work can be pulled from their hands, causing cuts.	Students must be shown how to hold work against the underside of the wheel to prevent it being pulled from their hands. They should polish evenly from the centre downwards, turning work as necessary. Extra care is needed when polishing corners, concave shapes and sharp edges of work. Guards behind the buffs prevent work being flung away from machine if pulled from students' hands. Students must turn off polisher to retrieve work pulled from their hands.
Dust and particles can be thrown off the polishing wheels and enter eyes.	Students should wear safety glasses.
Items such as chains or items with sharp edges are hazardous to polish. They can pull hands into the polisher and cut fingers.	If students need to polish items such as chain, they must be wound around a flat piece of wood to provide a backing to polish against. Use a small polishing wheel of about 50mm.
Brushes are much more abrasive and extra care must be taken not to touch them.	Keep mops on machine and attach brushes only when needed.
Work gets extremely hot while it is being buffed.	Warn students to allow work to cool at intervals while they polish it. When polishing acrylic, keep the item moving to avoid overheating.

6.6.3.2 Pendant drills

Description and use

A pendant drill has a flexible shaft driven by a small electrical motor. It is usually operated by a foot control, so hands are free to hold work and the hand piece. Interchangeable chucks hold drills of different sizes, small grinding points and polishing wheels.

Hazards	Precautions
Due to the drill's high spinning speed, loose items can get caught.	Students should secure long hair and loose clothing and jewellery when using the machine. Turn off the machine when changing over attachments.
Grit and dust can be thrown off the machine.	Safety glasses must be worn.

Maintenance and storage

Keep the flexible shaft lubricated. Do not use gloves or rags to hold the hand piece if it gets hot. Allow machine to cool for a few minutes. Slide guard fully downward to cover the rotating chuck.

6.6.3.3 Linishers/sanders

Description and use

A linishing sander combines a disc and belt sander. It is used to shape and smooth end-grain and finishing materials.

Hazards	Precautions
The abrasive surface can injure hands if contacted.	Show students how to hold work so fingers do not contact belt or sanding disc. Devices can be used to hold or locate the work against the machine. Small, hard to hold objects can be secured with grip made from masking tape.
Dust and particles can enter eyes.	Students must wear eye protection such as safety glasses or goggles.
Dust created is an inhalation hazard.	Work area should be well ventilated. Individual extraction systems can be used or a downdraft system. Teachers can refer to 8.1 *Materials list*, 8.1.10 Wood and 8.1.8 Plastics. Students should wear a dust mask or respiratory protection.

These machines are not normally a noise problem. Use correct grade sandpaper for the task. Hold work firmly to prevent it vibrating. Hand sanding is a quieter alternative to machine sanding. Work should be planned so minimum sanding is required.

Maintenance and storage

Ensure that linisher/sander is bolted down firmly and that all belt covers and associated parts are secure. Inspect belt drives and main bearing for wear. Promptly replace torn or worn sanding discs or belts. They will also influence noise levels.

6.6.4 Plastic forming equipment (plastic strip heaters, vacuum formers, injection molding equipment)

The main hazards with equipment used to heat and form plastic are fumes and hot materials and surfaces.

Hazards	Precautions
Hot plastic and equipment can be a burning hazard when using a plastic forming equipment.	Teachers must explain how to safely handle hot and molten materials. Students should wear safety glasses and protective, heatproof gloves. Lifting devices should be used to transfer materials. Forming jigs should be close to the thermoformer and the area kept clear of other students. Ready access to water is essential in the case of accidental burns.
Fumes from heated plastic are an inhalation hazard (refer to 8.1.8 *Material list*, Plastic).	Adequate ventilation is vital in vicinity of plastic forming equipment to protect students from toxic fumes caused by heating plastics. Local exhaust systems are preferable.

6.6.4.1 Thermoformers (vacuum forming, blow forming)

Description and use

A thermoformer forms heat-softened acrylic and other thermoplastic sheet material into a range of shapes through mechanical or pneumatic processes or a combination of these. Plastics are heated in the swivelling hood of the thermoformer. It is important that heating units have temperature controls so that plastic is not overheated.

Maintenance and storage

Keep covers on machines to avoid dust entering and clogging filters. Vacuum chamber occasionally. Avoid having machine in a dusty environment.

6.6.4.2 Vacuum forming machines

Description and use

A vacuum forming machine is used with a wooden or plaster mould in a vacuated chamber to create a range of shapes in thermoplastic material. It eliminates the need to handle hot material, as the sheet remains firmly clamped during the heating and shaping process. Undercut angles on moulds should be avoided to allow easy removal. Always finish with a blow action to ensure that the plastic releases from the mould.

Maintenance and storage

Keep machine covered when not in use to avoid accumulation of dust in the chamber. Do not leave clamps on when machine is not in use as rubber will become indented.

6.6.4.3 Blow moulding tables

Some schools may have blow moulding tables. These have holes drilled in a central area. Beneath the table below the holes is an airtight box connected to a hose with an air control tap and gauge and an air compressor. Blow moulding is used to produce hollow products. In schools, it is often used to form dome shapes.

Hazards	Precautions
Blow moulded plastics can explode if over-pressurised, which creates a high decibel noise.	Watch material and turn off air supply if a weakness or distortion appears. Students can wear ear protection as a precaution while blow moulding.

6.6.4.4 Plastic injection moulders

Some schools may have plastic injection moulding machines or use basic methods for injection moulding.

Hazards	Precautions
Molten plastic can be a burning hazard.	Warn students never to touch molten plastics.
Heated moulds and mouldings can be a burning hazard.	Heatproof gloves should be worn when handling hot moulds and mouldings.
Some plastics are unsuitable for use with injection moulding machines.	Polystyrene, polyethelene and polypropylene are commonly used. Polyvinylchloride should not be used as it can break down, causing chlorinated gases. Do not use plastics that absorb water from the atmosphere (hygroscopic) or burn and break down in the heater chamber.
Silicone release agent can be an inhalation hazard.	Silicone-release agent should be sprayed onto mould parts in a fume cupboard.

6.6.4.5 Strip heaters

Description and use

A strip heater is used to heat a narrow area of thermoplastic sheet material until flexible by placing material over the heater's electric element.

Secondary students will use a strip heater. If senior primary students use a strip heater, it will usually be in a secondary school setting under close supervision.

The distance between the heating element or the support tubes and the material determines the width of the area heated. The closer the plastic is to the heated strip, the narrower the band of plastic heated. Various width slots can be cut into metal plate and used to regulate the area being heated.

Hazards	Precautions
The strip heater can become extremely hot and pose a burning hazard.	Warn students not to hold their fingers over the strip heater element or touch hot parts. Do not run the strip heater for long periods. Disconnect it and allow it to cool. The cooling time for a strip heater is long.

Maintenance and storage

Clean gap between supports periodically to prevent build up of dust, which may catch fire.

6.6.4.6 Hot-air welding guns

Description and use

Hot-air welding guns generate hot air (a little like a hairdryer) and are used to fuse thermoplastics. The temperature can be controlled and is directed through different shaped tips.

Hazards	Precautions
The hot air and nozzle can be a burning hazard.	Students should point nozzle away from themselves and others.

6.6.4.7 Hot-wire cutters

Some schools have used hot-wire cutters to cut polystyrene but the fumes produced by styrene are extremely hazardous and this process is not recommended. The activity could be isolated in a fume cupboard to avoid fume inhalation. Refer to 7.6.12.6 *Surface treatments*, Glass fibre reinforced resins, for information on styrene.

6.7 Gas equipment

Technology students may use a range of gas equipment, such as soldering torches, oxy-acetylene welding equipment and gas ovens or hotplates. Gas equipment must be used with great care to avoid burning and explosion hazards.

Lines, manifolds, regulators, fittings and hoses should be inspected and tested at regular intervals for serviceability. Tubing used for gas torches should be flexible and suitable for use with natural or LPG gas. Hoses should be maintained to avoid leaks and risk of explosion. Before using gas soldering or welding equipment, check that gas hoses do not have holes or splits. Faulty taps should not be used and promptly repaired. The seals of bayonet-type gas outlets are prone to deterioration and may develop leaks. Replace with turret-type gas outlets.

Explain to students that they must report the smell of gas or any suspected gas leak to the teacher. Warn students not to light matches if there is a smell of gas in the area. Butane burners should only be used under strict supervision.

Give students explicit instruction in lighting up, operating and closing down gas appliances. Gas taps should be turned off when not in use. All gas welding equipment should be turned off at the cylinder when not in use. Older secondary students should check equipment before use and report any faults to teachers. It is the teacher's responsibility to maintain a safe learning environment.

6.7.1 Gas torches

Description and use

Gas torches are used to heat metals and for brazing and soldering. Students should be taught the safe use of gas torches and correct soldering and heating techniques. Only responsible secondary students may be allowed to use gas torches.

Hazards	Precautions
Gas torches use a naked flame that can cause items to catch fire.	Use gas torches with caution near clothing and hair. Secure hair and clothing when using torches. Flames should be directed towards work on soldering bench and away from students, gas hoses and pipes. Fire blankets and fire extinguishers should be easily accessible. Always turn off flame when torch is not in use. Never store flammable liquids on or near the soldering bench.

Hazards	Precautions
The torch becomes hot in use, causing a burning hazard if it contacts skin.	Teach students to assume that the gas torch tip is hot and to avoid touching it. Care must be taken when controlling the flame as the sleeve can become very hot.
Heated materials can be a burning hazard.	Teach students to assume work on soldering bench is hot and to handle it with tongs. Soldering bench should be near a sink or container of water to cool work. Ensure that work surface material can withstand high temperatures (for example, firebricks). Firebricks can be used to create a wall to conserve heat and protect other areas from heat.
Explosions are a hazard in using gas.	Take care in lighting gas torch. Gas should be lit with a flame not a spark. Students must be shown how to light and turn off gas torch safely. Never allow students to tamper with the gas supply to the torches.
Overheating can damage work.	Flame should be adjusted to suit the work being heated. Show students how to adjust the flame so that it does not overheat or damage their work.

Maintenance and storage

Students should never use a gas torch with a damaged hose. These should be checked regularly. The gas torch should be rested on its stand when not in use. The flames should be turned off to avoid accidents or reduced to a safe flame between frequent uses by closing air intake.

6.7.2 Bunsen and Meker burners

Description and use

Students should be taught the safe way to use Bunsen burners and Meker burners.

Hazards	Precautions
Hazards involve burns from open flame or heat of the burners after use.	Warn students about leaning across the open flame. Always turn off flame when torch is not in use. Students should always assume burners are hot and ensure that their clothes and skin do not contact them. Fire blankets and fire extinguishers should be easily accessible.

Show students the safe way to light burners. The air collar should be closed before lighting the burner. Burners should be lit with matches. Strips of burning paper must not be carried from burner to another. If the burner is not immediately required, close collar to give a visible luminous yellow flame. When in use, open the air collar to produce a blue flame. This flame is more difficult to see, creating a greater burning hazard. This equipment should only be used with a heatproof mat.

Maintenance and storage

Allow heating equipment to cool before moving or storing away. The rubber tubing can deteriorate. Check for splits and cracks and replace if necessary.

6.8 Oxy-acetylene equipment

Description and use

The oxy-acetylene process produces a high-temperature flame over 3000°C, which is used for heat-treating metal, brazing, fusion welding, cutting and bending. It is the only gas mixture hot enough to melt steel. The extremely high temperature of the flame and the explosive nature of acetylene gas means that extreme care must be taken with oxy-acetylene equipment.

Oxy-acetylene use exposes students to a number of hazards, including toxic fumes, dusts, burns, fires, explosions, radiation, noise, and heat stress. Only senior students considered responsible and safety-conscious should be instructed in using oxy-acetylene equipment. Conduct a thorough induction and training program to teach students of the dangers involved. They must be trained in the safe way to open, light, extinguish, and close down the oxy-acetylene equipment. Provide a checklist for students to follow. Teachers will still decide whether a trained student will be allowed to use the equipment for a particular project or in a particular lesson. Skilled adults may use oxy-acetylene equipment to help primary students in constructing their products (billy carts, pedal powered vehicles).

Hazards	Precautions
Bystanders can be at risk during welding.	Organise a specialist area for oxy-acetylene welding that protects other students from the welding process.
Extremely high temperature of flame and heated material can burn operators.	Students must wear protective clothing while welding. Lighted torch must always point away from themselves and others. They must not leave gas flame unattended. Always light flame with approved lighter (flint or electronic spark) so that fingers are not brought close to tip of torch. Students must wear sturdy leather gloves when handling materials being welded. All heated work should be marked with word hot on the metal in chalk or soapstone.
Extremely high temperature of flame and heated material can cause fires.	Combustible or flammable materials should not be near welding. When work cannot be done in a welding bay, area should be made safe by removing or protecting combustibles from ignition sources. Fire extinguishing equipment such as sand buckets, fire blankets or dry chemical extinguishers should be readily available.
Dense concrete base or asbestos cement base may explode when heated.	Benches used for welding should be covered with firebrick or similar materials.

Hazards	Precautions
Toxic fumes created by welded metals are a major hazard. Metals such as nickel and chromium found in different grades of steel create fumes that may cause lung cancer. Tin, copper and galvanised metal have hazardous coatings.	Students should not weld metals that are considered hazardous or which have hazardous coatings. (Refer to 3.2.8 *The learning environment*, Ventilation.) Welding and cutting should be done in an area with adequate ventilation that removes and disperses fumes to outside atmosphere. Local exhaust ventilation is required for certain metals.
Brazing rods can give off zinc and copper fumes and some silver solder contains cadmium. Fluxes can produce hazardous substances when heated (refer to 7.6.10 *Chemicals used in technology*, Solders and fluxes).	Welding and cutting should be done in an area with adequate ventilation that removes and disperses fumes to outside atmosphere.
Containers that have held flammable materials can explode if welded.	Under no circumstances should students weld drums, barrels, tanks or other containers.
Oxy-acetylene flames are bright, can create sparks and produce UV rays.	Tinted welding goggles must be worn. The filter grade to use depends on the intensity of the flame, which depends on the thickness of metal being welded. Safety goggles protect eyes from sparks. Safety glasses are worn when work is being cleaned.
At a pressure of over 100kPa acetylene 100kPa becomes unstable and can explode.	Keep acetylene flow pressure below (15p.s.i.). The pressure for regulator should be set to suit size of blowpipe tip. Correct tip and pressure must be used for task being performed.
A backfire (pop or crack) can occur if flame ignites gases inside nozzle and extinguishes itself.	Avoid holding torch too close to work. Regularly check nozzles and regulator pressures. If the flame still burns, valves need to be systematically closed down and torch relit.
A flashback (shrill hissing) can occur if flame burns inside torch. Flame can pass back through torch mixing chamber to the hose.	Flashback can be avoided through correct: • closing-down procedures • tip selection • gas pressure. Also ensure students do not used dirty welding or cutting tips. Avoid incorrect gas pressures, which give too low a gas velocity. If a flashback occurs, close oxygen blowpipe valve first, then close fuel gas valve. It is essential to examine torch, hoses and components and replace if necessary. Arrange inspection of equipment by qualified personnel before relighting. Non-return valves fitted to hoses will detect and stop reverse gas flow. A flashback arrestor is an automatic flame trap device that quenches flame and prevents it from reaching the regulator.

If oxy-acetylene cylinders are not stored outside the classroom, check that the regulator pressure screw is released, then open cylinder valves gradually. Never open cylinder valves more than one turn. Keep wrench in place in the acetylene cylinders so that the valve may be shut off quickly if necessary.

When using oxy-acetylene equipment students will:

- use equipment under close supervision by a suitably trained teacher or adult
- wear suitable protective equipment, including:
  - oxy-acetylene goggles when welding and safety goggles when performing other activities
  - buttoned-up overalls or similar without cuffs, open pockets, tears or gaps, covering arms and legs to protect from radiation burns and deflect sparks
  - protective gloves
  - solid footwear
- use a flint lighter or pilot light to light the blowpipe
- close cylinder valves when work is finished.

Maintenance and storage

Gases are supplied under high pressure. The colour coding is maroon for acetylene and black for oxygen. To prevent interchange of fittings between cylinders, oxygen cylinders have a right-hand thread and acetylene cylinders have a left-hand thread. Both cylinders are opened by turning the key or knob anti-clockwise and closed by turning clockwise.

Cylinders should preferably be stored in open air but always in a well-ventilated area, away from sources of heat, sparks, and other fire risks. The acetylene cylinder should always be stored upright (refer to 7.6.8 *Chemicals used in technology*, Gases). Each bottle should be secured to a wall by a removable chain with fixed lines feeding to the gauges. Oxygen cylinders should be stored at least three (3) metres from fuel gas cylinders or separated by a 30-minute fire-resistant barrier in a designated no-smoking area. Sets of gas bottles should not be stored in the school. One set is enough and it should be replaced as emptied.

Gas supply hoses must be protected from sparks, naked flames, hot metal, and sharp objects. Hoses should be as short as possible. Do not use damaged or frayed hoses.

Check gauges annually and replace every five (5) years. Regulators are sensitive instruments and should be handled with great care. Teachers should always double-check students' operation and setting of regulators.

Blow tips, which should suit the task, must be cleaned regularly with a set of reamers. Occasionally brush the end of the tip with a fine abrasive cloth. It is important for students to be taught the maintenance of oxy-acetylene equipment so that they will follow safe practices when working away from the school.

Oxygen can react violently with oils and grease. Do not use lubricating oils or sealant for the threads. Cylinder threads should be clean and free from oils and undamaged, especially for oxygen use. Never grease regulator threads. Use only clean rags to wipe this equipment. Close cylinder valves before moving cylinders.

6.9 Welding equipment

6.9.1 Spot welders (resistance welders)

Description and use

A spot welder is particularly useful for joining sheets of metal. Electrodes convey a flow of electricity through the metal. The metal is brought close to melting point and the pressure of the electrode points causes the sheets to join where they meet. Spot welders can be portable or fixed. Only secondary school students thoroughly instructed in its correct and safe use may use a spot welder. Primary school students may have a trained adult use a spot welder to help construct their products.

Hazards	Precautions
Heat generated by electrodes causes metal to become red hot, creating a burning hazard.	Students must wear sturdy leather gloves when handling materials being welded.
Too light a pressure causes the welder to spit.	Pressure needs to be correct for the weld to succeed. By reducing point pressure, more heat is created.
Machine can be overloaded.	Do not exceed capacity (the number of welds per minute) of welder.

Maintenance

Keep electrode points clean and in good condition. They must meet exactly and be parallel. Tips of electrode points need to be machined to a 3mm diameter flat point. Over-size tips will reduce heating, while small tips will burn the weld.

Check points often for deterioration while in use. A file can be used to shape the tips. A lathe is used to machine the points if the tips become oversize after constant use and repeated dressing.

6.9.2 Electric arc welders

Description and use

An arc welder is used to join metals by creating an electric arc that melts the edges of the joint. The arc welding electrode acts as a filler rod. Arc welding involves working with electricity, molten metal and sparks and produces rays extremely dangerous to the eyes. Using the arc welder improperly can expose the operator to hazards that include toxic fumes, dusts, burns, fires, explosions, welding flashes, electric shock, radiation, noise, and heat stress. Only students considered responsible and safety-conscious should be instructed in using arc welding equipment. In most cases these will be senior students. Conduct a thorough induction and training program to teach students of the dangers involved. Provide a checklist for students to follow. Teachers will still decide whether a trained student will be allowed to use the equipment for a particular project or in a particular lesson.

Hazards	Precautions
Bystanders can be at risk if near welding. Arc welding creates a flash hazardous to unprotected bystanders.	Organise a specialist area for electric arc welding that protects other students from the welding process The welding area must conform to *AS 1485-1983*, 12.5 Electric Welding. *The walls of the welding compartment should be non-reflecting or be finished with a non-reflective surface. Where portable screens are used, they should be durable and stable, and constructed of fire resistant material*. The arc welder should be in an area with adequate ventilation (refer to 3.2.8 *The learning environment*, Ventilation).
The high temperatures created by an arc welder can cause fire.	Floors must be of a non-combustible material. Cracks should be filled to prevent sparks and hot metal from entering. Combustible or flammable materials should not be near welding activities. When work cannot be done in a welding bay, the area should be made safe by removing or protecting combustibles from ignition sources. Fire extinguishing equipment such as sand buckets, fire blankets or dry chemical extinguishers must be readily available.
Dense concrete base or asbestos cement base may explode when heated.	Weld only on a firebrick surface.
Extremely high temperature of the heated material and the sparks created by arc welding can burn operators.	Students must wear protective clothing while welding. They must wear sturdy leather gloves when handling materials being welded. All heated work should be marked with the word *Hot* on the metal in chalk or soap-stone. Hot metal should be carefully quenched to prevent steam burns.
Toxic fumes created by welded metals are a major hazard. Metals such as nickel and chromium found in different grades of steel create fumes that may cause lung cancer. Tin, copper and galvanised metal have hazardous coatings.	Students should not weld metals considered hazardous or which have hazardous coatings. (Refer to 3.2.8 *The learning environment*, Ventilation.) General ventilation may be adequate for welding of short duration and intermittent. Ventilation must remove fumes and disperse them to outside atmosphere. Removal at source (local exhaust extraction) is the most effective method. The degree of exposure to fumes depends on welding position, location, and type and duration of work. Students must work with their heads away from the plume. Several students welding at one time create greater quantities of fumes.

Hazards	Precautions
Arc welding electrodes create toxic fumes.	See notes on ventilation above. Choice of welding rod affects composition and quantity of fume and gases. A range of welding electrodes is available – some safer than others. Strictly follow manufacturer's instructions for the use of the welding electrodes.
Welding in confined spaces can create build-up of toxic fumes.	School students should never work in confined spaces or enclosed and unventilated areas.
Containers that have held flammable materials can explode if welded.	Under no circumstances should students weld drums, barrels, tanks or other containers.
Electric shocks can occur during welding.	When welding is finished, remove electrodes from the holder. Hang holder where no accidental contact can occur and disconnect welder from power source. Position welding cables so that sparks and molten metal cannot fall on them. Prevent electric shock hazards such as wet or damp areas and standing areas made of steel or other conductive materials. Warn students of these dangers in case they weld away from the school.
Debris such as electrodes and electrode stubs can be a slipping hazard.	The welding area must be kept clear of tripping and slipping hazards.
The flash created by arc welding is extremely hazardous to eyes.	Warn students always to wear a welding face shield when welding and never to start weld without it in place. Never use a helmet with a cracked or broken filter plate or cover lens.
Slag chipped off welded materials and dust particles are hazardous to eyes.	Safety goggles must be worn when students are chipping off slag or cleaning work.

When using electric arc welding equipment students must follow the following rules:

- Only use the equipment under close supervision by a suitably trained teacher or adult.
- Protect their eyes from the welding flash by wearing an approved face shield fitted with the correct filter lenses for the welding process used.
- Wear safety goggles when chipping slag or wire brushing the finished bead.
- Wear suitable clothing to protect against heat, ultra-violet rays and sparks. This includes:
  - buttoned-up overalls or similar without cuffs, open pockets, tears or gaps, covering arms and legs to protect from radiation burns and deflect sparks. Clothing should be buttoned up and gaps avoided
  - leather gauntlets to protect arms and hands from UV radiation and spatter burns

- solid shoes with leather spats to prevent hot material entering shoes
- leather apron to protect clothes and body from spatter burns
- flame-proof cap if there is a danger of ignition and tied-back hair.

- Ensure that ventilation systems are working or that the area is well ventilated (this is also the teachers' responsibility).

Maintenance and storage

Turn off welder when work is being changed. Keep leads, lead terminal, supply leads and plug and hand-piece insulation in good condition. Check before beginning work. Store arc welder in a dry area, under cover. Students should report to the teacher if the electrode holder, holder cable connection, cable terminals at the machine, ground clamp or cable get hot. Make sure circuit-breaker is operating.

Electrodes are coated with flux. Keep them dry by storing in a sealed container.

6.9.3 MIG welders

Description and use

Metal inert gas (MIG) welding is based on a weld pool formed by a bare wire electrode protected by gas (helium, argon). It is used in most industries. The heat for welding is produced by forming an arc between a metal electrode and the work. The electrode melts to form the weld bead. The wire is continuously fed, so the process is referred to as semi-automatic welding. Different methods of welding can be used. Terminal connection differs for gasless welding (steel) and gas shield welding (aluminium and stainless steel).

MIG welders are considered relatively safe compared with other arc and oxy-acetylene welders. Teachers should refer to the section on arc welders for further precautions when welding.

Hazards	Precautions
Heated material and sparks created by welding can burn operators.	Students must wear protective clothing while welding and sturdy leather gloves when handling materials being welded.
Flash created by MIG welding is hazardous to eyes.	Warn students always to wear a welding face shield when welding and never to start the weld without it in place. Never use a helmet with a cracked or broken filter plate or cover lens.
Welded metals can create toxic fumes.	Students should not weld metals considered hazardous or which have hazardous coatings. General ventilation may be adequate for welding of short duration and intermittent. Ventilation must remove fumes and dispersed them to outside atmosphere. Removal at the source (local exhaust extraction) is the most effective method.

The shielding gas has a substantial effect on the stability of the arc and metal transfer and the behaviour of the weld pool. Care in setting voltage and feed of the wire is essential to control spatter and to perform welds.

Maintenance and storage

Maintain the MIG welder according the manufacturer's instructions. Check that controls are operating correctly before use. Ensure hoses are stored without kinks. Check that they are in good condition and not perished.

6.10 Compressed air equipment

Compressed air may be used to operate a range of tools such as spray guns, portable drills, power wrenches, portable grinders, power chisels (metal), descaling tool, sanders, and nail guns. These tools are used in much the same way as those powered by electricity and the same safety precautions should be observed. Only secondary students should use power pneumatic tools and equipment.

Misuse of compressed air can create very serious hazards, including the danger of loss of life or serious injury. *Compressed air must be used with caution.... Any warning notices required by competent authorities should be prominently displayed (AS 1485-1983*, 3.4).

6.10.1 Air compressors

Description and use

Air compressors supplying air to tools and equipment range from portable to large fixed machines. Students may use an air compressor when spray painting equipment or in pneumatics. All air hoses must have self-sealing fittings to prevent personal injury from an open-air hose. Compressors must be fitted with functioning relief valves and a suitable regulator. Teachers should refer to the equipment sections for information about the hazards in using compressed-air tools. All equipment should conform to Australian Standards. Teachers must monitor noise levels. Some equipment will make more noise than others. This is specified in the information related to the equipment in this section. Ear protection must be work if noise levels or exposure are excessive.

Hazards	Precautions
Serious injury or death can occur if compressed air is directed at the body, causing air bubbles to enter the blood-stream.	Compressed air should only be used for the intended purposes. It should not be used to clean machinery or benches, personal cooling or to blow dust from hair or clothing. It must never be directed at any part of the operator's or the body of anyone else.
Airborne dust and particles can be an eye hazard.	Students must wear eye protection when using compressed air.
Whipping of air hoses can injure operators.	Air hoses should have pistol-type nozzles and be securely held to prevent whipping.
Compressed air can propel material at high speeds.	Warn students not to misuse the supply of compressed air. Explain that only responsible students will be allowed to use this equipment.

When starting up the machine, ensure that the compressor is stable and on level ground. Release any remaining air in machine. Before starting, ensure that one valve cock is open. Start motor and allow to warm up.

Maintenance and storage

Store the compressor in a safe place with hoses rolled up and ends coupled together to ensure that foreign matter does not find its way in.

A qualified service person should inspect and test air compressor storage tanks, lines and fittings regularly. Maintenance of gauges and gas lines is extremely important. High pressure air can escape through burst service pipes, cylinders or tubing. Make sure that hoses are correctly connected and that all connections are tight. Leaking air lines should be repaired as soon as detected. Air filters should be cleaned. If using the compressor to spray paint drain the moisture trap or the paint finish will be affected.

Air pressure in compressors and pipelines should not exceed manufacturer's specifications. It should be regulated to the minimum pressure that will properly operate the equipment in use.

6.10.2 Spray guns

Description and use

A spray gun is used with an air compressor to paint items requiring a smooth finish such as car body parts or bicycle frames. Spray painting is the application of paint or other finishes using a spray gun.

Hazards	Precautions
Paint fumes and paint particles are an inhalation hazard. Spray painting causes drops of paint to be dispersed across a wide area.	Spray painting must be done in a properly constructed and ventilated spray booth. (Refer to 3.2.8.3 *Ventilation*, Spray booths.) Paint should be sprayed away from students and work placed beneath the ventilation system. Turntables can make this easier. Test spray guns by directing spray toward fan ventilation system and not booth walls. Keep exhaust system running for at least five minutes after spraying is completed. Clean equipment in spray booth with ventilation system running. Place clean-up materials in steel bins with close-fitting lids. Remove waste each day and dispose of in safe manner.
Paints and coating materials can emit toxic fumes.	Students should use only non-toxic paints and coating materials. Avoid combining materials that may spontaneously ignite (bleaching compounds with organic finishing materials). Students must wear respiratory devices in accordance with *AS/NZS 1716:1994*, Respiratory protective devices when using epoxy resin or polyurethane. Avoid lead-based paints. Clean equipment between uses. (See 7.4.2 *Restricted chemicals*, 7.4.2.1 Cadmium, 7.4.2.4 Lead and 7.6.12 Surface treatments.)

Hazards	Precautions
Fumes from paints, solvents and coating materials are flammable.	No naked flames or sources of ignition (electric heater, pilot lights, static electricity) should be near spray paint or spray booths. Fire extinguishers should be close by and suitable for materials being used. Do not use synthetic fabrics as polishing cloths as they cause static electricity. Avoid using combinations of substances that may combust spontaneously together. Dangerous combinations are lacquers containing nitrocellulose with varnishes, oil-based stains, air-drying enamels and primers. All deposits of material should be removed and exhaust ducts cleaned before spraying with the second substance.
Paint fumes and mist can enter eyes.	Students must wear safety glasses or goggles when spray painting.
Some paints, solvents and coating materials are a skin absorption hazard. Exposed skin can be coated by airborne paint particles.	Students must protect their skin from contact with paint and other substances by wearing overalls and head coverings. Barrier cream on hands and face will ensure spray can be easily cleaned off. Disposable or rubber gloves can be worn. Protective clothing should be stored away from spray area.
Paint on hands can be ingested. Food can be contaminated by airborne paint particles.	Students must wash faces and hands after working in spray the booth. Food and drink must not be stored near spray booth.

Maintenance and storage

The spray gun should be kept clean and free from an accumulation of residue. They should be cleaned with the ventilation system running.

6.11 Automotive equipment

Secondary students may be involved in monitoring, maintaining, testing, adjusting and repairing machines such as motor vehicles, lawn mowers, and engines. Students should be taught correct manual handling techniques if they have to move machines (refer to 4.3.3 *General hazards,* Manual handling of tools and equipment).

6.11.1 Vehicle hoists

Car hoists are used to lift motor vehicles to allow under-vehicle inspection and repair. Two-post hoists are commonly used in schools. The older four-post hoist must meet safety standards for locking. Approved hoist inspectors should inspect them annually. Students should be trained in the safe use of hoists. Only middle to senior secondary students will use vehicle hoists.

Hazards	Precautions
If a vehicle hoist fails, vehicles can drop onto students.	Safety locking equipment must be operating properly at all times. Support for the platform must be provided in case of equipment failing. Do not situate work benches under suspended hoists.
Feet can become trapped by the descending platform.	A means should be provided to prevent feet being caught under vehicle hoist.

6.11.2 Motor vehicles and motor cycles

Many secondary schools have operating motor vehicles for use in automotive classes. Only licensed drivers should drive these vehicles.

Hazards	Precautions
Loose clothing, hair and jewellery can be caught in moving parts of mounted car engines.	Cover engine fans with suitable guards over fan, pulleys and flywheels.
Engine or car parts can be a burning hazard.	Warn students not to touch motor parts directly with their hands. Exhaust pipes should be protected with perforated mesh.
Engines can produce noise levels in excess of 95 dB(A).	Hearing protection is required when test-running an engine. Check frame mounts and instrument panels for vibration and tighten loose parts. Ensure the engine can run smoothly at low revs. Only run engines with high-performance mufflers fitted. Fitting engine in a car body reduces noise hazard radius.
Exhaust fumes created by motors are an inhalation hazard.	Operating petrol engines can be done in two ways: with the engine connected to suitable exhaust extraction system or with the operating engine outside the workshop to allow dispersal of exhaust gas. Exhaust to an outside area via ducted exhaust outlets. Run the engine outside if weather permits. Avoid revving motor for long periods.
Engines can be an ignition source when refueling. Fumes or spillage can ignite.	Engines should be turned off before refuelling.
Cooling systems on engines operate at temperatures of up to 120 Celsius. If a leak develops or a cap is removed from a cooling system, scalding water or coolant can erupt violently.	Instruct students on safe use of cooling systems. Allow system to cool down before removing cap.
Contact with electrical shock from a high-energy (electronic) ignition system poses a particular danger to students and staff with heart defects or pacemakers.	Teachers must ensure manufacturer's instructions on testing procedures are followed to avoid electrical shocks.
Asbestos may be liberated during brake and clutch repair.	Students should not attempt these tasks unless vehicle is fitted with non-asbestos brake linings.

6.11.3 Car batteries

A car battery starts the car engine. It filters or stabilizes power and provides extra power for ignition, lighting and other accessories when the load exceeds the charging system's capability (when the engine is idling). A car battery provides power to the electrical system when the charging system is not operating.

Students should be instructed on the safe charging and use of batteries and the safe connection of batteries to avoid electrical circuits. Follow the manufacturer's instructions for testing, jumping, installing and charging.

Hazards	Precautions
Battery acid is highly corrosive and can damage skin, eyes and clothing.	Students must wear protective clothing, gloves and safety glasses when handling car batteries. Suitable carrying tools or straps should be used to move batteries. Eye-wash facilities should be available. Irrigate eyes or skin with water and seek immediate medical advice. Baking soda is an adequate alkaline neutraliser for battery acid. Never use chemical neutralisers on eye or skin burns.
Batteries contain a sulfuric acid electrolyte that produces gases when recharged and explodes if ignited. Liberated hydrogen gas is expelled during charging process.	Avoid sparks, open flames and smoking during recharging. Charging areas should have an air extraction system to remove gases.
Damage can occur to electrical components (computer, radio, charging system) if a battery cable is disconnected with engine running.	Always turn off engine before disconnecting battery cable.

Maintenance and storage

If batteries are not maintenance-free, brush battery posts to clean up any corrosion, then apply petroleum jelly. Check battery case for cracks, one of the causes of battery acid leakage.

6.11.4 Degreasing machines

Secondary school workshops may have degreasing machines to clean parts. Many operate by an electrical motor immersed in the solvent. Teachers should refer to the information on solvents in 7.6.11 *Chemicals used in technology*, Solvents. Students should be instructed in safe use of the degreasing machines.

6.11.5 Dynamic wheel balancers

Dynamic wheel balancers may be used to balance vehicle wheels in secondary school workshops. They rotate wheels at speeds up to the equivalent of 60 kph. Students should be instructed in safe use of wheel balancers.

Hazards	Precautions
Dynamic wheel balancers rotate at high speeds.	Machines should have all safety guards in place.
Wheels can spin loose if not mounted correctly.	Show students correct way to mount the wheel on machine. Teachers should supervise students.
Debris can be thrown off spinning wheel.	Students must wear eye protection to avoid eye injury.

6.11.6 Vehicle jacks

A vehicle jack is a portable tool or machine used for lifting vehicles. Students should be instructed in the safe use of jacks and the use and safe positioning of safety stands.

Hazards	Precautions
Vehicle jacks can collapse if load exceeds their strength.	Vehicle jacks should not be used to support cars while people work under them. Stands strong enough to support car weight must be in place.

Maintenance

Keep workshop floor jacks in good repair and inspected for damage regularly.

6.12 Electrical and electronic equipment

Students are not permitted to work with products that require a voltage greater than 50 volts AC or 120 volts DC (refer to 8.2.1 *Making safe electrical and electronic products*). Students should not be exposed to excessive radio transmission waves or to laser emissions (from dismantled CD players).

6.12.1 Batteries

Description and use

Technology activities may use range of batteries from battery packs, through to car batteries (refer to 6.4.1 *Electrical equipment*). Students should be taught the safe use of batteries and correct connection techniques.

Hazards	Precautions
Licking terminals may lead to electric shock.	Do not allow students to test batteries by licking them. Some batteries come with testing devices.
Rechargeable batteries can become dangerous if discharged quickly or short-circuited. A circuited rechargeable battery (has a wire attached from one end of the battery to other) will heat up and can burn fingers.	Ensure that rechargeable batteries are used properly. Only teachers should be responsible for recharging them.
Damage can occur if the voltage of the battery is greater than the rating of the equipment.	Make sure the battery voltage is not greater than the rating of equipment.
Lead-acid car batteries are corrosive and have flammable by-products.	Lead-acid car batteries should not be used in general technology activities.

Hazards	Precautions
Damage to batteries can result in venting, leakage and rupture.	Batteries should not be crushed, punctured or otherwise damaged. Do not dispose of them by attempting to burn.
Batteries can be short-circuited by small coins and keys.	Do not carry loose batteries in a pocket or purse with metal objects like coins or paper clips. This will short-circuit the battery, generating high heat.
Damage can occur if batteries of different chemistries are used together.	If devices require specific battery chemistry (for example NiMH Nickel Metal Hydride), do not use other battery chemistries even if the same size. Do not mix alkaline and rechargeable batteries.

Maintenance and storage

Store batteries in a cool, dry, place, away from heat, moisture and metal objects. Optimal storage is at room temperature. Extremely high or extremely low temperatures may reduce battery performance. Remove batteries from devices being stored for long periods.

Follow manufacturer's instructions for recharging batteries and use the charger designed for battery. It is normal for batteries to be warm during charging. Prolonged overcharging is not recommended. Do not leave rechargeable batteries discharged or unused for extended periods. Charge at least every 6–9 months to keep your battery fresh.

6.12.2 Electric soldering irons

Description and use

Electric soldering irons are used to solder wires in electrical circuits. Students should be taught the safe use of electric soldering irons and correct soldering techniques. Only senior primary and secondary school students will use soldering irons. Soldering irons should always be used in a well-ventilated area and under strict supervision. Enough space is needed so that hot components do not cause a hazard.

It is recommended that teachers buy low-voltage soldering irons that work off 12, 24 or 32 volts DC power supply and not directly off 240V. More expensive soldering irons are generally more reliable and durable. Soldering stations can be bought that include a transformer and a temperature-controlled soldering iron.

Hazards	Precautions
Soldering irons present a danger because of the high temperatures they reach. Iron tip and shaft of soldering iron remain hot for some time after switched off. They can cause burns, damage work surfaces, and melt plastic-coated electrical cords.	Ensure that the soldering iron is kept in a stand while on and in use to prevent it from damaging work surfaces or falling. Stands must be sturdy and non-flammable. Always work on a non-flammable surface. Show primary students how to prevent soldering iron contacting skin. Clamping or securing work reduces danger of hands being burned by tip of soldering iron. Primary students can wear cotton gloves. Take care to keep cords away from hot tip of soldering irons to prevent damage to cord. Clips can hold cords off the bench or power can be run down from ceiling.

Hazards	Precautions
Fumes from hot solder may contain lead and other substances harmful if inhaled.	Soldering irons must be used in a well-ventilated area. In secondary schools, students can work under a local extraction fan or in a well-ventilated room. In primary schools, students can work near an open window or doorway.
Lead in solder can be ingested.	Students should avoid skin contact with solder and wash their hands after using it. Cotton gloves can be worn to prevent the risk of students putting contaminated fingers in their mouths. (Refer to 7.4.2.4 *Restricted chemicals*, Lead and 7.6.10 *Chemicals used in technology*, Solders and fluxes.)
Most solder contains a core of 'flux' to facilitate good electrical contact. This can bubble and spit when heated and is hazardous to eyes.	Students must wear safety glasses when using a soldering iron.

Maintenance and storage

Leave soldering iron to cool before packing away. In some classrooms, soldering irons will be left out in work areas but stored so that cords are clear and they are switched off at the power point.

6.13 Agriculture equipment

Agriculture machinery refers to hand operated-machines used in agricultural activities. The same precautions apply as for other equipment. Check all frequently used machinery once a week. Establish a farm machinery maintenance program that clearly records when each machinery was last checked and by whom.

When using tools such as drenching guns and vaccinators or on animals, the major hazard will be handling the animal. Use tools according to manufacturer's instructions. Chemicals should be mixed by teachers or qualified adults and safety precautions on instructions followed closely (refer to 7.6.2 *Chemicals used in technology*, Agricultural chemicals).

Students in contact with farm stock must be instructed in proper safety procedures. They must be taught about the physical risks involved in the close contact with large animals, including unpredictable behaviour. High levels of hygiene should be maintained to reduce the risk of diseases being transmitted by animal contact.

Teachers need to assess the risks and hazards of the agricultural environment students work in. Cattle yards and shearing sheds have particular structural and environmental hazards that students need to be warned of. Train students to eliminate and avoid hazards in agricultural environments.

Teachers should contact the Victorian Farm Safety Training Centre (Phone 5334 3510) and the Victorian Farmers Federation, Industrial Department (Phone 9207 5512) for further details. Farmsafe Australia's *Managing Farm Safety* program has detailed information on farm safety. The WEST ED Education and Training, *Rural Injury Prevention Primary Education Resource (RIPPER)* is aimed at primary school students.

6.13.1 Lawn mowers

Description and use

Lawn mowers are used to cut lawns. They may be pushed, motorised or electric. Some schools may have ride-on mowers. Teachers should study mower's manuals. Only middle to senior secondary students will use a lawn mower. Although in everyday use they cause many injuries. Never allow primary students to use a lawn mower.

Hazards	Precautions
Cutting blade can cause serious injury to hands or feet allowed to get under mower deck while blade is running.	Never attempt to unclog or work on a lawnmower while the engine is running. Disconnect spark plug wire to ensure engine cannot start. Students must wear sturdy footwear. Check safety guards on operating mowers. Operator should not dismount from rides on mower while it is running.
Blades can throw up stones and other objects, striking the operator or others in the vicinity.	Students should wear protective clothing such as sturdy shoes, long sleeves, long trousers and safety goggles. Ensure that other students are well way from the mowing area. Grass catcher should be attached at all times as an additional safeguard. Clear area to be mown before starting the mower.
Mowers vary in noise levels.	Hearing protection should be worn. Four-stroke mowers tend to be quieter than two strokes. Low tone mufflers can be used to reduce noise levels.
Mower can roll back onto feet or operator used on a slope.	Push lawnmower across slope. Never pull mower. Ride-on lawn mowers must not be used on terrain that could cause them to roll back.
Refueling the lawn mower while it is hot can cause serious burns.	Always allow the mower to cool before refuelling. Refuel outside in a well-ventilated area and avoid starting mower close to refueling area. Use only approved fuel containers.
Carbon monoxide poisoning can occur if the lawn mower is left running in a confined space such as a garage.	Always start mower outdoors so dangerous gases cannot accumulate.

In some workshops, repairing lawn mowers is a regular task. Teachers should remove blades from mowers not required to cut grass after repair.

Maintenance and storage

Ensure that covers are securely fastened and that muffler and throttle are in good working order. Make sure the blades are free running and not striking guards. Keep blade sharp to reduce power required. Run engine at lowest speed needed to do job. Machines operating efficiently require higher revs and make more noise. Mark normal operating revs on throttle control. Ensure the correct petrol/oil mixture is used.

6.13.2 Brushcutters/whipper snippers

Brush cutters and whipper snippers are used to clear areas such as around trees and rockeries that mowers cannot reach. A whipper snipper uses a feed wire spinning at high speed to cut material. A brushcutter has a metal blade and poses a greater hazard to the operator. Only middle to senior secondary students fully instructed in their correct and safe use can use brushcutters or whipper snippers.

Hazards	Precautions
Brushcutter blades and whipper snipper wire spin at high speeds. The blades pose a cutting hazard.	Students must wear sturdy shoes or safety footwear. Chaps should be worn if cutter blades are used. Operate brushcutter or whipper snipper away from the body.
Debris and particles can enter eyes.	Students must wear safety glasses or goggles when using a brush cutter or whipper snipper. Keep other people clear of area.
Flying debris can injure students.	Suitable protective clothing must be worn to cover arms and legs. Remove hazards from area before beginning work.
Brush cutters produce high noise levels and pose a noise hazard, sometimes over long periods.	Students must wear hearing protection. Operate brushcutter in low-slung position to increase distance to operator's ears. Use as long a piece of cord as possible. Short lengths enable the machine to rev more highly and create more noise.
Brushcutters and whipper snippers can be manual-handling hazards.	Students should always use harness supplied, ensure they have firm footing, and use both hands to operate machine.

Maintenance

Keep brushcutters well maintained with all loose parts tightened. Follow manufacturer's instructions for refueling or recharging.

6.13.3 Mulchers/plant shredders

A mulcher or plant shredder is used to break up plant material into small pieces suitable for mulching. Only middle to senior secondary students fully instructed in its correct and safe use can use a mulcher.

Hazards	Precautions
Debris and particles can enter eyes.	Students must wear safety glasses or goggles when using a mulcher. Keep other people clear of area.
Flying debris can injure students.	Suitable protective clothing must be worn, including sturdy gloves and shoes. Size of pieces inserted should not be too large for machine to handle. Do not force down with any implement.
Mulchers produce high noise levels and pose a noise hazard.	Students must wear hearing protection when using a mulcher.

6.13.4 Chainsaws

Description and use

Chainsaws are used for the quick cutting of logs and for pruning trees. Only use a chainsaw when absolutely necessary and then only one with-built in safety features. Chainsaws pose a very high risk and safety precautions must be carefully followed. Teachers must be familiar with the manufacturer' instructions on safe use.

Some students have access to chainsaws out of school and it is important they understand the correct and safe way to use them. Teachers should demonstrate the proper way to use chainsaws to these students. It is recommended that students do not use a chainsaw in school activities.

Under no circumstances should any person use a chainsaw unless they have been fully instructed on the safety hazards and trained in the safe use of the machine. It is recommended that operators undergo instruction by qualified person.

Hazards	Precautions
Materials can be propelled off chainsaw at high speeds.	Operators must wear a hardhat and sturdy eye protection.
Kickback can occur if nose or tip of guide bar comes in contact with a solid object or is pinched. Saw recoils towards the operator. Reactive force of kickback causes loss of control of chainsaw.	Use only chainsaws with anti-kickback features. Avoid sawing with tip or nose of the guide bar. Maintain high speed when entering or leaving a cut. Make sure guide bar is not substantially longer than thickness of wood to be cut. Avoid using a guide bar that is too short, causing it be buried in wood.
Prolonged exposure to chainsaw vibration can cause carpal tunnel syndrome. This condition causes numbness in hands and loss of control.	Do not use chainsaw for long periods. it Hold firmly with both hands, with left hand holding front handle bar and right hand holding the rear handle and trigger. Rubber bushings between handle and saw body or on engine mountings help reduce vibration, reducing fatigue.
Dropping saw to start it can result in loss of control.	Start saw by placing it on firm ground or by holding it between your legs just above the knees.
Powered chainsaws produce noise levels in excess of 100 dB(A).	Wear high-quality hearing protection. Reduction of exposure time is recommended. Do not rev saw but use only enough power to perform cutting operation safely. Shut down chainsaw during reasonable breaks in use. Use shears, handsaw or electric reciprocating saw for pruning.

Hazards	Precautions
Operator coming into contact with moving chainsaw blade causes most chainsaw accidents. Chainsaws cut through materials extremely quickly.	Warn students to stay out of path of chainsaw, especially as saw cuts through materials. Do not use the saw at heights or overhead.
Electrically powered chainsaws can cause electric shocks.	Do not work in wet areas. Use only a three-wire cord of proper size with three-pronged plugs and a grounded three-wire outlet. A ground fault interrupter in power supply line will help prevent fatal shocks. Arrange cord so as not to interfere with work or be inadvertently cut with saw.

Operators must wear close-fitting clothes with long sleeves and long pants, safety shoes or boots with non-slip soles, and light non-slip gloves.

Maintenance and storage

Start the chainsaw on clear ground and oil the chain. The chain should not move during idling. Adjust if necessary.

Use the manufacturer's recommended fuel mixture. Only refuel the engine when it is cool in an area clear of inflammable materials. Do not smoke during refuelling. Use a funnel or flexible nozzle to avoid spillage on the engine. If fuel is spilled with saw on the ground, thoroughly clean the engine.

Each time the chainsaw is refuelled, check the refill oiler, air filter, chain tension, and tightness of all nuts, bolts and screws. Proper lubrication will prolong a chain's useful life. On saws with automatic oilers, be sure the oiler is properly adjusted so it doesn't over-oil and run dry during operation. Automatic oilers need an extra squirt of oil occasionally.

Keep the air filter clean and replace at the recommended interval. Chainsaws should be well tuned. Mufflers should be securely bolted to the side of the engine block. Check baffles for rust holes. Examine the guide bar for damage. Make sure the handles are clean and dry.

6.13.5 Tractors

Description and use

Tractors are used in some schools with agricultural programs. They can be hazardous machines and have caused many farm accidents. Anyone operating a tractor-mounted bucket or front-end loader on school farms must hold a ticket of competency. Only qualified teachers or adults must teach students how to operate a tractor. Only senior students considered responsible and safety-conscious should be instructed in operating tractors. They need to hold a current learner driver's permit and must be made well aware of the hazards of using tractors and the types of common accidents. Teachers should conduct written tests and familiarisation programs for each operation. Tests should cover tractor construction and stability, engine operation, routine maintenance, and safe operation rules.

Hazards	Precautions
Falling off is a hazard in using a tractor.	Tractors are designed to carry only one person, the driver. At no time should anyone ride on any part of the tractor or attached implements as a passenger.
Tractors can overturn in rough terrain, if driven too fast or turned too suddenly. Implements not attached properly can cause tractors to overturn.	Adjust operating procedures to suit conditions. Reduce speed should reduced when turning, crossing slopes or on rough surfaces. Avoid sharp turns. Back up inclines and avoid steep slopes. Keep wheels spread wide whenever possible. Implements must be attached and pulled correctly. Roll bars or protective cabins prevent injuries caused by tractors overturning.
Engine noise hampers communication and may cause misunderstandings.	Students should learn hand signals to communicate with others.
Tractors can create a toxic exhaust fume that can build up if started in an enclosed space.	Start tractor with door open to allow fumes to be removed.
A tractor can cause serious accidents if left running when the operator has dismounted.	Stop the engine before getting off the tractor.
The power take-off (PTO) of tractors can cause serious accidents when operators become entangled in the rotating shaft by accident or when connecting implements.	Tractor engines must be switched off when connecting implements to the PTO shaft.

Students need to be taught supervising teacher how to perform a pre-start check of the tractor. When tractor is started, everyone except the driver should be clear. The hydraulic controls should be in neutral and the power take-off (PTO) must be disengaged. The PTO should be disengaged when not in use. Use the power shield whenever the equipment is in use. When stopping the tractor, both brakes should be applied evenly and the PTO disengaged. When students use tractors, foot brakes must be joined together. Students must use the hand throttle and not the foot throttle when operating a tractor. A fire extinguisher should always be carried on the tractor. Students should not wear loose clothing while operating a tractor.

Maintenance

Keep the tractor and the cabin glass clean. Before using the tractor, check all control lights. Make sure all shields and covers are in place.

When refuelling, stop engine and allow it to cool. Never refuel near an open flame. Always refuel outside away from combustible materials.

6.13.6 3 point linkages and posthole diggers

A 3-point linkage allows implements, such as a posthole digger, to be attached to a tractor. A posthole digger can dig deep holes quickly and easily. Only senior students considered responsible and safety-conscious and instructed by a qualified person in using tractors (refer to 6.13.5 *Agriculture equipment,* Tractor) will use 3-point mounted equipment.

Hazards	Precautions
Tractor power take-off stubs and shafts used to power farm implements can cause operators to become entangled.	All guards should be in place. Operators should wear close-fitting clothes and secure hair.
The shaft rotating at a high speed can throw objects, causing injuries.	Bystanders must keep a safe distance from the machine and moving parts.
The moving machinery can cause a crushing injury.	Bystanders and operators must keep clear of moving machinery. Ensure park break is on, power take-off is out of gear and tractor is turned off after use.
Operators can slip and fall if they stand on the posthole digger.	Do not attempt to add extra weight by standing on post-hole digger.

6.13.7 Shearing equipment

Shearing equipment is used to cut wool from sheep. Students should be adequately instructed in shearing and crutching by a suitably qualified instructor. It is recommended that only trained students take part in these activities, as they require considerable skill in handling both stock and machinery. Shearing sheds can contain both physical and environmental hazards. Students should be warned of hazards and adequate precautions taken.

Hazards	Precautions
Shearing and crutching sheep present manual handling hazards.	Train students to perform these activities without physical strain or injury. Make sure shearing board, wool table, bins and press are so positioned as to reduce manual handling and eliminate strains and physical injuries.
Handling stock can be a manual-handling hazard.	Size and nature of the stock will determine measures needed to keep students safe. Follow codes of practice.
Shearing and shearing sheds can present hazards.	Monitor noise and have students wear ear protection if necessary. Take steps to reduce noise.

Maintenance

Keep all equipment in good operating order. Combs and cutters should only be sharpened by a skilled operator, wearing eye protection.

6.13.8 Wire strainers and wire spinners

Wire strainers and wire spinners are used to construct high-tensile wire fencing. Only middle to senior secondary fully instructed in their correct and safe use can use wire strainers and wire spinners.

Hazards	Precautions
High-tensile wire and barbed wire can cause eye injuries.	Safety glasses must be worn.
Overrun on wire spinner can be a hazard.	Ensure tension on wire spinner is adjusted and spinner is secure.
Lifting wire and fence posts can be a manual-handling hazard.	Adopt best possible procedures for lifting and carrying fence posts and rolls of wire. (Refer to 3.2.12 *The learning environment*, Manual handling.)
High-tensile wire and barbed wire and wire strainers and spinners can cause physical injuries.	Suitable clothing including sturdy gloves and shoes or safety footwear must be worn.

Maintenance

Keep all equipment in good operating order. Wire spinners may need lubrication. Check jaws of wire strainers for excess wear. Worn wire can slip.

6.13.9 Cattle crushes

A cattle crush is a structure used to secure cattle for a variety of purposes. They can be mobile or fixed. Students should be adequately instructed by a qualified instructor in how to handle cattle before using a cattle crush. It is recommended that only trained middle to senior students take part in these activities, as they require considerable skill in handling both stock and equipment. Cattle yards can contain both physical and environmental hazards. Students should be warned of hazards and adequate precautions taken.

Hazards	Precautions
Cattle crush can pose a crushing hazard.	Safety exit route must be identified for students before they use crush.
Students can slip and fall in a cattle yard.	Students must wear suitable footwear and clothing. Floor should be anti-slip and students should use grip rails.
Restrained animals can be a noise hazard.	Ear protection may be required if animals bellow loudly when restrained.

References

Australian Standards

- *AS/NZS 1269.1:1998 Occupational noise management – Measurement and assessment of noise emission and exposure*
- *AS 1801-1981 Head Protection*
- *AS/NZS 1715:1994 Selection, use and maintenance of respiratory protective devices*
- *AS 1270 Hearing Protection*
- *AS 3191 Approval and test specification – Electric flexible cords*
- *AS 3760:2001 In-service safety inspection and testing of electrical equipment*

- *AS 3760 In-service safety inspection and testing of electrical equipment*
- *AS 4024.1-1996 Safe guarding of machinery – General Principles*
- *AS 1485-1983 Safety and Health in Workrooms of Educational Establishments*

  3.3.3 Operating instructions

  3.4 Safety in the use of compressed air

  4.7.4 Storage of compressed gas cylinders

  5.2.3 Clearance of moving parts

  5.2.4 Arrangement of machines

  5.3 Machine controls

  5.4 Guarding of machinery

  5.5 Electrical installation

  5.6 Gas and oil fuel installations

  7.2 Hand tools

  7.2.2 Wood chisel

  7.2.3 Hand saw

  7.2.4 Plane

  7.2.5 Metal-cutting chisel

  7.2.6 Hammer

  7.2.7 Spanner and wrench

  7.2.8 Screwdriver

  7.2.9 File

  7.3 Portable power tools

  7.3.1 Portable circular saw

  7.3.4 Drill

  7.4 Drilling machine

  7.5 Grinding and polishing machine

  7.5.7 Linishing machine

  8.6 Power hacksaw

  8.7 Milling machine

  8.8 Shaping machine

  9.3.2 Bandsaws

  9.7 Lathes

  12 Welding

  12.3 Gas welding, brazing and flame cutting

AS/NZS 3504 Fire Blankets

Victorian Government Schools Reference Guide

4.4.5.2.1 Technology, Safe use of machines and equipment

6.9.1.2.4 OHS (Noise) Regulations 1992

Education Department of Western Australia and the Building Management Authority, *Noise Control Manual for Schools*, 1995.

7 Safe use of materials: chemicals

7.1 Hazardous substances

Technology activities may expose teachers and students to potentially harmful substances in the form of chemicals and materials that require special precautions in the interest of safety, health, fire prevention and pollution. The *Occupational Health and Safety* (*Hazardous Substances) Regulations 1999* provide a performance based risk management approach to the handling of chemicals that must be followed by workplaces. Hazardous substances are those which, alone or in combination with others, could be or could become:

- toxic
- irritant
- explosive
- flammable
- corrosive
- obnoxious.

(*AS 1485-1983*, 1.4.2 Harmful substances)

This chapter deals with chemicals, while Chapter 8, *Safe use of materials: general* focuses on materials. Teachers must be aware of hazards of the substances they use in technology, how these substances can be used safely, and how to minimise risks. Possible hazards encountered when using chemicals or general materials include:

- toxicity from absorption, inhalation or ingestion
- spillage
- combustion
- explosion
- corrosion
- extremes of temperature.

An important source of information about hazardous substances is manufacturer's material safety data sheets (MSDS). Manufacturers are required by law to provide these on request to those who may be exposed to their chemicals. Although MSDS are not required for substances considered non-hazardous, some manufacturers will provide them. The MSDS gives information on hazardous ingredients, handling and exposure to chemicals, health hazards information, reactive chemicals, and precautions.

School technology programs must have a MSDS on every hazardous substance used or in supply. Teachers should request MSDS from five suppliers when ordering chemicals and materials. They should be less than five (5) years old. Where possible, it is recommended

that MSDS come directly from the manufacturer or supplier. MSDS are available on the Internet or on CD-ROM.

Storage and handling information provided by MSDS should be made available to students and other teachers. Laminated information sheets could be displayed on the outside of storage cupboards and storerooms and in work areas.

Hazardous substances can enter the body in a number of ways. They can be inhaled, ingested or absorbed through the skin. Both substances and materials used in technology can cause problems. An outline of these hazards follows.

Absorption and skin contact

Toxins can be absorbed directly through the skin or through sores, cuts and abrasions. Some chemicals such as solvents can penetrate the skin. Burns, irritations, ulcers and allergic dermatitis can result from even brief contact with some substances. Acids or alkalis can cause severe burns.

Personal hygiene is important when working with chemicals. Ensure that students know they must cover cuts and abrasions and wash their hands thoroughly after working with chemicals that may be hazardous. This procedure should be followed after all practical activities, especially before eating or drinking. Protective gear may be required with some substances to prevent direct contact with skin or eyes.

Ingestion

Hazardous substances are usually ingested accidentally. Students may bite fingernails, suck fingers, make hand to mouth contacts, place items in their mouths such as pencils, paintbrushes or tools all of which can result in ingestion of hazardous materials. Accidental ingestion can occur if students eat foods left in a work area, or eat with unclean hands. General infections can be spread through sharing if hygiene is not emphasised and practised.

Warn students of the dangers of accidental ingestion. Never store chemicals in food containers such as soft drink-bottles. Students must wash hands after practical tasks, especially before eating foods.

Inhalation

Inhalation of fumes or airborne particles is the commonest way for toxins to enter the body. Some chemicals give off hazardous fumes. Vapours from solvents, aerosol sprays, welding, heating metals and gases can injure lung tissue and pass into the bloodstream. Powdered substances such as dyes, paint and plaster should also be avoided.

Hazardous substances entering the body can cause the following types of problems:

- Acute illness, which is an immediate reaction to a burn from a substance such as a chemical.
- Chronic illness, which usually develops after exposure over a long period.
- Cancer, which is an example of a chronic illness. Cancer may develop after only a minute exposure to a carcinogen. Some substances are classified as known or suspected carcinogens.
- Sensitizing, which is caused by substances that provoke allergies.

7.2 Chemicals

Chemicals may be found in the technology curriculum in both primary and secondary schools. Glues, acids, detergents, paint and other chemicals are used in a variety of technology processes. Using and storing chemicals involve potential risks and it is the school's responsibility to ensure that these risks are minimised.

It is the teachers' responsibility to seek all available information about potential chemical hazards before starting any activity. Labels or MSDS should be referred to for information on whether a restricted or prohibited chemical is included in a substance. If there is any doubt about the safety of any chemical or process, then the activity must not proceed. Teachers should design technology programs that eliminate or reduce the use of hazardous substances.

Teachers should refer to Department of Education & Training, *Guidelines for the storage of science chemicals* and the Compliance Guidelines for Schools: Dangerous Goods (Storage & Handling) Regulations 2000. Schools need to comply with the Occupational Health and Safety (Hazardous Substances) Regulations 1999 and Code of Practice for Hazardous Substances. Schools can link to relevant documents in Human Resources/Safety, Health & Wellbeing on http://www.eduweb.vic.gov.au/hrweb/safetyhw/default.htm

7.2.1 Dangerous goods

Dangerous goods are substances and items classified as such under Section 2 of the Australian Dangerous Goods code. Teachers must follow procedures established under the *Dangerous Goods (Storage and Handling) Regulations 1989* for the safe storage of laboratory chemicals. Dangerous Goods Classifications include:

- flammable liquids (acetone, kerosene, methylated spirit, turpentine),
- substances that are dangerous when wet, (camphor, napthalene)
- oxidising substances (hydrogen peroxide)
- poisons, radioactive substances
- corrosives (nitric acid, sulfuric acid).

Each hazardous substance falls into a particular Dangerous Good class relating to its primary hazardous property. The following information defines some of the classifications for Dangerous Goods that may be included in technology programs.

7.2.1.1 Class 1 Explosives

These are substances capable of a sudden release of energy and the rapid formation of a large volume of gas. When the gas is compressed, this leads to the development of a high-pressure wave (blast). It is illegal to mix chemicals to make any explosive or pyrotechnic composition except in a licensed explosives factory. Access to chemicals in schools should be strictly controlled, particularly for substances that may be ingredients in explosive mixtures (refer to 7.4 *Prohibited and restricted chemicals*). The study of explosives and the explosives industry is not considered a suitable topic in school curriculums. Experimentation with explosives must not be permitted or encouraged.

7.2.1.2 Class 2 Gases

These include compressed, liquefied or dissolved-under-pressure gases. The gases are subdivided in subclasses of 2.1 Flammable gases (acetylene), 2.2 Non-flammable, non-toxic gases (helium, oxygen, compressed air), and 2.3 Poisonous gases (chlorine).

7.2.1.3 Class 3 Flammable liquids

These are liquids that can burn. They are subdivided in subclasses of 3.1 Flammable liquids (flash point <23°C), and 3.2 Flammable liquids (flash point >23°C). Flammable liquids include acetone, kerosene, methylated spirit, and turpentine. Flammable substances should not be stored in domestic refrigerators. They require a specially constructed chemical refrigerator fitted with spark arrestors on the motor to eliminate sparking. These refrigerators should not be used to store foods if storing flammable substances. Acetone, contact cement, lacquer thinners, methylated spirits, petrol, stains are some of the chemicals used in technology that are Class 3.1 Flammable liquids. Machines with internal combustion engines must be refueled when the engines are cool.

7.2.1.4 Class 5 Oxidising agents

5.1 Oxidising substances (pool chlorine) and 5.2 Organic peroxides (methyl ethyl ketone peroxide). These substances oxidise other substances.

7.2.1.5 Class 6 Poisons and infectious substances

These are divided into 6.1 (a) Poisonous substances, 6.1 (b) Harmful (toxic) substances, and 6.2 Infectious substances. The *Drugs, Poisons and Controlled Substances Act 1981* requires that chemicals listed in the Schedule 4 of the Act and listed regulated poisons cannot be supplied or possessed unless a school has an educational permit. None of these chemicals is commonly used in schools. The Schedules to the Act are published in *The Standard for the Uniform Scheduling of Drugs and Poisons* No 6 1992. *Listed Regulated Poisons* can be found in the Poisons Code. Further information can be obtained from Commonwealth Department of Health and Family Services.

If poisons are accidentally swallowed or inhaled, immediate action must be taken according to the instructions on the chemical. It may be appropriate to give plenty of water or to induce vomiting. Note that in some cases it is dangerous to induce vomiting. Seek immediate medical attention.

7.2.1.6 Class 8 Corrosives

These are substances (acids and alkalis) that corrode others. They are subdivided in subclasses of 8.1 Corrosive substances, excluding bases, and 8.2 Corrosive bases. Most acids are corrosives (nitric acid, sulfuric acid). Acids and alkalis (sodium hydroxide) must be stored separately.

7.2.1.7 Class 9 Miscellaneous dangerous goods

These are substances that do not fit into any other category and include things like asbestos, aerosols, and dry ice.

7.3 Safe handling and storage of chemicals

Safe storage of chemicals must be part of the total risk-management strategy for schools (refer to 2.3 *Risk management processes*). The procedures established under the *Dangerous Goods (Storage and Handling) Regulations 1989* for the safe storage of laboratory chemicals apply to chemicals stored for technology as well as to other curriculum areas such as science and art. Teachers should also refer to the current MSDS for each chemical.

7.3.1 Storing chemicals

Chemicals should be bought and stored in small quantities, segregated according to *Dangerous Goods (Storage and Handling) Regulations 1989*. Stockpiling chemicals creates storage risks, large amounts are a hazard, and some chemicals may have a limited shelf life.

All containers holding chemicals must be sealed and labelled according to current regulations, with relevant hazard classification.

Students must not have access to the chemical storage area. Chemicals must be stored away from other materials in a well-ventilated locked cupboard in the science laboratory, storeroom or, in primary schools, the staff room. Lock chemical storerooms when unattended. Chemicals should be stored off the floor on suitable shelving that can be reached safely. Materials such as particleboard can break down and will absorb chemicals. It is unsuitable for shelving. Do not store protective clothing or other items with chemicals. Floors near chemical storage areas should be kept clean and free of tripping hazards.

Chemicals should be stored in ways that recognize the hazards they pose and according to manufacturer's instructions. For example, flammable materials must be stored in a cool, dry place (preferably in a flammables cabinet) at the correct temperature (refer to *AS 1940-1993* The storage and handling of flammable and combustible liquids). Highly flammable adhesives should be stored within a temperature range of 5°–30°celsius, preferably in a chemical refrigerator. Containers must be sealed and of an approved design for storing flammable liquids. Further information can be found in *AS 1940-1993* The storage and handling of flammable and combustible liquids.

All chemicals must be stored, dispensed or distributed in containers that are impervious to physical or chemical deterioration by the material contained. Containers must have suitable lids or covers that will prevent the contents from spilling or leaking during the activity or storage period. Never store chemicals in food, feed, medicine or drink containers.

The following points can be used as a guide when storing chemicals:

- Ensure that chemical containers and their seals or stoppers are suited to the type and volume of chemical stored.
- Inspect containers regularly as they may deteriorate over time and increase the likelihood of spills or the escape of fumes.
- Chemical containers must be clearly labeled so that all potential users are aware of the nature of the materials inside.
- Avoid damage to labels when chemicals are being dispensed. Pour liquids on the side away from the label.
- Label containers with chemical name, hazard class, and date of purchase. Labels should indicate:
  - correct name of material contained, chemical formula, Dangerous Goods Class, and UN number for Dangerous Goods
  - nature of any risk associated with chemical (corrosiveness, toxic, flammable)
  - concentration of solution
  - type of solvent used (aqueous, alcohol)
  - recommended safety precautions and first-aid procedures
  - date of preparation
  - name of person who prepared chemical
  - reference to MSDS available.

7.3.2 Handling chemicals

All staff and students must be suitably trained in the safe handling of the chemicals they are required to use. Schools may need to review the chemicals they have stored and to ensure that the staff and students who may come in contact with them are properly instructed. Teachers should ensure that their students are aware of:

- potential hazards of the substances they use
- how to control hazards
- how to use personal protective equipment when required
- emergency procedures to follow in the event of a spill, fire or explosion.

Secondary students should be fully instructed in the symptoms of chemical ingestion, skin absorption or inhalation so that they recognise danger before the damage is done. Primary students should be shown how to use substances safely and warned about hazards in ways that suit their level of understanding.

Safe procedures should be established for the distribution and dispensing of chemicals, whether liquid, solid or in solution. Prepare minimum quantities or concentrations for the activity. Be certain that the correct chemical is being prepared. Double-check the name of the chemical required against the name on the storage bottle or jar. If in doubt, check the spelling and chemical formula. Technology teachers can ask for advice from Science teachers or laboratory technicians. Refer to the *Merck Index* or *Ajax Fine Chemical Reference Manual*.

Students and staff should follow procedures to restrict the possibility of spillage and accidental contact with chemicals or the production of dangerous by-products. The following points can be used as a guide:

- Minimise amounts of chemicals used.
- Use chemical solutions of the lowest concentration practicable for the success of the activity.
- Restrict movement around benches by providing chemicals for each group of students if they all need to use them (dyeing fabrics) or restrict processes using chemicals to one area.
- Replace and tighten lids on containers immediately after use.
- Buy and use minimum quantities.
- Prevent random mixing or cross-contamination of chemicals.
- Ensure access to running water at all times (refer to 7.5.1.1 *Personal protection, Eye care*).

Only suitably trained teachers or science laboratory staff should clean up spilled chemicals. Spilled liquid chemicals can be absorbed using commercially available absorption granules or vermiculite. These should not be stored with chemicals but in an easily accessible place. Spill barriers will restrict the spread of the liquid. Sand can be used, but is not suitable as an absorption material. Solid materials should be contained and collected. All collected material, including all absorption and barrier materials, must be contained and treated as required by the *Dangerous Goods Code* for the chemical spilled.

7.3.3 Disposal of chemicals

Schools should regularly review chemicals held in storage and dispose of those no longer required or permitted in schools (refer to 7.4 *Prohibited and restricted chemicals*). Old chemicals should be discarded correctly. Some may contain substances no longer considered

suitable for use in schools. Unwanted and waste chemicals should be disposed of according to current environmental protection regulations. Schools can contact the local water board and municipal authority. If uncertain contact the Environmental Protection Authority (EPA) for advice on clean up and disposal of chemicals.

Schools chemical laboratories require a marble-chip trap to neutralise acid waste and treat water before it enters the sewerage system. Do not dispose of sulphuric acid in the acid trap. It coats the marble chips, making them ineffective. Every two years, an EPA-approved plumber should flush out the traps. Marble chips can be topped up if necessary.

Empty chemical containers can be rinsed if it is safe to do so (read label) or sealed with their lids. Prevent rinsed container from further use by puncturing or squashing (if not made of glass). Unrinsed containers must be sealed and correctly disposed of so that they are beyond anyone's reach.

Take care when using flammable chemicals that rags or items soaked in the chemical are disposed of safely and correctly. Store waste materials in cans with fitted self-closing lids. Ensure these are properly disposed of after activities.

7.4 Prohibited and restricted chemicals

The following chemicals have been listed under the headings of prohibited and restricted chemicals. For advice on prohibited chemicals teachers should refer to the Department of Education & Training *Guidelines for the storage of science chemicals* which is available on http://www.eduweb.vic.gov.au/hrweb/ohs/worken/chem.htm.

7.4.1 Prohibited chemicals

The following chemicals, which may be found in Technology rooms or in substances used in Technology activities, are included in the list of restricted chemicals in *Guidelines for the storage of science chemicals*. They should be disposed of immediately, following consultation with local government authorities on the most suitable method, and using the services of a professional chemical disposal agent (refer to the Yellow Pages under 'Waste reduction and disposal services').

7.4.1.1 Ammonium dichromate

The use of ammonium dichromate in volcano experiments is not permitted. Both the reactant and the product of the reaction, chromium (VI) oxide, are carcinogenic and may cause severe irritation to the eye, lungs and skin. Dusts and solutions are toxic. It is an irritant to eyes and skin, a strong oxidizer and dangerous fire risk. It may explode on contact with organic materials. Dispose of dichromate compounds (potassium dichromate) appropriately.

7.4.1.2 Asbestos

Asbestos is the name for a group of naturally occurring minerals that can be separated into strong very fine fibres. These fibres are extremely durable and are heat and fire resistant. Because of these qualities, asbestos has been used in many industrial, construction and consumer products.

Asbestos sheeting may be in technology classrooms as soldering mats or as building materials. All schools have had an asbestos audit and, where required, developed an asbestos management plan. Schools have a responsibility to ensure that any asbestos is handled in the correct way and disposed of immediately using the services of a professional disposal agent.

7.4.1.3 Benzene

Benzene is an aromatic hydrocarbon. It is formed by both natural processes and human activities. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke. It is used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Benzene is used to make other chemicals that are used to make plastics, resins, and nylon and synthetic fibres.

Benzene is classified as Group 1 'Carcinogenic to humans' by the International Agency for Cancer Research. Short-term exposure to high levels of benzene can cause drowsiness, dizziness, and unconsciousness. Benzene can also be absorbed through the skin. Any benzene held in schools must be disposed of immediately using the services of a professional chemical disposal agent.

7.4.1.4 Toluene (methyl benzene)

Toluene is a clear colourless liquid used in the production of paints, paint thinners, nail polish, lacquers, adhesives, and rubber. It is also a by-product of styrene. Traces of toluene can be transferred to foods stored in polystyrene containers.

High doses of toluene can have severe effects on the brain. Moderate exposure may produce a range of symptoms, including tiredness, confusion, and weakness. Exposure to large amounts of toluene in a short time, such as deliberate sniffing of glue, can cause light-headedness. If exposure continues, unconsciousness and even death may occur. Permanent brain damage may occur if deliberate inhalation is habitual. Toluene is prohibited in schools and must be removed immediately using the services of a professional chemical disposal agent.

7.4.2 Restricted chemicals

The following chemicals may be found in Technology classrooms or in substances used in Technology activities. Some chemicals should be avoided while others can be used with the appropriate safety measures. These chemicals should not be used in Primary schools.

7.4.2.1 Cadmium

Cadmium is a natural element in the earth's crust. It is used extensively in industrial and consumer products such as batteries, metal coatings, plastics, and in electroplating. Cadmium is also found in industrial paints and may represent a hazard when spray painting or scraping off old paint. Green, yellow, orange and red paints may contain cadmium. Welding and soldering can result in cadmium exposure. Care must be taken to avoid cadmium-containing alloys and silver solders.

Breathing high levels of cadmium severely damages lungs. Cadmium is classified as Group 1 'Carcinogenic for humans' by the International Agency for Cancer Research.

7.4.2.2 Chromium

Chromium is a naturally occurring element found in rocks, animals, plants, soil and volcanic dust and gases. The metal chromium, which is the chromium (0) form, is used for making steel. Chromium (VI) and chromium (III) are used for chrome plating. Certain green yellow and orange pigments contain chromium. Chromium (VI) is classified as Group 1 'Carcinogenic for humans' by the International Agency for Cancer Research. It is recommended that student work is sent out to a professional electroplater be chrome plated. Students should avoid welding, cutting and grinding chromium alloys.

7.4.2.3 Formaldehyde

Formaldehyde is a clear, colourless gas or liquid. It is mainly used as a preservative and in disinfectants, fumigants, embalming, and in photography as a film hardener. It is used as a raw material in the manufacture of resins. These resins are widely used in the building and furnishings industries as an adhesive. It is also a naturally occurring substance. Formaldehyde is assessed as Group 2 A, 'probably carcinogenic to humans' by the International Agency for Cancer Research.

Formaldehyde is not used in Technology classroom activities but may be used in Science. It is however present in pressed-wood products such as medium density fibreboard (MDF), plywood and particleboard. Refer to 7.6.1 *Chemicals used in technology,* Adhesives and 8.1.10 *Materials list,* Wood for further information.

Formaldehyde is harmful if inhaled or absorbed through skin. It causes irritation to skin, eyes and respiratory tract and is a strong sensitiser. Formaldehyde must be handled using the appropriate procedures defined in the Material Safety Data Sheet (MSDS). Respiratory protection, local mechanical exhaust (fume hood), impervious gloves, eye protection and chemical resistant clothing are recommended when handling formaldehyde. Students should not handle formaldehyde.

7.4.2.4 Lead

Lead is a soft bluish-gray metal used in auto batteries, cable casings, and metal products. Lead can be found in house paint, especially older paintwork, automobile paint, copper enamels, solders, oil paints, and ceramic glazes. Due to health concerns, lead in petrol, paint, ceramic and other products has been reduced significantly in recent years.

Lead fumes or dust are hazardous if inhaled or ingested. Take care if working with old timber that may be painted with lead-based paint. Lead paint can be inhaled when it is sanded. Avoid lead-based paints, high lead solders, and enamel powders containing lead. Avoid processes that involve substances with high lead content when leadlighting, enameling copper, and glazing ceramics.

Using and handling solders or other substances containing lead and not washing hands afterwards may cause accidental ingestion of lead. Exposure to high levels of lead can affect almost every organ and system in the body. The most sensitive is the central nervous system, especially in young children. Due to their high metabolic rate and greater health risks, primary students should not come in contact with products containing lead.

Lead is also referred to in 5.4.6 *Soldering iron (not for electronics)*, 6.12.2 *Electric soldering iron*, and 7.6.10 *Solders and fluxes*.

7.4.2.5 Sulfur

Sulfur is known to be of low toxicity and poses very little if any risk to human health. It has been placed in EPA Toxicity Category IV, the least toxic category. However, any activity involving the heating or burning of sulfur must be avoided. For example, the combination reaction between iron and sulfur to form iron sulfide, or the vulcanising of rubber – will form sulfur dioxide fumes. These are extremely corrosive and irritating to the eyes, stomach and respiratory system. This is likely to trigger asthma, nausea or other adverse reactions in susceptible individuals.

7.5 Safe use of chemicals in technology

Teachers are responsible for managing a safe educational environment and for ensuring that activities involving chemicals take account of safety issues and follow safety procedures. When planning and conducting an activity involving chemicals, it is expected that teachers will:

- design the curriculum to eliminate the need to use more hazardous substances
- research the hazards associated with chemicals and the recommended safety procedures
- use the least hazardous substances available for the task
- trial the activity
- instruct students about hazards and procedures for dealing with chemicals
- actively supervise students
- clean up chemicals correctly at the end of the activity
- ensure that the learning environment is suitable for the activity and the distribution and disposal of chemicals (refer to 3.2 *The learning environment*).

Before students handle any chemical, teachers must ensure that they are familiar with any risk associated with the material (refer to MSDS). Hazardous substances used in schools should be:

- stored in unbreakable containers
- stored in suitable locked cupboards or other suitable storage to prevent access by unauthorised people
- stored in classifications according to recommended practice
- held in the minimum quantities required for teaching purposes
- taken into the workroom in minimum quantities needed for immediate use
- returned to storage if unused
- opened carefully in case of deterioration or pressurisation of containers.

Students must be taught how to reduce the possibility of spillage or accidents with chemical being used and the correct way of dealing with spillage or accidents. When using hazardous chemicals, teachers must ensure:

- access to clean running water
- an eye wash station or safety shower spray
- absorbing or neutralising materials is available to use in the event of a spill.

When students are using chemicals that produce toxic, corrosive or flammable vapours, a fume cupboard should be used. The fume cupboard fan should run until all hazardous material has been removed (refer to 3.2.8.1 *Ventilation*, Fume cupboards). Fume cupboards should comply with *AS 2243.8* Non-recirculating Fume Cupboards or *AS 2243.9* Recirculating Fume Cupboards.

Teachers will decide which chemicals are suitable for students to use in classroom activities and at what stage students will be allowed to use them. Some chemicals will be restricted to senior students. Every chemical used by students will require instruction in its safe use. Teachers must ensure that students understand these instructions before they take part in activities. Instructions on chemical labels must be read carefully to see when to use, how to use, and other safety precautions. These instructions must be strictly followed.

Using chemicals in primary classrooms calls for extra care and instruction. Primary students should be instructed not to touch chemicals or unknown substances without permission. Show them how to handle chemicals safely by using equipment such as spatulas, measuring containers or droppers.

Technology activities in primary schools may use household chemicals such as baking powder, borax, vinegar, sugar, and glycerine. While they may not ordinarily be considered hazardous, there can be an element of risk in the processes used. Heating or mixing of substances can lead to eye injury or skin injury from thermal and chemical burns. Common household cleaners can be dangerous when mixed with other chemicals. Extra precautions must be taken to ensure that primary students wear protective clothing and equipment as their manual skills and coordination and not as refined as those of secondary school students.

Develop a set of general safety rules for students to follow when using chemicals. Not all the chemicals students may come in contact with in technology are covered in this document. Where there are general hazards not detailed here teachers must apply the principles outlined in this chapter for similar hazards. The rules must be suited to the level of the students and the hazards involved in chemicals they are required to use. The following points can be used as a guide:

- Always wear protective clothing and equipment when handling chemicals.
- Never taste substances and only smell a substance if instructed on how to do so safely by the teacher.
- Use suitable equipment to dispense and prepare chemicals.
- Take care not to accidentally put chemicals in mouth.
- Do not siphon any substance by mouth.
- Wash hands thoroughly at the end of the activity.

7.5.1 Personal protection

Teachers will instruct students on the correct protective clothing to wear with chemicals they use. Some chemicals will require only general precautions (such as washing hands after use), while others will require extensive precautions, such as wearing safety glasses, respiratory protection, dust coat, disposable gloves, tying hair back (refer to 3.5 *Personal protective clothing and equipment*).

7.5.1.1 Eye care

Particular attention must be paid to eye protection when using chemicals. Students must be directed to wear eye protection when working with chemicals that could accidentally enter eyes. They should be warned of the danger of rubbing their eyes with chemicals on their hands. Some chemicals, such as bases, may not irritate eyes immediately. Goggles with air vents at the side are not suitable when fumes are created. These allow fumes to contact students' eyes. Safety glasses and goggles should be kept clean, free from scratches, and periodically disinfected. In secondary school, it is preferable for students to own their own safety glasses.

In secondary schools, teachers should ensure that students have ready access to an operable and clean eye wash or safety shower spray. The eye wash bottles found in many science laboratories are no longer considered suitable first-aid treatment. Unless refilled frequently with sterile water, they are likely to contain microorganisms such as bacteria and fungi, which will exacerbate injury to the eye from a chemical splash. Refer to *AS/NZS 2243.2:1997*, Safety in laboratories – Chemical aspects.

In primary schools, ready access to fresh water is essential, and teachers should have a clean eye bath on hand. This can be kept in a first aid kit (refer to 2.9 *First aid*).

7.6 Chemicals used in technology

The following chart shows the range of chemicals students may use in technology. Potential problems can involve the use of substances such as solvents, acids, powdered dyes, fuels, paints, soldering flux and solders, welding rods, surface treatments, and adhesives.

Teachers can use a variety of ways to indicate the level of hazard of chemicals students use in technology. Chemicals can be classified as ones students:

- use without restriction
- use with caution
- use with extreme caution
- use only under special circumstances or with supervision
- do not use under any circumstances (these should not be available to students).

The chemicals available to students and classified as 'can use' will vary with the students' level. Prep students will be allowed to use very few substances without supervision. Senior students, however, may be able to use all available chemicals if properly trained. The method used to identify the level of hazard will also vary with the students' level. Use labels and symbols that suit students' age group. The hazards involved in using each of these chemical groups are given following this chart.

Chemicals used in Technology

Adhesives
Clag paste
hobby glue
PVA
glue sticks
epoxy resin (Araldite)
hot melt and low melt glue sticks
instant glue
contact adhesive (liquid cement)
all- purpose adhesive (Multibond)
Tarzan's Grip
aerosol adhesive

Automotive
coolant
engine lubricant
brake fluid

Agricultural and horticultural
pesticides
herbicides
fertilisers
blood and bone
liquid seaweed
fly spray
lime
pyrethoids
garlic spray
white oil
Derris (Rotenone)
soap flakes spray
RoundUp
Zero

Cleaners and disinfectants
hand cleaner
whiteboard cleaner
bleach
Solvol
spray cleaners
Pinocleen
Ajax
cleaning ammonia (ammonium hydroxide)
soda ash, washing soda (sodium, carbonate)

Corrosives
sulfuric acid
nitric acid
hydrochloric acid
zinc chloride
ammonium chloride
ferric chloride
Drano, caustic soda
(sodium hydroxide)

Detergents
degreaser
dish washing liquid
laundry powder

Dyes
food dye
transfer dyes
silk dyes
batik dyes
liquid fixing agent
fabric paints
wax

Gas
Acetylene

Household
salt
alka seltzer
sodium bicarbonate
vinegar (acetic acid)

Solders and fluxes
lead solder
silver solder
Borax flux
Auflux
Batterns self-pickling flux
Baker's Soldering Fluid
bronze brazing flux

Solvents
methyl ethyl ketone peroxide
dimethyl adipate
paint thinners
degreasers
turpentine
methylated spirit
white spirit
petrol
kerosene
nail polish remover (acetone)
engine oil

Surface treatments
Paint: acrylic paint
poster paint
acrylic house paint
enamel house paint
automotive paint
glass fibre reinforced resin
polyurethane
varnish
lacquer
woodstain
putty
oil (linseed, tung)
Brasso
Silvo
low bake enamels
copper enamel powder
resin
polishing compounds
plastic powder coating
silicone release agent

Arc welding electrodes

Testing
chemicals to test fibres

7.6.1 Adhesives

Use and description

A variety of adhesives is used in technology. Teachers will decide when to introduce particular glues to students and which glues will be available for them to use. Adhesives are chosen because of their suitability for joining particular materials. For example, the glues used for joining wood (contact adhesive, casein glue, epoxy glues, polyvinyl acetate (PVA) and cyanoacrylate) may not be suitable for materials such as plastic or metal.

Some adhesives are safe for young students to use (Clag paste), while others should be limited to use by secondary students (aerosol adhesive). Some adhesives must only be used under strict supervision, instant (cyanoacrylate), and epoxy glues.

Primary students should not use solvent-based adhesives, instant glues or epoxy glues. White glue, such as polyvinyl acetate (PVA) and craft glue, and preservative-free pastes are suitable.

Hazards

Adhesives can pose an inhalation, absorption and ingestion hazard. Even students in primary schools may have access to hazardous adhesives at home. It is important to show them the safe and correct way to use these and warn them of the dangers of misusing them. Label instructions must be followed. Teachers need to interpret these instructions for students. Secondary students should develop skills in following label instructions. Solvent-based adhesives, instant glues and aerosol adhesives should be stored in a locked cupboard.

Solvent-based adhesives are flammable and may have low flashpoints (the temperature at which vapours can ignite) and must not be used near naked flames or around items such as electric heaters.

Formaldehyde resin glues are used when strong structural joints are required. They are also used to bond wood particles together in particleboard and MDF. The glue may release formaldehyde even after it is cured and when machined or sanded. Use alternatives to hazardous adhesives (refer to 7.4.2.3 *Restricted chemicals*, Formaldehyde).

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Some adhesive fumes are hazardous if inhaled.	Skin contact may cause absorption of hazardous substances and skin irritations to occur. Most adhesives pose a danger in contact with eyes.	There is a danger of adhesives being ingested if students get them on their hands.
Precaution	Follow instructions on the label. Avoid inhalation of adhesive fumes and provide adequate ventilation when fumes are created.	Follow instructions on the label. Avoid skin contact with hazardous adhesives by wearing impervious gloves or barrier cream. Avoid contact with eyes by wearing safety glasses.	Wash hands before eating or drinking after using adhesives.

Organic solvent based adhesives

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Inhalation of solvent vapour.	Solvents can be absorbed through the skin.	As for adhesives.
Precaution	Use must be strictly controlled. Use good dilution ventilation (refer to 3.2.8 *The learning environment*, Ventilation). Large quantities of these glues require local exhaust ventilation.	Wear impervious gloves or barrier cream when using solvent-based adhesives.	As for adhesives.

Formaldehyde-resin glues

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Highly toxic by inhalation.	Highly toxic by eye contact. Moderately toxic by skin contact.	As for adhesives.
Precaution	Avoid the use of formaldehyde-resin glues.	Avoid the use of formaldehyde-resin glues.	Avoid the use of formaldehyde-resin glues.

Adhesives are classified by their chemical type or the way they are used. The strongest adhesives solidify by chemical reaction. Less strong types harden by physical change.

Chemical reactions

Anaerobic adhesives, often known as locking compounds, harden when in contact with metal and air is excluded such as by a screw in a thread.

Cyanoacrylate adhesives, also called instant glues, cure with reaction with moisture held on the surfaces being bonded. They are also called instant glues. They are moderately toxic by skin or eye contact. Use caution when using instant glues as they can glue together skin or skin and other materials. Eye contact can cause severe irritation. Restrict use of instant glues to secondary students. Primary students should not have access to instant glues.

Toughened acrylic adhesives are fast curing. They are supplied in two parts (resin and catalyst) that are usually applied separately, then the surfaces joined.

Epoxy adhesives consist of an epoxy resin and a hardener. They are available in one-part, two-part and film. They are moderately toxic by skin and eye contact and inhalation. Hardeners can cause skin allergies and inhalation can cause asthma and other lung problems. Wear impervious gloves or barrier cream when using epoxy glues.

Primary students are not permitted to use epoxy glues. In secondary colleges students may only use epoxy glues in fume cupboards or other suitably ventilated areas. Victorian Government Schools Reference Guide 4.4.5.3.8 The Arts, Organic solvents.

Polyurethane adhesives are usually two-part and fast curing. They are used to bond glass reinforced plastics and are usually applied by machine.

Modified phenolics are used for metals. They require heat and pressure for the curing process.

Physical reactions

Hot melt adhesives are used for fast assembly of structures that will not bear a load.

Plastisol adhesives are modified PVC dispersions that require heat to harden.

Rubber adhesives solidify through loss of solvent or water medium. Contact adhesive is extremely flammable and may contain chemicals hazardous to inhale.

Polyvinyl acetates (PVA) are suited to bonding porous materials such as paper and wood. Water-based glues such as PVA or rubber latex do not generally pose a hazard to students. Latex contains ammonia in the uncured state. This can be irritating to eyes and nose and should be used in a well-ventilated area. Use water-based adhesives rather than solvent types where possible.

Pressure-sensitive adhesives are used on tapes and labels. They do not solidify but may be able to withstand adverse environments.

Natural glue

Casein glue is a water-based protein derived from skimmed milk. It is one of the last commonly used natural glues. Its drying time can be controlled, making it ideal for large laminated pieces and attachment of laminates. It is slightly toxic by skin contact and not significantly toxic by inhalation or ingestion.

Dry casein glues are highly toxic by inhalation or ingestion and moderately toxic by skin contact. Wear gloves, safety glasses and a toxic dust mask if glue is used in dry form. It is recommended that dry casein glues not be used in schools.

7.6.2 Agricultural chemicals

Agriculture and Horticulture studies are included in the VCE group of studies for technology; as are VCE VET programs for example, Certificate II in Agriculture. Students may also be involved in units in agriculture and horticulture at earlier secondary levels, and some primary students may take part in environmental programs.

Use and description

Agricultural chemicals include pesticides, herbicides, veterinary products, fertilisers and other industrial chemicals, growing medium, and soil conditioners. Activities with these chemicals include storing, mixing, applying, and disposal of containers and unused sprays. Teachers or supervising adults using these chemicals should be qualified in the management of agricultural chemicals.

Secondary students can be trained safely to use agricultural chemicals by using coloured water as a substitute for the chemical. Primary students must not use insecticides or herbicides or any hazardous agricultural chemical.

Agricultural chemicals can range from slightly to extremely toxic. When using insecticides, use ones with the lowest possible risk to the environment. Schools can use pyrethoids, garlic spray, white oil, Derris (Rotenone), and soap flakes spray. Schools should not use products rated S6 or higher. Do not use the insecticides Aldrin, Clordane, Endrin, Demeton-S-Methyl, Dieldrin, DDT, and Lindane. When choosing insecticides, pests should be clearly identified to ensure correct control measures.

Herbicides should give adequate control for particular situations. While toxic chemicals, herbicides are safe to use if directions are followed and precautions taken. Use only registered products of low toxicity and low persistence. The glyphosphate group that includes RoundUp and Zero are examples of biodegradable low-persistent and low-toxic herbicides effective in controlling weeds in unwanted areas. Do not use herbicides Hepachlor2, 4-D, Paraquat, and Diquat.

Agricultural chemicals should be stored in a well-ventilated area away from water. Chemicals should be segregated to avoid cross-contamination. In particular, herbicides should not be stored with pesticides and fungicides. All herbicides and insecticides should be stored in a secure place and made inaccessible to students and all other unauthorised persons (refer to the *Victorian Government Schools Reference Guide* 4.4.6.3 Insecticides and herbicides).

Agricultural chemicals

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Inhalation is a hazard of using agricultural chemicals.	Skin contamination is a hazard of using agricultural chemicals. Chemicals may splash onto users or be accidentally spilt.	There is a danger of agricultural chemicals being ingested if they get on hands.
Precaution	Wear breathing apparatus or a facemask in accordance with manufacturer's instructions to avoid inhalation of chemicals.	Wear protective clothing (rubber gloves, aprons and sturdy shoes that are impervious to chemicals) when handling chemicals even when using a coloured water substitute. Areas used for mixing chemicals should be equipped with adequate water supply, soap, emergency shower, and decontamination materials that will neutralise chemicals.	Avoid ingestion of agricultural chemicals by observing strict hygiene rules and not eating or drinking while the face and hands may be contaminated. Wash hands and face after using chemicals Do not store pesticides or empty pesticide containers near food or drink (including that of animals).

Soil and potting mix

	Inhalation	Absorption/skin contact	Ingestion
Hazard	All decaying material in nature contains microorganisms such as *Legionnella longbeachii*. Diseases in soils and potting mix can be airborne and can therefore be inhaled by students.	Potting mix and soils contains microorganisms that can enter cuts and sores. Dust particles may enter student's eyes.	Accidental ingestion of soil or potting mix.
Precaution	Work with soil and potting mix on still days and keep the soil and potting mix damp. Work with any breeze blowing away from students, and in an open or well-ventilated area. Students with asthma or bronchitis should avoid working with soils or potting mix (refer to 8.1.6 *Materials list*, Natural materials).	Students should avoid direct skin contact and wash their hands after use. Suitable gardening gloves are recommended. Students may need to wear safety glasses while they work with or collect natural materials to avoid dust particles from soil, sand, potting mix-entering eyes.	Warn students of the hazards of placing fingers in mouths after handling materials that may be unhygienic or toxic.

Precautions

Take the following precautions when using agricultural and horticultural chemicals.

- Read labels and follow directions on application rates, safety precautions, first-aid directions, and pests or plants to be controlled. If there is no label, do not use the chemical. Follow application rates and methods of application as directed on labels. Use measuring containers to ensure accurate measurements and keep these with the chemical to avoid contamination.
- Ensure equipment used is properly maintained and used in accordance with manufacturer's recommendations. Use separate spray equipment for poisonous and non-poisonous substances. Do not reuse the spray unit for other chemicals unless thoroughly rinsed.
- Decide whether weather conditions are suitable for the intended spraying operation. Spray in the early morning and when a light breeze is blowing away from areas that could be adversely affected by the spray. Ensure that sprays do not drift onto non-target areas.
- Remove any clothes splashed with chemicals. Wash all protective clothing thoroughly after use. Wash separately from other clothing.
- Display a prominent and clear warning sign where spraying has been carried out. Do not spray when:
  - others are present and unprotected
  - feeling unwell

- adequate personal protection is not available
- weather conditions are windy or hot
- ponds or fish tanks are nearby
- instructions are not clear or not available
- preferable methods of control are available.

Dispose of containers according to instructions. Do not tip left-over solutions down the drain. Areas should be chosen for the disposal of containers or unused sprays so as to reduce potentially hazardous situations to both user and the environment.

7.6.3 Automotive chemicals

Use and description

Automotive chemicals are commonly available and include substances such as coolant, engine oil, battery acid and brake fluid. It is important that manufacturer's instructions are followed when using these chemicals as the hazards can vary from product to product.

Hazards

Hazards for automotive chemicals generally include accidental splashing into eyes and accidental ingestion. They may be corrosive.

Precautions

Students must wear safety glasses or goggles to prevent splashes contacting eyes and protective clothing. Student should wear suitable gloves when handling automotive chemicals and should wash hands thoroughly after handling to avoid the possibility of ingestion.

7.6.4 Cleaners and disinfectants

Use and description

Take care the choosing of cleaners and disinfectants for use in the classroom as some may contain hazardous chemicals. Cleaners and disinfectants should be safe, environmentally friendly, and suit the materials they are used to clean. When working with foods, ensure that chemicals are suitable for this purpose.

Disinfectants vary considerably in their ability to destroy microorganisms. Products containing quaternary ammonium compounds (QACs) are suitable for cleaning within a food area and for general disinfection tasks. Disinfectants containing QACs are not thought to present a risk to the user but protective clothing should still be worn.

Students will be familiar with cleaners and disinfectants, so emphasise the importance of reading labels and taking the recommended precautions even when using familiar substances.

Hazards

Students should not use corrosive or toxic disinfectants or cleaners. Cleaners and disinfectants should be stored away from food in a locked cupboard. They should never be stored in food containers such as soft-drink bottles. Cleaners containing very strong acids or alkalis are extremely hazardous and should not be used by students. These include sink and drain cleaners, oven cleaners, bleaches, and dishwasher chemicals. Bleaches can vary in their toxicity, so it is important, when handling them, to wear impervious gloves, safety glasses and a protective apron.

Precautions

Provide correct protective equipment for students (rubber gloves, dustcoats) and ensure that they use them. Take the following precautions when using cleaners and disinfectants:

- Only teachers should dilute and dispense cleaners and disinfectants.
- Dilute chemicals according to instructions on label and make up fresh solutions (cleaners and disinfectants rapidly degrade when diluted).
- Protect skin from dryness, chafing and allergic reactions by providing students with gloves when disinfectants and cleaners are used.
- Avoid getting cleaners and disinfectants into eyes.
- Immediately irrigate eyes with water for at least (ten) 10 minutes if cleaners or disinfectants gets into them. Seek medical attention if in any doubt.
- Never mix cleaners.

7.6.5 Corrosives

Use and description

Corrosive substances are generally used in technology to clean or etch metals. The quantities of corrosive substances stored in schools should be determined by the minimum requirements for teaching purposes. Take only the quantity needed for immediate use into the workroom. Unused quantities should be returned to storage. Corrosive substances must be stored in correctly labelled containers. They must be kept in a locked cupboard or other suitable storage in the science laboratory or technology storeroom. to prevent access by unauthorised people. The substances should be stored according to recommended practice (refer to *the Dangerous Goods (Storage and Handling) Regulations 1989*. Acids must never be stored with alkalis.

Primary students should not use acids or any corrosive substances.

Acid

Use and description

Acids are used to create a solution called an acid bath or pickle to clean oxides on metals. They are also used to etch metals when making circuit boards or to create an etched surface on metal. If students work in the automotive area, they need to be taught the dangers of battery acid (sulfuric).

Several precautions should be taken when working with acids. When acids are being diluted, water must always go into the container first and the acid added then in small quantities. Only the teacher should mix the diluted solutions in the fume cupboard. The floor near the fume cupboard should be impervious to acid splashes and easily washed. If acid is spilt, review safety precautions for the particular acid before proceeding with clean up. Use suitable personal protection equipment. Create a dyke around spill to prevent spreading. Use absorbent material to pick up spill. Some acid solutions can be neutralised by adding an alkali to them in the science laboratory. Acids must be disposed of properly in closed containers. Never pour an acid into a solvent bottle.

Disposal of a used etchant should be via a chemical waste trap (marble filter as used in chemical laboratories) or chemical disposal collection. Do not dispose of sulfuric acid via a marble trap as it can deactivate components. An EPA-licensed contractor should collect concentrated acid waste for removal.

Acids

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Acids give off vapours and create fumes when reacting with materials in an acid bath. Most operations with acids and metals will evolve hydrogen gas, which is highly flammable in air. Other dangerous gases evolved include nitrogen dioxide and sulfur dioxide, both toxic and corrosive.	Acids are corrosive and can damage skin and clothing in contact with them. Acid can be accidentally splashed on skin or into eyes.	There is a danger of acids being ingested if students get them on their hands.
Precaution	Fumes must be prevented from entering classroom by keeping acids in a fume cupboard with the sash kept closed. The cupboard must provide adequate ventilation to remove acid vapour. The fume cupboard fan should be on when students are using acid. Install flash- or explosion-proof fans, exhaust motors and lighting. These may be made acid-resistant with a coating of epoxy resin (refer to 3.2 *The learning environment*, Ventilation, Fume cupboards).	Students must take care not to get acid solution on their hands. They must wear protective clothing, fully enclosed safety goggles and rubber gloves when working with acids. A face shield should be worn if there is a possibility of material splashing or spraying. If acid is splashed on the skin (or clothing) the area must be thoroughly washed with fresh water. If acid is splashed into eyes, they must be thoroughly irrigated with fresh water and medical attention sought. Use tongs made from a material that will not react with the acid to remove items from the acid bath. Take care that items are not dropped back into the acid bath. Rinse items thoroughly in the fume cupboard sink before removing.	No foods or drinking utensils must be allowed near the fume cupboard or around acids. Students must wash their hands before eating and drinking after working with acids.

A description of acids that may be used in technology follows:

Hydrochloric acid (Corrosive 8) is used in diluted form as a flux for soldering galvanised iron, zinc and zinc anneal. It is also used diluted 1:10 to clean and etch metals. Gas and liquid forms are highly corrosive to eyes, skin, and mucous membranes. Acid may produce burns, ulceration, and scarring on skin and mucous membranes. Eye contact may result in reduced vision or blindness.

To dispose of acid, neutralise with crushed limestone, soda ash, lime, or sodium bicarbonate, then take up with sand or other non-combustible absorbent material and place in closed container for disposal.

Sulfuric acid (Corrosive 8) is diluted 1:10 to make a pickle solution to clean metal. Contact with skin causes severe burns. Repeated contact with dilute solutions can cause dermatitis. The fumes or mists of sulfuric acid cause coughing and irritate the eyes and upper respiratory tract. It is a powerful, acidic oxidizer that can ignite or even explode on contact with materials such as acetic acid, acetone and other chemicals. It is dangerous when heated and emits highly toxic fumes.

Nitric acid (Corrosive 8) diluted 1:5 is used as a mordant or etching solution. It is also used as a strong pickle solution on silver and aluminium. It is a caustic and corrosive liquid and a very high, irritant to skin, eyes and mucous membranes. It reacts violently with acetic acid, acetone and some other chemicals. Do not return used acid to stock container.

Zinc chloride (Corrosive 8) is used for the soft soldering of steel, tinplate, copper brass, bronze and nickel silver. It is a corrosive flux. It is harmful if inhaled and irritating to mucous membranes and upper respiratory tract. It is harmful if absorbed through skin and irritating to skin and eyes. It should be neutralised with soda ash/HCI before discharge to the sewer.

Ammonium chloride is known as sal ammoniac. It is available in powder and solid form and used when tinning. It is a corrosive flux and a severe irritant to skin and tissue. The fumes are toxic. Wear suitable clothing such as rubber gloves, apron, and face shield. Use in fume hood and avoid breathing in vapours. If permitted, dispose of down the drain with running tap water. It should be neutralised with soda ash/HCI before discharge to the sewer.

Iron (III) Chloride (Corrosive 8) is used to etch circuit boards in electronics. Ferric chloride oxidises metal in a different way from nitric and hydrochloric acids. It works well on copper and zinc and produces no gas bubbles. It is recommended that the plates be etched vertically in a tank, allowing metal deposits to fall to the bottom. Agitating the solution will assist the etching process.

The solution is normally heated during use, which may cause vapours. It is very important to provide adequate ventilation. The container with the solution can be placed in an unbreakable container of hot water or in a thermostatically controlled crock-pot (50 C).

Ferric chloride has been infrequently associated with skin sensitization in humans. Overexposure by inhalation can result in irritation of the upper respiratory passages, with coughing. Eye problems can occur if overexposure occurs by eye contact. Skin contact can cause skin irritation, with discomfort or rash, skin burns, or ulceration. It should be neutralised with soda ash/HCI before discharge to the sewer.

Ammonium persulphate (5.1 Oxidising agent) is also used for etching circuit boards.

7.6.6 Detergents

Use and description

Detergents are added to some cleaning products to assist in the removal of grease and dirt. Care should be taken in choosing detergents for use in the classroom as some may contain hazardous chemicals. Detergents should be safe, environmentally friendly and suit the materials they are used to clean. When working with foods, ensure that chemicals are suitable for this purpose.

Students will be familiar with detergents. Emphasise the importance of reading labels and taking the recommended precautions even when using familiar substances.

Hazards

The use of laundry substances such as ammonia solution, bleaches and hydrogen peroxide should be carefully supervised. These materials should never be mixed. Detergents should be stored away from food in a locked cupboard and should never be stored in food containers such as soft-drink bottles.

Precautions

Provide the correct protective equipment for students (rubber gloves) and ensure that they use them. Take the following precautions when using detergents and disinfectants:

- Protect skin from dryness, chafing and allergic reactions by providing gloves for students when detergents are used.
- Avoid getting detergent in eyes.
- Irrigate eyes immediately with water for at least 15 minutes if detergent gets into eyes. Seek medical attention if in doubt.

7.6.7 Dyes

Use and description

Dyes are used to produce colours in fabrics. They are classified according to their chemical constitution or their method of application.

Primary students should not use hazardous dyes or powder dyes. If dyeing fabrics, parents or adult helpers should assist. Only dyes that present a low-to-no health risk should be used in schools (refer to 7.4.2.2 *Restricted chemicals*, Chromium). All students handling dyes should take precautions to avoid accidental ingestion, inhalation, and skin or eye contact, and should be aware of any limitations of use.

When using mixing boxes for dyes, remove the top layer of damp newspaper and discard after the dye is mixed. Otherwise clean up dye particles with damp paper toweling and seal in a garbage bag. Do not leave open jars or bottles unsealed or where they can be knocked over.

Dyes

	Inhalation	Absorption/skin contact	Ingestion
Hazard	The main hazard of using dyes is inhaling particles or fumes. Dyes are dangerous when in powder form. Particles are fine and become airborne. Once mixed, this hazard does not exist. Exhaust systems can actually draw dust upwards, causing an inhalation hazard. Fibre-reactive dye can create highly hazardous dust. Cold-water dye can cause respiratory allergies. Dyes using salt as a dyeing assistant and heat during the dyeing process are benzide-based and highly toxic by inhalation.	Cold-water dye is a strong sensitiser. Napthol dye can cause skin irritation and is corrosive by skin contact. It is not recommended for use with primary students. Dyes using salt as a dyeing assistant and heat during the dyeing process are benzide-based and highly toxic by absorption.	Dyes can be accidentally ingested if students get them on their hands. Direct dyes (azo, coaltar, aniline) are often poisonous. Napthol dye is corrosive by ingestion. Dyes using salt as a dyeing assistant and heat during the dyeing process are benzide-based and highly toxic by ingestion.

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Personal protective equipment such as dust masks and respirators with particulate filters must be provided when using dyes and paints. Teachers should demonstrate how to prepare and mix dyes to avoid the incidence of airborne particles. Mix powders with liquids as soon as possible or mix them in ways that avoid them entering the air. Cover work areas with dampened newspaper and ensure adequate ventilation. A mixing box reduces the risks involved in mixing powdered dyes. Use an upturned cardboard box with a side cut out, with layers of dampened newspaper in the bottom. If possible, buy dyes in liquid form. Liquid dyes spilled and left to dry can still be inhaled.	Following good standards of hygiene in the use and storage of dyes can prevent problems. When working with dyes, students must wear rubber, disposable gloves to prevent prolonged or repeated contact with skin. Dustcoats should be worn to protect clothing. Use suitable equipment to stir solutions and dye baths. Stir fabrics in the dye solution with a stick and wear gloves to wring out. Rinse fabrics well after dyeing. Wear old clothes not worn for other purposes. Wash hands thoroughly after using dyes. If chemical products get into eyes by accident, wash thoroughly with water and seek medical attention.	Warn students not to ingest chemicals from paints or dyes by placing paintbrushes or other equipment in their mouths. Dyeing should not be done in areas used for food preparation or for eating and drinking. Do not use the utensils used for dyeing for other domestic purposes (serving food).

Wax

Use and description

Wax is used in the batik dyeing process or in lost-wax casting of metals. Lost-wax casting is a technique used to cast metal objects. Wax should be stored in a dry, clean locked cupboard. Students should be instructed on safety precautions and fire risk when using hot wax. Primary students should not melt wax or handle hot wax.

Hazards

Never leave heated wax unattended. If wax or oil ignites, cover with a metal lid, fire blanket or any non-flammable object. Do not attempt to carry it outside. Do not allow water to come in contact with melted wax.

Wax

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Heated wax releases chemicals that can be irritating. It forms potentially hazardous vapors such as acrolein and aldehyde fumes at high temperatures.	Melted wax poses a burning hazard. Wax may ignite at high temperatures.	
Precaution	Provide dilution ventilation when heating wax. Wax should be heated to lowest liquid temperature. When wax is heated to extremely high temperatures, as in lost-wax casting, direct ventilation must be provided to remove fumes. Kilns should be vented to outside.	Avoid the need to move melted wax. Do not allow students to carry it across the room. Do not use open flames such as gas or propane burners to heat wax. Use a crock-pot or electric frying pan with a temperature control.	

7.6.8 Gases

Use and description

Acetylene is a colorless, flammable gas with a garlic-like smell. It is shipped and stored in dissolved acetone. To ensure safety when storing acetylene, the acetylene cylinder contains a porous material impregnated with acetone. Acetylene is dissolved under pressure into the acetone. Refer to 6.8 *Oxy-acetylene equipment*.

Hazards

The same properties that make acetylene a suitable gas for cutting and welding also make it an extremely dangerous gas to abuse. It becomes unstable (explosive) when under pressure. It can decompose spontaneously if pressure exceeds 15 PSIG. Acetylene can easily be ignited by static electricity. Because of this plastic piping is not used in the transmission of acetylene. Any effort to fill a foreign container such as a balloon or plastic bag with acetylene is highly dangerous. Practices such as these are extremely hazardous. Not only can the user be severely burned by acetylene's high heat content, but severe injury may also be caused by the intense shock wave created by a small quantity of ignited gas.

Precautions

The acetylene cylinder must always be kept in an upright position. Never attempt to transfer acetylene from one cylinder to another, to refill acetylene cylinders or to mix any other gas with acetylene in a cylinder.

7.6.9 Household chemicals

Use and description

Household chemicals are commonly found in home kitchens or laundries. These do not usually pose a risk to students but commonsense should be used when including them in technology activities. Make clear to students that household chemicals are not necessarily harmless. Cleaning products are often poisonous. Even when using common chemicals, students should be encouraged to follow safe procedures for handling substances.

Precautions

Some household chemicals such as salt, vinegar, Alka Seltzer and sodium bicarbonate may create reactions that overflow or erupt.

7.6.10 Solders and fluxes

Use and description

Solders are alloys that adhere to the surface of metals and form a strong bond when molten. Solders with melting points below 300°C are known as soft solders. Those above 700°C are known as hard solders. Soft solders are alloys of tin and lead. Hard solders are alloys of silver, copper and zinc, often called silver solders or silver brazing alloys. These create strong joints on a variety of metals.

The solder and flux chosen must suit the task (refer to 7.6.5 *Corrosives* in this section). Solders are classified into grades depending on their composition. Students use solder when soldering tinplate, brazing, or making jewellery. They may use lead based (soft) solders, silver solders, flux cored solders for electronics or brazing rods to join mild steel or other metals. Although electronic solders contain some lead, they have improved in safety. Australian brands such as Weller and Scope are recommended. Lead-free solders are available and should be selected to suit the metals being soldered.

Solder

	Inhalation	Absorption/skin contact	Ingestion
Hazard	The main soldering hazard is the inhalation of poisonous solder fumes. Brazing rods can give off zinc and copper fumes. Cadmium-based silver solder produce highly poisonous fumes and can cause chemical pneumonia if inhaled. The fumes are carried through the body by the blood and can cause damage to organs.		Students handling solder can accidentally ingest lead or other substances.
Precaution	Provide adequate ventilation directly above soldering benches to draw fumes away from breathing zone. Warn students to avoid breathing the fumes from lead-based solders. Teachers should buy cadmium free solders such as Johnson and Matthey G 6 range. Cadmium-based silver solders must not be used in schools (refer to 7.4.2.1 *Restricted chemicals*, Cadmium).		Students should avoid handling lead-based solders. They should wash their hands thoroughly after handling solders or soft soldering to prevent ingesting hazardous substances.

Use and description

Flux is used with solder to dissolve the oxides formed when metal is heated and to assist solders to flow. Borax, Auflux and Batterns self-pickling flux are used with silver solders. Solder used in electronic work contains a flux core so surfaces do not need a separate flux added. Solders with additives to achieve greater strength or special flow characteristics may require special fluxes. Consult manufacturer's recommendations on proper procedures and fluxes for these solders. A strong corrosive flux may continue its corrosive action from flux residue after soldering has finished.

Flux

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Fumes created by heating flux can be poisonous.	Students should avoid getting fluxes such as Baker's Soldering Fluid on their skin. Flux may bubble and spit when heated and is very harmful to the eyes.	
Precaution	Students must avoid breathing in flux fumes. Teachers must ensure their soldering area is well ventilated. Exhaust fans should be operating when students are soldering in secondary schools.	Students must avoid touching fluxes and should wash their hands thoroughly if flux gets on skin. Students should wear safety glasses while soldering to prevent flux entering eyes.	

7.6.11 Solvents

Use and description

Solvents are substances, usually liquid, that dissolve other substances. Common uses are degreasing and dissolving paint. They are found in many substances such as glues, paint, and paint strippers. Organic solvents are commonly used as components of inks, glues and paints. Students use solvents to clean materials such as metal and glass or to remove materials such as varnish and paint.

Primary students should not use solvents or organic solvent-based products such as adhesives. They should only used water based paints, markers and glues.

The use of some solvents (benzene, toluene, 1,2-dichlorethane) is prohibited in schools (refer to 7.4 *Prohibited and restricted chemicals*). The polyester resin catalyst methyl ethyl ketone peroxide (MEKP) is extremely hazardous. During chemical reactions it releases poisonous fumes hazardous to eyes and lungs. Students must always wear protective clothing when using this solvent. It is a powerful oxidising agent and must be stored away from combustible materials and reducing agents, direct light and heat. Its maximum shelf life is one year, so only small quantities should be kept. Rags soaked in MEKP can self-ignite so spills should be cleaned up with water and sand.

Substituting safer solvents can reduce hazards significantly. Modifying processes can also reduce hazards. Cohesive bonding is the use of pure solvents to soften the surfaces of plastic (acrylic) to be joined (solvent bonding). It involves dipping acrylic into solvent. This process is not recommended for students and should be modified. The solvent should be applied with a syringe bottle to localise the area for capillary attraction.

Solvents

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Most solvents are highly toxic if inhaled. They can cause acute symptoms and long-term problems. If the vapours can be smelled, then students are being exposed. Do not wait for adverse symptoms such as dizziness, headaches and nausea, which mean they are being over-exposed. Solvent vapours are often denser than air and will remain below open windows.	Most solvents are highly or moderately toxic by skin contact or absorption. Skin contact can cause dry scaly skin, rashes, irritation, and burns. Solvents entering the bloodstream through the skin can cause acute symptoms. The polyester resin catalyst, methyl ethyl ketone peroxide (MEKP) can cause blindness if splashed in eyes.	Most solvents are highly or moderately toxic by ingestion.
Precaution	Use solvents only in areas with good ventilation. Working under an adequate extraction system designed to draw vapours away is recommended. Consult occupational hygienists or ventilation engineers if activities involving solvents are included in the school curriculum. Respiration protection is vital where ventilation is poor and solvent exposure is high. Safer solvents should be substituted for more hazardous ones. For example, the paint stripper dimethyl adipate is safer than other solvent types as it does not evaporate as readily. Non-flammable paint strippers are available. Waste materials used with solvent-based products must be disposed of in an approved self-closing waste disposal can emptied each day.	Fully enclosed safety goggles without ventilation holes should be worn when methyl ethyl ketone peroxide is used. When handling solvents, students should wear protective clothing, impervious gloves and safety glasses to avoid solvents being splashed in eyes. Take care over the uses of solvents and other flammable liquids. Quantity in the room must be limited and supplied in spill-proof containers. Avoid skin contact when cleaning up a spillage. Clean up should be done with rags or absorbed by sawdust, sand, or soil and removed in covered container. The solvent can be placed where it can evaporate into the atmosphere away from any ignition source.	Wearing gloves and washing hands thoroughly after using solvents will prevent students accidentally ingesting them. All solvents must be stored in suitable non-food containers.

Hazards

Solvent-based substances are highly flammable. This means they should never be used in a room with a naked flame or near objects that generate high levels of heat that can ignite fumes. Some solvents are combustible, having a flash point under 100° Fahrenheit or below room temperature. Because solvents are volatile, they create hazardous vapours that can be inhaled.

Precautions

Special storage such as a fireproof flammable liquid cupboard clearly labelled is required for paint, thinners, solvents and other volatile liquids. Solvents and other flammable liquids should be stored in a cool place in securely sealed containers, clearly and permanently labelled with contents and safety precautions for use. This must not be in a domestic refrigerator (refer to 7.3.1 *Safe handling and storage of chemicals,* Storing chemicals). Emergency procedures to follow should be prominently displayed in areas where these substances are stored and used. Volatile liquids should not be stored in plastic containers.

Teachers must ensure flammable liquids are not present where sparks or naked flames are present (refer to 2.7 Use of emergency equipment). Rags and paper towels will also be flammable. Ensure that these are removed from the room and stored in an enclosed container.

7.6.11.1 Degreasers

Use and description

Degreasers are formulated to remove heavy dirt, grease and tar from parts of vehicles that get dirtiest – engines, wheel wells and door and trunk jambs. Degreasers are usually solvent-based but water-based biodegradable products are available.

Precautions

Highly flammable or highly toxic chemicals should not be used in degreasing machine parts. Use only a proprietary solvent from a solvent cleaning company or 'narrow cut kerosene', a low-toxicity, high-flashpoint solvent. Standard kerosene does not have a high enough flashpoint.

Solvent degreasing systems should be kept away from open flames, sparks or electric heaters in a well-ventilated area. Students must wear impervious gloves and indirectly-ventilated fully-enclosed goggles. An operable eye wash or safety shower spray to irrigate eyes should be close at hand.

7.6.12 Surface treatments

Use and description

Surface finishes are used to protect the surface of material and to improve or change their appearance or the way they feel. Many materials require surface treatments to protect them from oxidisation, dust or staining, or to make them durable or waterproof. Surface finishes are sometimes used simply to enhance the appearance of a material.

A variety of chemicals can be used to protect or enhance the appearance of materials. These are chosen for particular purposes and to suit particular materials. Oil, polish, woodstain, paint and varnish protect wood, while lacquer, oil, paint, enamel, bluing, anodizing, electroplating, galvanising, plastic coating, and colouring are used to protect metal.

Hazards

Each type of surface treatment poses different hazards to students. Some are safe enough for primary students to use, others need strict supervision.

Many surface treatments contain solvents such as solvent-based waxes, varnishes and stains. Common solvents such as mineral spirits or turpentine are moderately toxic by skin contact, inhalation and ingestion (refer to Solvents in this section). If products contain solvents, they are usually flammable and suitable precautions must be taken.

Precautions

General guidelines for using surface finishes are:

- Read all instructions and application methods carefully before use
- Wear protective clothing as required.
- Clean equipment used in applying the surface finish (brushes) in suitable cleaning material.
- Ensure that cleaning materials are not poured down sink.
- Provide dilution ventilation or do finishing outside.
- Use an explosion-proof spray booth with hazardous spray finishes or have students wear a respirator with an organic vapour cartridge and dust and mist filter.

7.6.12.1 Anodising and electroplating

Use and descriptions

Electroplating is a highly specialised technique that can be dangerous. It involves depositing a metal coating onto an electrically conductive surface. The solution used in plating contains cyanide. Apart from the risk of an accident, the fumes present a definite hazard.

Anodising is an electro-chemical process used to form a tough oxide film on the surface of metals. Most metals will anodise. The process is used on aluminium to give it a hard, attractive and protective surface.

Hazards

Both processes pose the risk of inhalation of hazardous substances. Acid mist from chrome-plating solutions is toxic and corrosive and presents a considerable health hazard. Chromium and cadmium, used in plating processes, are included in 7.4 *Prohibited and restricted chemicals*. Acids may also be used in the anodising process.

Precautions

Due to the hazards involved and the specialist equipment required, it is recommended that schools send work to be electroplated or anodised to specialist industrial premises. Small-scale work such as jewellery can be electroplated without the use of cyanides.

7.6.12.2 Chemical colouring

Use and description

Metals can be coloured using a variety of chemicals to obtain different colours.

Lacquer is used to protect the coloured surface (refer to Stains, lacquer and varnish in this section). Some metals, including steel, are heated to create colours on a clean surface, then quenched in oil to maintain the colour. Steel can be quenched in sump oil. Bluing compounds are used to colour steel. Avoid compounds that contain selenium.

Hazards

Teachers must know the hazards associated with chemicals used for colouring and follow manufacturer's instructions. The chemicals used vary widely in their toxicity. For example, potassium sulphide (Liver of Sulphur) is mixed with warm water to colour metals. It must not be overheated or allowed to come to the boil as it turns to hydrogen sulphide, which is similar to carbon monoxide in toxicity.

Precautions

Obtain material safety data sheets from manufacturers and follow their instructions carefully. Ensure that these procedures are carried out with adequate ventilation and that students avoid inhaling any fumes created. They should wear protective gear such as dustcoats or aprons, goggles, and impervious gloves.

7.6.12.3 Paint

Use and description

Paint is used to decorate and protect a variety of surfaces in technology. Primary school students may use only water-based paints, such as poster paints or acrylic paints. Secondary students may use paints that are not water-based, such as enamel paint. Paint types include acrylic art paint, poster paint, powdered paint, house paint, metal primers, automotive paint (acrylic and enamel), and aerosol paint. (Refer to 6.10.2 *Compressed air equipment*, Spray gun.)

Paints are made up of thinners, binders and pigments. Thinners usually consist of solvents that evaporate when paint is applied (refer to Solvents in this section). There are two types of binders: epoxy resins and urethane resins.

Pigments in paint give it color and improve its durability. Teachers should carefully check labels on the paint they intend to use.

Paint

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Paint in powder form, such as powdered tempera, may be hazardous if inhaled. Some contain toxic pigments or other chemicals. Many pigments contain hazardous substances such as lead chromates, chromates, cadmium and other chemicals (refer to 7.4 *Prohibited and restricted chemicals*). Many pigments may cause cancer. Epoxy resins can cause immediate symptoms and are dangerous if exposure is repeated. Urethane resins can cause allergic reactions.	Students should avoid skin contact with non-water-based paints (enamel, automotive, oil). Skin can absorb solvents and chemicals in paints. Users can develop dermatitis from some pigments in paints.	Paint may be ingested if care is not taken with containers used to mix it. These should never be used for food. Students may accidentally ingest paint if they place fingers or tools used to apply paint in mouths.

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Paints should only be used in well-ventilated areas. Avoid any possibility of paint entering body. Avoid paints with lead and other hazardous chemicals. Avoid mixing powder paints and buy liquid paints. Clean up dry paint with damp sponges. Where possible, substitute water-based paints for solvent-based paints. Water-based paints may still contain small amounts of solvents but not enough to pose a hazard.	Ensure students protect skin from contact with paint by wearing gloves, aprons, dustcoats, and smocks. Hands should never be cleaned with solvents such as turpentine. Rub baby oil into skin and wash off with soapy water as an alternative. Students should wash their hands after using paint.	Warn students of dangers of accidental ingestion. Do not use paint containers for foods.

Aerosol paint and airborne paint particles

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Using paint in aerosol cans is more hazardous than using a paintbrush since paint drops are dispersed over a wide area. Aerosol automobile paint may contain lead.	Solvents in spray paints can be absorbed into the skin. Exposed skin can be coated with airborne paint particles.	There is a danger of paint being ingested if students get it on hands Food can be contaminated by airborne paint particles.
Precaution	Aerosol cans should be used outside away from other students. Point can in direction that blows mist away from students. If hazard can't be reduced through ventilation or a method of painting, then respirators should be worn and a spray booth used. Avoid lead-based automotive aerosol paints.	A layer of barrier cream on hands and face will ensure spray can be easily cleaned off. Protective clothing should be worn.	Before eating students should wash face and hands after using aerosol paint. Food and drink must not be stored near spray painting.

7.6.12.4 Polyurethane gloss paint

Use and description

Polyurethane gloss paint (*AS 1485-1983*, 10.9 Polyurethane) produces a very smooth shiny surface on wood.

Hazards

It presents a toxic hazard during application.

Precautions

Same precautions should be taken as for glass fibre reinforced resins. Adequate ventilation should be provided. If sprayed, a spray booth must be used.

7.6.12.5 Polishing compounds

Use and description

Polishing compounds for metals come in bar form and consist of grades of abrasives, such as crocus, rouge, Tripoli, and whiting. These are used to coat polishing mops on polishing or buffing machines. Cutting compounds have a coarse abrasive for cutting back the surface of metals. Liquid abrasives used for hand polishing consist of fine abrasives in a liquid. (Examples are Brasso and Silvo.) They produce a high lustre on previously polished surfaces.

Hazards

Polishing may create fluff and dust. Chemicals in polishing compounds may be hazardous if accidentally ingested.

Precautions

Students can wear a dust mask, if dust and fluff are a problem. They should wash their hands after polishing metals with a polishing machine or using liquid abrasives, especially before eating.

Students should wear rubber disposable gloves when hand polishing with liquid abrasives.

7.6.12.6 Glass fibre reinforced resins

Use and description

For information on glass reinforced plastics teachers should refer to 8.1.8 *Materials list*, Plastics.

Resin is a liquid polymer that cures to a solid state when catalyzed. Two types of resins are used – epoxy and polyester. Epoxy resins can be combined with a number of different hardeners. The most commonly used are amine hardeners. Anhydride hardeners can also be used. Polyester resins are usually combined with methyl ethyl ketone peroxide (MEKP) (refer to 7.6.11 *Chemicals used in technology*, Solvents).

Care must be taken when mixing the components of glass fibre reinforced resin (catalyst, accelerator and resin). Catalyst is the common name given to the substance added to the resin to initiate the cure. An accelerator is an additive to polyester resin that reacts with the catalyst to speed up polymerisation in room temperature-cured resin. Mix components in disposable containers (not polystyrene). Never mix the catalyst and accelerator without the resin to dilute the mixture. They can explode when combined. They should never be mixed or stored together.

Most resins are flammable. Store resins, hardeners and accelerators in separate, flammable liquid storage cabinets. Never store them together. Keep tins tightly closed when not in use and when empty.

Organic peroxides used as catalysts must be stored according to the *Dangerous Goods Act 1985* and the *Dangerous Goods (Storage and Handling) Regulations 1989* for Class 5.2 Organic peroxides. Refer to *AS 1484-1983*, 10.8.5 and 10.8.7 for details on fire and explosion hazard and storage. Suitable fire extinguishers and warning signs are needed in these areas.

Care should be taken when disposing of resins and hardeners. Cover benches with plastic sheeting and a layer of paper when working with resins. Paper can be disposed of when it gets resin or hardener on it. The plastic sheeting is disposed of after the activity. Put unused resin in bins partly filled with water to avoid a fire. Small left-over amounts can be mixed and left to cure, then disposed of when cool. Do not dispose of in a liquid state. Containers of curing materials may get hot enough to give off hazardous fumes and ignite combustible materials. Do not dispose of hardener in waste containing sawdust of fine cellulose materials. Spontaneous combustion may occur.

Glass fibre reinforced resins

	Inhalation	Absorption/skin contact	Ingestion
Hazard	Styrene vapours are main toxic hazard of uncured glass fibre reinforced resin. Most polyester resins contain styrene, although some have lower styrene emissions. Styrene is a solvent and can enter body through lungs or skin. Fumes can irritate eyes, nose and throat and cause headaches, nausea and drowsiness. Long-term damage can include memory loss, mood and personality changes, and liver damage. High temperatures make evaporation and subsequent vapours greater. Size of the surface being coated will influence amount of vapour. Inhaling dust created when sanding can be hazardous and can increase risk of sensitisation.	Use of resins and hardeners poses serious dermatitis risk. Some chemicals used in resins and hardeners are sensitisers and many chemicals used in hardeners for epoxy resins are potent sensitisers.	Danger of resins being ingested if students get them on their hands and place fingers in mouths.

Glass fibre reinforced resins

	Inhalation	Absorption/skin contact	Ingestion
Precaution	Glass fibre reinforced resins should only be used in a well-ventilated area. Local exhaust ventilation that can draw away fumes is recommended. Minimise number of students using material at one time. Prevent fumes of resins, hardeners and solvents from entering students' breathing zone. Keep the work between student and ventilation system. Students should wear a suitable, properly fitted respirator if ventilation system does not completely remove hazardous fumes and vapours. Provide ventilation and wear dust mask when sanding.	Read MSDS for hardeners and promoters and choose ones without sensitisers. Seek advice from manufacturer. Avoid skin contact with resins and hardeners by wearing protective clothing (heavy-duty vinyl gloves, overalls, aprons, and safety goggles). Use squeegees and rollers, not hands, to smooth air bubbles. Any contamination should be washed off immediately. Use non-solvent hand cleaners. Always wash protective clothing by itself.	Wash hands before eating or drinking after using resins. Do not store food near glass fibre reinforced resins.

7.6.12.7 Stains, lacquers and varnishes

Use and description

Stain is used to change the colour of wood while leaving grain visible. Stains enhance but do not protect the surface of wood.

Lacquers are used on metals such as copper and brass to prevent tarnishing. They may contain toxic solvents such as toluene and hexane.

Varnish provides a clear tough surface on wood and can provide a high degree of protection against moisture.

Hazards

Most stains, lacquers and varnishes will contain hazardous solvents. This also means they will be flammable (refer to 7.6.11 *Chemicals used in technology*, Solvents in this section). Some people may develop allergies to these substances.

Precautions

Limit the use of lacquers and varnishes. Provide adequate ventilation when using them and follow manufacturer's instructions. Paint rather than spray these finishes onto surfaces to avoid inhalation. It is important to avoid skin contact by wearing impervious gloves. Choose products that do not contain highly toxic solvents (benzene, toluene).

7.6.12.8 Oils

Use and description

Oil finishes such as linseed and tung oil provide a water-resistant non-gloss finish. Oil darkens the wood but leave the grain visible. It is applied liberally and the excess wiped off after a while.

Hazards

Tung oil, and linseed oil and most other wood-finishing oils do not have significant toxic hazards but can be sensitizers. Oil-soaked rags and paper towels are a spontaneous-combustion hazard.

Precaution

Store oil-soaked rags in waste cans emptied daily. Avoid skin contact with oil finishes by wearing impervious gloves.

7.6.12.9 Powdered plastic coating

Use and description

Small metal objects can be coated with plastic to provide a protective and decorative surface. A range of plastic compounds is available in powder form. The heated object is immersed in a fluidised bed, which is powdered plastic through which air is forced. The plastic fuses to the heated metal surface.

Hazards

Inhalation of fumes or plastic powder may occur if care is not taken.

Precaution

Ensure adequate ventilation and have students wear dust masks if there is a hazard of inhaling plastic powder.

7.6.12.10 Enamels

Use and description

Vitreous enamel is a combination of clear glass and coloured metallic oxide in powder form applied to copper and baked in a kiln to fuse it to the metal surface.

Hazards

Enamels may contain toxic compounds such as lead. Dispose of enamels that contain lead. Enamel powder can be inhaled.

Precautions

Prevent enamel powder from becoming airborne by applying enamels in an enclosed box. Keep the enameling area clean so that no dust is left on surfaces. Cover work area with dampened newspaper and ensure adequate ventilation. Remember that exhaust systems may actually bring dust upwards to where it can be inhaled. Clean up with damp paper toweling and seal in a garbage bag. Avoid inhalation of fumes from heating process by ensuring adequate ventilation when firing.

7.6.13 Testing

7.6.13.1 Fabric testing

A variety of chemical tests can be done to identify the nature of fibres.

Hazards

A number of chemicals used for fibre testing are hazardous and therefore require careful handling.

Precautions

It is recommended that only senior students perform these activities. Fabric testing should be done in a science laboratory or similar location under the supervision of a qualified teacher and in consultation with science teachers and laboratory technicians. The following precautions should be taken:

- The teacher or laboratory technician should dilute and prepare chemicals.
- Tests must be carried out in a well-ventilated room.
- Students must be instructed on the safe use of chemicals they will use.
- Wear suitable clothing and eye protection.
- Wear suitable gloves when a corrosive or irritant solution is used.

7.6.13.2 Food testing

Food may be tested with chemicals to determine its constituents.

Hazards

Chemicals used to test food may present hazards. Activities involving microbes (investigating growth of bacteria or studying decay of foods by mould) pose significant risks, because it is often impossible to be sure of the type of microorganism present.

Precautions

All food tests should be carried out in a science laboratory to minimise the risk of contamination of food in the food-preparation room.

Activities involving microbes should be carried out in a science laboratory. Special care and attention should be taken if and when agar plates are used in experiments involving food and microbial growth. When recording results of microbial growth, the agar plates should be sealed so that observation is done with the lid in place. Plates must not be removed from the laboratory. Disposal of the agar plates should follow correct sterilization procedures. Teachers should check with science teachers or laboratory staff for advice.

7.6.14 Welding electrodes

Use and description

Electrodes are pieces of wire coated with solid flux clamped into the electrode holder of an arc welder. A variety of electrodes are available to suit the metal being welded and the weld properties required. Strictly follow manufacturer's instructions for using welding electrodes.

Hazards

Hazardous fumes can be created by heating most types of metals, especially metals with galvanised or painted surfaces. Electrodes may contain very hazardous substances such as lead, cadmium and mercury. As the flux on the electrode burns, it produces gases.

Precautions

Ventilation is extremely important when arc welding. Good general ventilation is required, and a booth or welding area should be used (refer to 3.2.8 *The learning environment,* Ventilation and 6.9.2 *Welding equipment,* Electric arc welders).

Consult packaging for information about electrodes. Avoid those that contain hazardous substances.

References

Department of Education & Training

Guidelines for Storage of Science Chemicals, Second Edition, 1999.

Compliance Guidelines for Schools: Dangerous Goods (Strorage and Handing) Regulations 2000.

Victorian Government Schools Reference Guide

- 4.4.5. Safety in the Curriculum
- 4.4.5.1.3 Science, Chemicals
- 4.4.5.3 The Arts
- 4.4.6.3 Insecticides, herbicides and termiticides
- 7.24.7.1 Asbestos management

Australian Standards

AS 1483-1985 Health and safety in workrooms of educational establishments

- 10 Harmful substances
- 10.5 Electroplating and anodizing
- 4.7 Handling and storage.
- 4.7.1.2 Acid Solutions
- 10.4 Pickling steel surfaces

AS/NZS 2243:1997 Parts 1–10, Safety in laboratories

- Part 8 Non-recirculating Fume Cupboards
- Part 9 Recirculating Fume Cupboards

AS 2982 Laboratory Construction

AS 1627.5-1994 Metal finishing. Preparation and pre-treatment of surfaces. Pickling, descaling and oxide removal.

Victorian Government

Dangerous Goods Act 1985

Dangerous Goods (Storage and Handling Regulations) 1989

Drugs, Poisons and Controlled Substances Act 1981

National Health and Medical Research Council, Standard for the Uniform Scheduling of Drugs and Poisons No 7 1992

EPA information bulletin Publication 423: *List of treatment and disposal facilities for prescribed waste January 1998*

8 Safe use of materials: general

The wide range of materials students use in technology can be classified into the following broad groups:

- Design equipment
- Fibres and fabrics
- Foods
- Miscellaneous materials
- Metals
- Natural materials
- Paper and cardboard
- Plastics
- Recycled materials
- Wood.

Although these groups encompass a great variety of materials, they do not cover all materials that may be used in technology programs. For example, schools may offer programs in agriculture and horticulture or electronics that require specialised materials. Most materials will not pose hazards if used and handled correctly and according to MSDS information.

Teachers should be aware of any hazards associated with materials students use and the safety precautions required in working with them. Materials bought should have labels clearly identifying the material and giving information about the manufacturer. When reading labels, teachers should be aware that warnings can have a wide range of interpretations. For example, 'Use with adequate ventilation' can mean use near an open window, use in a spray booth, or use with an extraction system. Detailed information should be sought from manufacturers and MSDS.

Manual handling of materials

Hazardous substances can be inhaled, ingested or absorbed through the skin (refer to 7.1 *Hazardous substances*). Materials can also pose a manual-handling hazard if they are large, heavy, awkward or have sharp edges or protrusions, and students lift or move them. Materials should be bought precut or in sizes that can be transported safely. Students should not be required to lift, move or carry materials the weight or size of which could cause/involve injury. Teachers should refer to 3.2.12 *Manual handling* for information. OHS *(Manual handling) Regulation*s provide guidance on assessing manual handling risks, approaches to moving and transporting materials, and controlling risk.

Students should be instructed and supervised in correct lifting methods. Long lengths of materials should be supported horizontally by two people when being carried. Materials should be carried in front of the body and held so that the corners do not injure self or others. Care should be taken when lifting foods from shelves (bags of flour, bulk foods, student work). A sturdy stepladder or step should be used to reach high shelves. Heavy, awkward loads should be stored at convenient heights and care taken when lifting them on and off. Students should wear cotton or leather gloves when transporting large sheets to avoid cutting hands on sharp edges.

Distances that materials are moved should be kept to a minimum. Delivery should be as close a possible to storage areas. Passageways through which students carry materials must be kept clear and free of tripping hazards. Ensure that suitable trolleys are used to transport materials.

Common processes have been identified for each material in the following Materials list. For further details teachers must refer to 7 *Safe use of materials: chemicals* for chemical processes, and to 4 *Safe use of tools and equipment* for processes involving tools and equipment.

8.1 Materials list

8.1.1 Design equipment

Design equipment includes items such as felt-tipped pens, paints, grey lead pencils, coloured pencils, permanent markers, whiteboard markers, and white-out.

The main hazards with design equipment are chemical absorption through skin, accidental ingestion of substances, and inhalation of fumes (refer to 7.5 *Safe use of chemicals in technology*). Solvents in solvent-based items such as markers can be absorbed through skin and give off fumes that can be inhaled. Solvent hazards are outlined in 7.6.11 *Chemicals used in technology*, Solvents. Water-based alternatives should be substituted for solvent-based ones. Tape or water-based alternatives are available as a substitute for white-out containing solvents.

Primary students should not come into contact with items containing organic solvents.

Students should be warned of the dangers of ingesting chemicals if they put items in their mouths.

8.1.2 Fibres and fabrics

Fibres and fabrics come in a variety of types. Fabrics are generally cut from a roll or smaller pieces. Fibres are also available in skeins and balls. Some fibres such as uncarded wool are available in an unprocessed form.

Processes commonly used with fibres and fabrics are cutting, sewing, pinning, dyeing, glueing, overlocking, tying, weaving, and ironing.

Working with fibres and fabrics does not generally pose a hazard to students. However, some substances used with fibres or fabrics, such as glues, dyes, printing materials or chemicals for testing, may pose hazards. Hazardous substances such as these are also included in 7.5 *Safe use of chemicals in technology*.

Absorption and skin contact.

Some chemicals in substances used with textiles may be absorbed through the skin. Always check labels and obtain MSDS to decide what precautions are needed. Impervious gloves

should be worn when handling dyes, glues and other hazardous substances (refer to manufacturer's specifications).

Avoid using or limit use of solvent-based products with fabrics and fibres (glues, white spirits).

Avoid skin contact with glues. Most glue contains solvents or other hazardous chemicals that may be absorbed through the skin. Use water-soluble glues such as hobby glues where possible (refer to 7.6.1 *Chemicals used in Technology*, Adhesives).

Melted wax used for batik work poses a burning hazard and should only be used under close supervision (refer to 7.6.7 *Chemicals used in Technology*, Dyes)

Students should always wear safety glasses if there is any risk of dust or other hazardous substances entering eyes.

Ingestion

When working with chemicals such as dyes, students must be extremely careful not to inadvertently place utensils in mouths or eat foods exposed in the room. They must wash hands thoroughly before eating. If food utensils are used as dyeing tools do not reuse them for preparing food (refer to 7.6.7 *Chemicals used in Technology*, Dyes).

Before activities students must cover cuts or wounds on hands or arms with waterproof bandages. Provide soap and disposable paper towels for student use when handling hazardous substances.

Inhalation

Dyes are most dangerous in powder form and can be extremely hazardous if inhaled. Once mixed, this hazard does not exist. Teachers should not use powder dyes with primary students (refer to 7.6.7 *Chemicals used in Technology*, Dyes).

8.1.3 Foods

Students work with a variety of foods in technology. Common processes are cutting, mixing, heating, and a range of cooking methods. The hazards associated with food concern hygiene and food preparation, handling, storage, selection, consumption and disposal. Changes to the Victorian Food Act 1984 promote and support good hygiene practices in food businesses. These laws now apply to all food business operators and food premises in Victoria. Teachers should refer to the Food Safety Victoria website http://www.foodsafety.vic.gov.au for information on safe food systems. The Templates section includes an *Events Food Safety Program* template for one-off events, temporary stalls, festivals and community groups. Teachers may also decide to complete the *FoodSmart* template to become familiar with what is involved in a Food Safety Program for businesses.

8.1.3.1 Hygiene

Hygiene is a vital consideration when working with foods. A high standard of personal hygiene and cleanliness will reduce the chance of food contamination. Before handling food, students should:

- Wash hands thoroughly with soap and water, particularly after visiting the toilet, using a handkerchief or tissue, handling garbage, or touching ears, nose, mouth and hair. Food preparation areas in secondary schools should be equipped with soap and disposable paper towels for student use.

- Understand the importance of hygiene if handling food when they have coughs or colds. Students with an infectious disease should not handle food.
- Understand the hazards of tasting foods, then replacing tasting utensil in food (commonly called double dipping).
- Wear clean and washable protective clothing.
- Avoid hair coming into contact with food by tying long hair back or wearing a hat or hairnet.
- Avoid skin coming into contact with food by wearing disposable gloves when handling food at school.
- Cover cuts or wounds on hands or arms with waterproof bandages. Coloured dressings, easily seen if they fall off, are available.
- Remove rings and bracelets when preparing food.
- Keep fingernails clean and short and without nail polish.

8.1.3.2 Food preparation areas

In secondary schools, the food preparation area should have hot and cold water for washing tools and equipment. Teachers should ensure the following conditions in the food preparation environment:

- Free of vermin and insects (fly screens, self-closing doors or plastic strips).
- Free of dust by keeping floors and work benches clean.
- Food and equipment kept in enclosed storage areas when not in use.
- Adequate ventilation such as open windows or doors. Exhaust ventilation systems in secondary school food preparation areas.
- Efficient and hygienic means of disposing of kitchen waste.
- Food not prepared close to chalkboards in general classrooms to prevent chalk dust contaminating it. Whiteboards rather than chalkboards in food preparation areas in secondary schools.

Limit the transporting of hot foods as much as possible. Sinks and heatproof surfaces should be positioned to avoid unnecessary movement of hot foods.

Care must be taken when straining foods that hot liquid does not splash students. Suitable strainers should be used and other students warned to stand clear. Leave a safe distance between students and food preparation area when demonstrating food preparation.

Students must be shown the correct way to handle hot foods and cooking equipment. Oil or fat being heated must never be left unattended.

Primary students should not work with hot foods or liquids.

Teachers should demonstrate ways to avoid particles getting into the air when working with foods in powder form (flour, icing sugar, baking powder). Mix powders with liquids as soon as possible or mix in ways that avoids powders getting into the air.

8.1.3.3 Selecting foods

Choosing food for preparation and consumption at school is initially the teacher's responsibility. Although students generally do not select and store food, it is essential that they be taught the correct procedures to avoid health hazards. Students can apply these procedures for selecting and storing food at home.

Foods chosen for student use should be as fresh as possible. The teacher (or assistant in a secondary school) will need to check food for damage and freshness. Scrutinise use-by and best-before dates on food and do not buy or use foods beyond these.

Food should be returned or discarded if mouldy or damaged, swollen, out of shape or in rusty cans. These can indicate bacterial contamination. Green potatoes show the presence of solanin, which is poisonous if eaten.

In planning student activities involving food, teachers must consider whether tasting, preparation and handling of certain foods (such as meat, alcohol, drinks containing caffeine) may be unacceptable culturally or legally.

8.1.3.4 Handling foods

Food must be handled correctly and prepared in hygienic conditions to avoid contamination and to prevent the bacteria already in food from multiplying. Bacteria multiply rapidly in temperatures between 5°C and 60°C, so it is important that food is in this temperature range as briefly as possible. In raw food cooked thoroughly to 100°C, most bacteria will be destroyed.

Raw food to be cooked can be safely handled with clean hands.

No cooked and ready-to-eat food should be touched with bare hands. Use tongs, spoons, spatulas or disposable gloves. Keep raw and cooked food separate at all times as raw food can contaminate cooked food. Use different utensils for preparing raw or cooked food. If it is not possible to have two sets of equipment, thoroughly wash utensils in hot soapy water between uses.

Food should be thawed before cooking. If it must be cooked while frozen, care must be taken that the food's internal temperature reaches 70°C.

Some foods, such as fruit and vegetables, must be washed in clean water to remove chemicals and bacteria before preparing it to eat.

8.1.3.5 Storing foods

Most food is likely to be stored near to the food preparation area in secondary schools. Smaller quantities of non-perishable food, particularly for primary student use, may be stored in a staffroom or general classroom. Take care in storing perishable items. Non-perishable foods, such as flour, sugar, rice, should be stored in sealed containers. Consider the following when storing foods:

- Follow storage instructions on food packages and observe use-by dates.
- Design and maintain storage areas so that pests cannot get in.
- Keep all foods off floor level.
- Clean and tidy shelves regularly, rotating stock and discarding all old stock.
- Store all open packets of food in labelled airtight containers with the use-by date marked.
- Label and date any foods prepared and stored (preserves, frozen foods).
- Store fresh fruit and vegetables in a cool environment or in the refrigerator's crisper.

When storing foods in the refrigerator or freezer, ensure that:

- All highly perishable food is immediately placed in the refrigerator or freezer.
- Cooked foods are cooled before storage.
- All food is covered and stored in suitable containers.

- Raw and cooked foods are stored separately.
- Raw fish, meat and poultry are placed on the bottom shelf where they cannot drip onto other food. Otherwise store in suitable leakproof containers.
- The temperature is correct for safe storage. Frozen food should be stored at minus 18°C and refrigerated foods at 2°C –3°C.
- Frozen food is evenly stacked and not placed above the load line in freezer cabinet.
- Food is packaged, labelled and dated before freezing.
- Frozen food is placed in refrigerator to thaw to ensure that it remains cold throughout the thawing process.

Note
When frozen food is thawing, bacteria in it start multiplying. Food may be thawed in the microwave oven but must be cooked immediately. Do not refreeze thawed food, as bacteria will have started multiplying during the thawing process. Refreezing does not kill the bacteria. When the food is thawed again the bacteria level is likely to be higher than before.

8.1.3.6 Consumption

If students eat contaminated food they may suffer from food poisoning. Proper handling and storage of foods will prevent this. Food naturally contains bacteria. Some, especially raw foods, may contain food-poisoning bacteria. Even healthy people carry food poisoning bacteria on their bodies that can be spread to the hands through touching.

Teachers should be notified of students' food allergies as registered on student medical records. They must ensure that the students do not eat these foods.

8.1.3.7 Waste disposal

After each class remove food scraps from the food preparation area. Some schools may have a recycling program that requires all items to be placed in separate receptacles. Food wastes can pose a hazard if pests such as flies, other insects or rodents can get to it. These can transfer bacteria to food in storage areas or to food left uncovered during food preparation. In turn, this food may cause food poisoning if eaten. Observe good hygiene when handling food waste. Establish procedures for sorting waste so that suitable foods can be used in compost and packaging recycled.

- Remove garbage and refuse from food-handling areas after each practical session and store in containers that are easily cleaned, durable, fly-proof, rodent proof and have a tight fitting lid.
- Ensure garbage and refuse containers are in good repair and cleaned regularly.
- Keep bins away from food areas.

8.1.4 Metals

Metals come in a variety of types and forms – rod, square, flat, round tube, square tube, angle, sheet, and foil. Metals commonly used in technology include brass, copper, bronze, nickle, silver, tinplate, aluminium, pewter, zinc, mild steel, medium carbon steel, stainless steel. Students will use common, easily manipulated metals such as tin cans, aluminium foil, coathanger wire, and paper clips.

Processes commonly used with metals are sawing, cutting, filing, grinding, bending, casting, heating, soldering, turning, beating, chemical colouring, and welding. Many of these processes can be hazardous.

Absorption and skin contact

Metals are generally not clean. They may be chemically treated, oxidised, corroded, dusty dirty, greasy, oily or scaly. Old cloths or rags can be used to wipe surfaces to remove dirt, oil or grease before use. In some cases, metal will need to be cleaned before processing. This may involve filing, pickling in acid, wire brushing, sanding, or using solvent.

Metals that have been in an acid bath must be thoroughly rinsed in the fume cupboard sink. Warn students of the dangers of handling metals that have been in acid (refer 7.6.5 *Chemicals used in technology*, Corrosives).

If hazardous substances such as solders, solvents, lacquers, turpentine, methylated spirits or other chemicals are used on metals the correct precautions must be taken. Supply gloves for students to use while working with hazardous substances. Other precautions should be taken as needed, including wearing facemasks and improving ventilation. Students should cover any cuts or abrasions with suitable dressings to prevent metal dust or other substances entering. They can wear disposable gloves over these for added protection.

Solvents are particular hazardous (refer to 7.6.11 *Chemicals used in Technology*, Solvents). Use should be limited and primary students should not use them at all.

Students should take care when handling metals. Cut or drilled metals can have burrs or rough edges that pose a cutting hazard. Burrs or rough edges can be removed with a file. Wire is sharp and can be an eye hazard if small pieces are cut. Students should wear safety glasses when handling wire.

Working with metals may involve heat. Some metals do not change appearance when heated and students can accidentally pick up or touch hot metal. Keep heated metals away from general work areas and teach students to assume that metals are hot. They should handle heated metals with tongs. Ensure that students keep clear of the area when metals are transported to a sink or water bucket.

8.1.4.1 Molten metals

Metals may be melted during processes such as casting pewter or silver and foundry work. Lead should not be used for casting. Care must be taken to prevent spills or splashes if students handle molten metal. Protective clothing and equipment must be used. Show students how to handle the metal safely. For example, when casting silver in a centrifugal casting unit (refer to 6.6.2.3 *Centrifugal casting unit*), students must wear fireproof gloves that fully protect hands and forearms. A full-face mask is recommended to protect from molten metal splashes.

Moisture is danger to avoid when casting. Materials such as cuttlefish or balsa wood used for making molds for pewter casting must be perfectly dry. Dampness or water can cause molten metal to erupt.

Metal for silver casting must be clean and free of solder and other particles. Test by passing magnet through it.

Dust and particles created by processing metals can be eye hazards. Students should wear safety glasses or goggles when there is a risk of airborne particles or when working with hazardous substances that may splash into eyes or create fumes (glues or solvents).

Ingestion

To guard against ingestion of hazardous substances when working with metals, no food must be allowed in purpose-built technology classrooms. Students must wash their hands thoroughly after practical work with metals. Warn students about putting tools in mouths

and biting fingernails or sucking fingers while working with metals. In primary schools, food should not be eaten until materials have been cleared away, the area cleaned, and students have washed their hands.

Students should avoid skin contact with lead. (Refer to 7.4.2.4 *Lead* and 7.6.10 *Solders and fluxes*.) It is especially hazardous if ingested and students must wash hands thoroughly after handling lead in leadlighting (refer to *Victorian Government Schools Reference Guide* 4.4.5.3.6 *The Arts, Leadlighting*).

Care must be taken with chemically treated or oxidised metals. For example, green oxide on copper is poisonous.

Inhalation

Metalworking processes such as heating, metal casting, leadlighting, welding, soldering and pickling in acid create fumes hazardous to inhale. When buying silver solder, choose one that does not contain cadmium. Cadmium creates fumes that can cause lung damage. It must not be used in schools.

Hazardous airborne particles can be created when students saw, file and grind metals, or use enameling powders. Ensure that students learn to prepare materials so that they need a minimum amount of filing or grinding. Substances like enameling powders should be applied in an enclosed container to avoid particles escaping into the air.

Some processes used with metals create fumes. If fumes cannot be eliminated, ventilation is needed in the form of mechanical extraction systems, fume cupboards, or ventilated welding bays. Opening doors and windows allows fresh air into a room but will not necessarily extract harmful airborne particles or fumes (refer to 3.2.8 *The learning environment*, Ventilation). Local exhaust ventilation will capture contaminants where they are generated.

Students should wear dust masks or respiratory equipment when engaged in processes that create dust or fumes.

8.1.5 Miscellaneous materials

Miscellaneous materials are those that don't fall into the other groups and are commonly used in schools. They include glass, candles, batteries, globes, electrical wire. Teachers should apply risk-management processes to these materials. They should ask: What are the hazards, if any, of using this material. Is there a substitute without these hazards? Can the activity be done without using the material? What information do students need to use this material safely?

Glass containers or sheets may be used in students' projects. If not used carefully, it poses a cutting hazard. If possible, replace glass with materials such as plastic. Cover sheet glass with a protective backing or masking tape.

Candles may be used to heat materials or for demonstration in technology. Students may also make candleholders. Candles pose a burning hazard and must not be in the same area as flammable liquids. Secure candles in a candleholder, sand-filled can or in Plasticene to eliminate the risk of tipping over. To collect melted wax and prevent fire if the candle falls over, stand candles on non-flammable surfaces such as a shallow cooking tray. Never leave candles unattended.

Students must tie back their hair and secure loose clothing when observing or using candles or any naked flame.

8.1.6 Natural materials

Natural materials are items found in nature and easily collected by students.

They include sand, soil, plants, logs, rocks, shells, and plant material such as branches, gum nuts, seeds. Processes used with natural materials include digging, planting, cutting, constructing, and glueing.

Absorption and skin contact

Collecting natural materials pose the hazards of bitten by insects and coming in contact with toxic plants or unclean and unhygienic items. Teachers may decide gloves are required when collecting.

Teachers will decide whether students should wear safety glasses while working with or collecting natural materials to avoid dust particles from soil, sand, or potting-mix entering eyes.

Care should be taken when working with soils and potting mix. Students should avoid direct skin contact by wearing rubber gloves or gardening gloves. They should wash hands and any exposed areas thoroughly after handling soils. Gardening clothes should be laundered, especially when chemicals have been used (refer to 7.6.2 *Chemicals used in technology*, Agricultural chemicals).

Ingestion

Students must wash hands after handling natural materials. Warn them of the hazards of placing fingers in mouths after handling materials that may be unhygienic or toxic.

Inhalation

Soil and potting mix contain composted material. All decaying material in nature contains micro-organisms such as Legionnella longbeachii. Diseases in soils and potting mix can be airborne and can be inhaled by students. To avoid this, working with soil should be done only on still days. Any breeze should blow away from students, and they should work in the open or in a well-ventilated area. Cut open bags of potting mix with scissors. Do not tear open as this may cause fine particles to enter the air. Organic materials such as composts, potting mixes and other organic gardening materials should be stored in a cool, dry area.

Students with asthma or bronchitis should avoid working with soils or potting mix.

8.1.7 Paper and cardboard

Paper and cardboard come in many forms, including tissue, tubing, corrugated cardboard, poster paper, and tracing paper. These materials are used to make models or prototypes of students' designs or to present designs. In primary schools, students may use paper or cardboard items to make their products. Common processes with paper and cardboard are glueing, stapling, taping, cutting, and folding.

There are no particular material hazards in using paper and cardboard.

These come from the processes or equipment used – for example, cuts from craft knives, scissors or paper itself, or mishandling of glues (refer to 4 *Safe use of tools and equipment*).

8.1.8 Plastics

Plastics are available in different forms, including liquid, powder, granules, and pellets. These are manipulated to produce sheet, film, rods, and tubes, blocks (styrene), or more complex liquids (liquid resin). Thermoplastics are plastics that soften readily when heat is applied and harden again at room temperature. Acrylic sheet belongs to this group. It is

often used in schools as it can be easily formed and is available in many colours, thicknesses, and sheet sizes. Other plastics used in schools include polystyrene, polyester-based resin, lunch wrap, plastic food containers, plastic sheet, and plastic testing kits.

Glass reinforced plastic or fibreglass reinforced plastic is plastic material strengthened by glass fibres. These may be used by some schools to make products including surfboards, swimming pools, and car body parts.

Common processes used with plastics include: thermoforming, vacuum forming, casting, cutting, filing, sanding, scraping, heating, bending, drilling, glueing, and polishing.

Possible hazards include heat generated by forming equipment, inhalation of fumes and particles, moving parts on equipment, and explosion from over-pressurised blow forming.

Plastics should not contact open flames such as candles, soldering torches or oxy-acetylene torches. Strip heaters and the heating hood on a thermoformers are suitable for heating acrylic sheet. Do not use radiant heaters. Plastic can fall onto the element unless it is encased in a fine grill or wire mesh. Ovens for heating plastics must not be used for cooking foods. Vapours left by plastic are toxic.

Absorption and skin contact

Students must wash their hands after cutting plastics so that particles do not enter and infect any cuts. Glass fibres can cause transitory skin irritation. This can be reduced by covering exposed skin with long sleeves, buttoning up shirts, and long trousers.

Heated plastics can cause a burning hazard. Students should wear suitable protective clothing such as heatproof gloves when handling heated and super-heated plastics and working with equipment producing heat.

When scoring and snapping plastic sheet, take care that particles do not snap off and hit students in the face or eye. Acrylic sheet is a brittle material and will crack if drilled with blunt tools.

When using substances such as solvents and glues to join plastics, ensure that direct contact is not made with them. Impervious gloves should be worn. Solvents dissolve the surfaces of plastics, joining them by cohesion. Cements join plastics without changing them. The polyester resin catalyst methyl ethyl ketone peroxide (MEKP) can cause blindness if splashed in eyes. Safety goggles without ventilation holes must be worn whenever this is handled (refer to in 7.6.11 *Chemicals used in technology*, Solvents).

Particles created by processing plastic can be an eye hazard. Students should wear safety glasses or goggles during processes that create particles or when working with hazardous substances, such as glues or solvents, that may splash in eyes or create fumes.

Ingestion

Students must wash their hands after working to avoid accidentally ingesting particles created when sawing or shaping plastics.

Inhalation

Particles fine enough to be inhaled are created when plastics are sawn, sanded or filed. Design products so that the need to sand or file is reduced. Buy plastic in sizes that minimize the need for cutting. Work only in an area that is adequately ventilated. Dust masks should be work where ventilation is not adequate or dust is extensive.

Particles created when cutting or sanding glass-reinforced plastic can irritate eyes, nose, throat and skin. They are not thin enough to pass deep into the lungs, so are not suspected

of causing cancer. Attach extraction devices to equipment used for cutting and grinding or work under an extraction system that removes air to the outside. Explain to students that the work must be between themselves and the ventilation system. Students should wear a respirator or particle mask to prevent inhalation of particles.

Plastics can give off hazardous fumes when heated during processes such as vacuum forming or drilling and sawing. Ensure that ventilation is adequate to prevent students being exposed to the fumes, especially if the whole class is working on the same project. Reducing the number of students working at one time will help reduce fumes. Show students how to machine and saw plastics without over-heating them. A temperature range of 150° to 170° Celsius is adequate to heat acrylic sheet for shaping. It will overheat and melt if not cooled when machined or polished. Never heat unidentified plastics, as fumes may be toxic. Only heat plastics bought specially for projects.

Polystyrene is sometimes shaped with hot-wire cutters which creates hazardous fumes. (Refer to *AS 1485-1983*, 10.9.2 Polyurethane foams and *Victorian Government Schools Reference Guide* 4.4.5.3.10 The Arts, Plastics). A strong exhaust system is required to extract fumes. Avoid activities that create hazardous styrene fumes (refer to 7.6.12.6 *Surface treatments*, Glass fibre reinforced resins).

It is recommended that primary students do not heat or cut polystyrene with hot wire cutters.

Inhalation of solvent-based substances such as glues, amyl acetate, methyl ethyl ketone peroxide or methylated spirits should be avoided and the use of these substances limited. (Refer to 7.6.11 *Chemicals used in technology*, Solvents). Take precautions to ensure that fumes are kept to a minimum and are adequately removed from classrooms. Provide good dilution ventilation, as well as local exhaust ventilation that captures contaminants where they are generated (refer to 3.2.8 *The learning environment*, Ventilation). Primary students should not use solvent-based substances.

Labels should name solvents used in a product. Refer to the solvents in 7.4 *Prohibited and restricted chemicals* to find which should not be used.

Amyl acetate or methylated spirits may be used with plastics to degrease surfaces to be joined, and some solvents can be used to bond acrylics. Teachers should limit the use of these substances. Substances such as catalysts (hardeners) used in polyester resins can be very hazardous. For example, methyl ethyl ketone peroxide (MEKP) is flammable and potentially explosive (refer to 7.6.11 *Chemicals used in technology*, Solvents).

8.1.9 Recycled materials

Recycled materials include aluminium cans, household plastics, containers, building materials, newspapers, tyres, furniture, crates, timber, scrap metals. Students use the same processes as with other materials when processing recycled materials into products. For example, if using recycled timber, students may saw, glue, sand, and drill it. Teachers should refer to the sections such as Metal and Plastics for further guidelines (refer to *Victorian Government Schools Reference Guide* 4.4.5.3.11 The Arts, Scrap materials).

Recycled materials must be handled with caution. Apart from possible hazards in the processes used, recycled materials themselves may be dirty or have a hazardous surface coating. Avoid using scrap or old woods of unknown origin as these may have hazardous surface treatments.

Recycled household items should be cleaned before being brought to school. Materials collected at school should be washed and disinfected when necessary. Teachers may decide that students need gloves when handling materials.

8.1.10 Wood

Trees are categorised as either hardwood (jarrah, blue gum, river red gum) or softwood (radiata pine, Carribean pine). Softwoods are conifers. The basic structural difference is that hardwoods (broad leaves, bear seeds in fruit, deciduous or evergreen) have pores or vessels and softwoods (conifers) do not.

Wood can be processed in blocks, boards, planks, dowel, edging and sheets. Manufactured boards such as fibreboard, chipboard and particle-board can be bought in large sheets. Plywood comes in sheet form (it is made of layers of veneer glued together). Masonite is made from wood fibres mixed with resin glue and pressed into sheets. Wood veneer is a thin layer of wood used to cover less attractive timbers.

Woods used in technology include radiata pine, particleboard, Masonite, decorative chipboards, veneer, hard and medium density fibreboard, and recycled timber. Students in primary schools will use common, easily manipulated woods such as icypole sticks, skewers, wooden offcuts, or small precut pieces. Teachers should ask suppliers to ensure scrap materials do not contain hazardous woods.

Teachers must be familiar with the hazards presented by woods in the classroom. Charts giving information on possible effects or symptoms from contact with dust, leaves, bark or wood of various timbers are available on the Internet. Many hardwoods, especially exotic woods, are common sensitisers and can cause allergic skin reactions. Some hardwood dust can cause hypersensitivity and some hardwoods contain toxic chemicals. Softwoods cause fewer skin and respiratory problems than hardwoods. Prolonged exposure to wood dust may cause nasal or nasal cavity cancer. The International Agency for Research on Cancer has classified wood dust as Group 1 'Carcinogenic to humans'.

Pesticides and preservatives are often applied to wood. Some timber will be labelled so teachers can refer to material safety data sheets (MSDS) on the chemicals used to treat it. Refer to 7.1 *Harmful substances* for information on MSDS. Sometimes it is difficult to find out what chemicals have been used on timber brought into school. In this case follow the precautions for hazardous wood and avoid inhalation of dust.

Manufactured wood boards

Boards such as medium density fibreboard (MDF), plywood and particleboard may contain formaldehyde which is used in the manufacturing process to bond particles. Refer to 7.6.1 *Adhesives* and 7.4.2.3 *Formaldehyde* for further information. These boards are widely used in industry where they are processed according to industry standards. Extraction systems draw away dust and fumes and users wear appropriate respiratory protection. Equipment is of industry standard so overheating the material during processing is avoided. Unfortunately the widespread use of this material in craft and in Do-It-Yourself projects shown in the media has led to a relaxed attitude to safety when using it. The material is commonly available in the community so it is important that safe work practices are discussed with students. Schools have a responsibility to teach safe work practices that students can take with them into the work place or home.

The main hazard posed by these boards is inhalation of wood dust. An extremely fine dust is created when MDF is processed. If the boards are overheated during processing formaldehyde fumes may be emitted. Formaldehyde may also be emitted in small amounts if the boards are stored in large quantities in a confined, poorly ventilated space.

It is important to note that manufacturers have greatly reduced the level of formaldehyde in wood pressed boards and stringent international standards have been adopted. Boards manufactured in Australia must meet Australian Standard (*AS 1859*) published in 1997,

which requires the production of low formaldehyde emission MDF. If schools choose to use manufactured wood boards in technology classes they must ensure that they purchase low formaldehyde emission boards and adhere to the following guidelines for use and storage.

Guidelines for the use of MDF and other manufactured wood boards in schools

Schools allowing students to use low formaldehyde emission boards must implement the following measures as a minimum requirement:

- Choose an alternative safer material where possible
- Inform students of the hazards associated with using the material
- Eliminate or reduce fumes or dust by:
  - buying precut pieces
  - designing products that reduce the need for processing
  - using tools and equipment that are in good condition
  - working close to an efficient local exhaust ventilation system (LEV) or fitting exhaust devices to equipment when processing the material. Refer to 3.2.8 *The learning environment,* Ventilation.
- Students should wear protective clothing and work gloves when handling the material
- Students should wear safety glasses
- If students are using processes that create a high level of dust (using power tools or machines) they should wear a half mask respirator with a combination organic/particulate (P1 or P2) filter. Refer to 3.5 *Personal Protective clothing and equipment*. Ensure other students are not exposed to this dust by processing the material in isolation or in an area with efficient ventilation
- Wipe down respirators between uses and seal in a container to prolong filter life
- Vacuum and/or wet wipe down the area before other students use it
- Avoid inadvertent exposure by emptying dust storage bags into sealed rubbish bags
- Students should wash any exposed skin when clean up is complete
- Clean protective clothing between uses if it becomes dusty
- Store protective equipment away from work area.

To prevent emission of formaldehyde it is recommended that completed products be sealed with a minimum of two coats of paint, varnish or special formaldehyde sealant. This should be applied to all exposed edges and surfaces, such as undersides of countertops, cabinet interiors, and drawers.

Storage of MDF and other manufactured wood boards

To avoid any respirable risk caused by the storage of manufactured wood boards containing formaldehyde it is important that:

- boards containing formaldehyde are purchased and stored in small quantities
- storage areas are periodically reviewed and materials excess to current needs disposed of appropriately
- unsealed materials are not stored from year to year
- storage areas are well ventilated
- ventilation is increased if bringing new sources of formaldehyde into the technology room.

General precautions for working with wood

Absorption and skin contact

If handling hazardous or chemically treated wood that can cause skin irritations or allergies, students should wear gloves or apply barrier cream and wash hands carefully after work.

Cuts or abrasions should be covered with suitable dressings to prevent dust or other substances entering when working with wood. Students can wear disposable gloves for added protection.

Dust created by processing wood can be an eye hazard. Students should wear safety glasses or goggles when creating dust or when working with hazardous substances such as glues or solvents that may splash in eyes or create fumes.

Students should wear impervious gloves when using chemicals with wood such as paint, varnish, polyurethane, turpentine, acetone, thinners and solvent-based stains. Avoid using solvents to remove paint and lacquer from recycled woods (refer to 7.6.11 *Chemicals used in Technology*, Solvents).

When using epoxy glues or solvent-based adhesives, students should wear suitable gloves and barrier cream. Refer to 7.6.1 *Chemicals used in Technology*, Adhesives for information on safe use of adhesives.

Ingestion

Food should not be kept in rooms where hazardous substances are used on woods or where wood dust is created. Students must wash hands thoroughly after processes using hazardous substances, especially before eating. In primary schools, students may need to work in a special-purpose room (such as the art or technology room) or outside when engaged in activities that may contaminate food.

Inhalation

Inhaling wood dust is the major hazard of working with wood. Processes such as sawing, sanding, and drilling create wood dust. Although it is unlikely that students will be exposed to high levels of wood dust, teachers should warn them of long-term dangers, especially if they are interested in a career working with wood.

It is important to reduce dust caused by processing wood. As far as possible, teachers should buy cut and dressed wood to minimise handling problems. Organise projects so that the need to sand or file is reduced.

Good ventilation is important when working with wood. In primary schools, students may need to work in a special purpose room (such as the art or technology room) or outside. Primary students should wear dust masks if the dust volume is great or if they have allergies.

In secondary technology rooms ventilation systems should be appropriate for the materials being processed. Local exhaust ventilation will capture wood dust and contaminants where they are generated. The air velocity through ductwork must be high enough to cause contaminated air to flow into the hood. Local exhaust ventilation systems require a minimum capture velocity of 18 to 20 metres per second for general wood dust. MDF, hardboard and some hardwoods create finer dust that is more readily dispersed into the surrounding air and require a capture velocity of 20 to 30 metres per second.

Newer models of belt and oscillating sanders should be fitted with dust bags or have outlets for a portable dust extractor. Fixed sanding machines and linishers should be connected to an extraction system. Empty dust bag on sanding machines before beginning work.

Where ventilation is not adequate or dust is extensive, dust masks must be worn. These should be comply with *AS/NZS 1716-1994/Amdt 1-1996 Respiratory protective devices*. Hazardous or chemically-treated woods require proper respiratory protection. Students must wear a toxic dust respirator and safety goggles to protect eyes from dust.

The room should be kept free of dust through wet mopping or wet sweeping. Industrial vacuum cleaners fitted with a HEPA exhaust filter are recommended for the removal of dust from floors and machinery.

Inhalation of solvent-based substances such as paint, varnish, polyurethane, turpentine, acetone, thinners and stains should be avoided and use of these substances limited (refer to 7.6.11 *Chemicals used in Technology*, Solvents). Take precautions to ensure that fumes are kept to a minimum and adequately removed from classrooms. Provide good dilution ventilation as well as local exhaust ventilation that will capture contaminants where they are generated (refer to 3.2.8 *The learning environment*, Ventilation). Primary students should not use solvent-based substances.

Labels should name solvents used in a product. Refer to the solvents in 7.4 *Prohibited and restricted chemicals* to find which should not be used. Use water-based, rather than solvent-based paints. Lacquering and finishing of wood products should be done with water-based, environmentally friendly products such as Crystal Clear or Speed Clear.

A spray booth can be used when working with solvents (refer to 3.2.8 *The learning environment*, Ventilation). If adequate ventilation cannot be provided, students must wear a respirator with a replaceable filter suitable for solvent fumes. Filters are available to filter a ranger of hazardous substances. Students using spray-cans should work outside away from other students. They must avoid having spray blow back at them.

A variety of glues are used to laminate and join woods. These include contact adhesives, casein glue, epoxy glues, formaldehyde resin glues, polyvinyl acetate (PVA) and instant glues (refer to 7.6.1 *Chemicals used in technology*, Adhesives). Avoid glues containing formaldehyde or prohibited solvents. Provide adequate ventilation for those that contain solvents and create fumes.

8.2 Making safe products

Student technology projects are growing in variety. Teachers have a clear responsibility to ensure that articles produced in their technology classes are safe. They should take all necessary steps to ensure that practical projects are functionally safe and conform to all relevant legislation (and Australian Standards, where applicable). Products whose safety is difficult to control or assure should not be included in the curriculum. Teachers should consider the following:

- Have all safety aspects of function and manufacture been considered?
- Are my teaching qualifications and experience adequate to teach the necessary skills and techniques?
- Are my teaching qualifications and experience adequate to recognise potential hazards in products designed by students?
- Can students produce products of the quality required to make them safe to use?
- Do students have the skills needed to safely construct products?

The products students make may be hazardous for a number of reasons. They may involve:

- moving or detachable parts
- testing that involves hazards such as propulsion, throwing or driving
- unsuitable materials
- hazardous materials
- poor design skills
- poor production skills.

Products intended to move (such as playground equipment or toy vehicles) may have parts that can spin off or fly off and hit students. Ensure that moving parts are secure and will not pose a hazard. Warn students not to test products without checking them or having the teacher check them first.

Testing of rubber band-powered cars, paper planes, catapults, rockets or other projectile-launching devices may lead to injury. Care must be taken to ensure that they are not mishandled. When testing, specify areas a safe distance from onlookers. If chemicals are used as fuels, teachers must ensure that these will not be hazardous or explosive. It is illegal to make explosive substances (for example, gunpowder). Students should not inhale any gases produced. Provide students with clear guidelines on the safe testing of the products.

Students may have to drive or control a product they build (such as a billy cart). Injuries can result from unsafe tracks, unsafe areas provided for spectators, and from drivers running off the road. A straight billy cart track will be safer than one with curves.

When testing materials for strength, ensure that students are clear of falling weights or materials. These can recoil on breaking. A bucket or similar container padded with newspaper can be used to cushion the landing of a weight. Placing an old piece of fabric over objects that will snap under testing minimises the risk of pieces flying off.

Other problems may be caused by using unsuitable materials for project. For example, materials used for a candleholder must be non-flammable. Check the suitability of materials students intend to use. Will the materials cause a safety hazard? The hazards in using particular materials are outlined earlier in this chapter. Avoid using any material considered a direct hazard. Teachers should always check the safety of recycled materials or materials brought from home.

A poorly-designed product can be a hazard to the user. For example, students may get their foot caught if the steering mechanism of a billy cart is poorly designed. A good design check asks whether a product is suitable for its purpose.

8.2.1 Making safe electrical and electronic products

Students may work on electrical products in Technology. They are not permitted to work with products that require a voltage greater than 50 volts AC or 120 volts DC. They can work with approved apparatus, appliances and test equipment containing voltages up to 250 volts but must not access or modify any component on the apparatus or appliance that involves a voltage above 50 volts AC or 120 volts DC.

When students design, construct, test and operate electrical products they must adhere to Australian Standards *AS/NZS 3000:2000*, Electrical installations (Australian/New Zealand Wiring rules) and *AS/NZ 3100:2002*, Approval and test specification – General requirements for electrical equipment. Students can only work on electrical or electronic products in a supervised class.

Care must be taken when students build products (such as wind generators) that produce electricity. The hazards related to these products must be explained to students. When students work on electrical and electronic products they must adhere to Australian Standards.

References

OHS (Manual Handling) Regulations 1988 and Code of Practice (Manual Handling) 2000

Department of Education & Training, *Preventing Manual Handling Injuries,* Second Edition, 2000

Department of Education & Training, *Guidelines for the Storage of Science Chemicals*, Second Edition, 1999

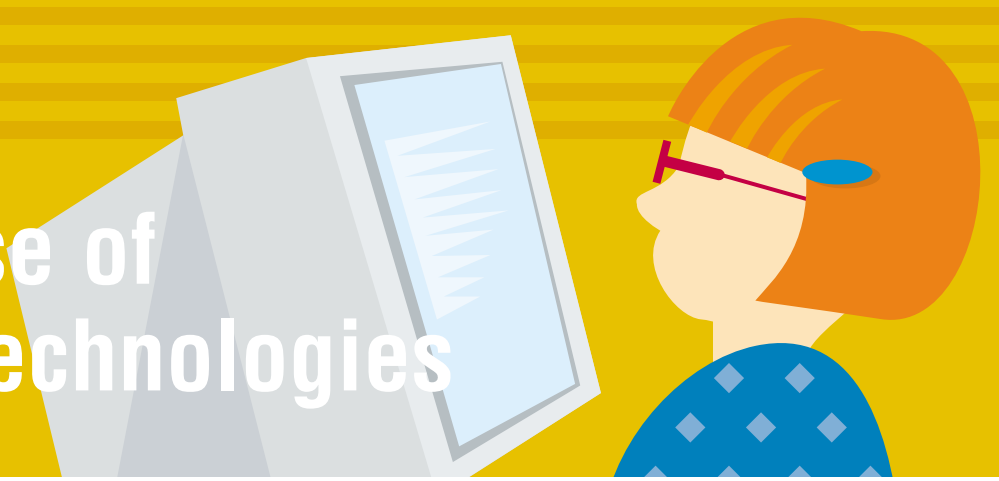
AS 1483-1985 Health and safety in workrooms of educational establishments

- 4.7 Handling and storage
- 10.9.2 Polyurethane foams

Victorian Government Schools Reference Guide

- 4.4.5.3.6 The Arts, Leadlighting
- 4.4.5.3.8 The Arts, Organic solvents
- 4.4.5.3.10 The Arts, Plastics

9 Safe use of learning technologies



9.1 Organising learning technologies

Victorian government schools are making significant progress in introducing information and communication technologies into their curriculum. The Department's *eLearning Planning Guide* (available at SOFWeb www.sofweb.vic.edu.au/lt/pguide/index.htm) sums up the current situation on learning technologies in Victorian schools. It also sets out a clear vision and achievable targets for schools. The statement highlights the need for increased use of learning technologies by students across all key learning areas and all year levels. Policy documents such as CSF, the VCE study designs and VCE VET programs emphasise the importance of learning technologies. It is expected that students in Victorian government schools will start to use a range of information and communication technologies from the first year of primary school.

It is important to set goals for incorporating learning technologies into education. Schools are expected to implement a learning technologies plan that promotes, among other things, access to computers, use of a range of applications and curriculum products, use of on-line information and communication, and the use of a variety of technology tools.

Schools needing advice and assistance to introduce learning technologies into their curriculum should refer to advice in the Victorian WorkCover Authority (VWA) document *Officewise. A Guide to Health and Safety in the Office*. The Department's *eLearning Planning Guide* has been designed to help schools plan, implement and use information technology to improve teaching and learning. It includes sections on developing a learning and teaching strategy for eLearning and an eLearning ICT strategy. Information on *Using the Internet* is also available on SOFWeb http://www.sofweb.vic.edu.au/internet/index.htm

9.2 The learning environment

The school is responsible for maintaining a safe learning environment that enables appropriate levels of supervision at all times. For information on school facilities, refer to the *Victorian Government Schools Reference Guide*, 7.21 Facilities overview. For information on health and safety issues related to office situations refer to the VWA document, *Officewise: A Guide to Health and Safety in the Office*.

Teachers should be able to see all work areas and reach them easily. Room layout should allow safe movement of students and clear access to exits. The working space should allow safe working by individuals and the group as a whole and for the satisfactory performance of activities. Ensure that all permanently fixed equipment is set up with enough space around it for students to work safely. Teachers should also refer to 3.2 *The learning environment*.

Schools should set up computer work areas that meet the needs of students using them and allow them to safely and comfortably use equipment. Schools will generally organise computers in individual classrooms, technology rooms or in computer laboratories. Computers must be located so students can gain easy access to them and work comfortably. Housing computers in laboratories may provide greater flexibility in the ergonomic design of workspaces but will limit access to computers to timetabled use. Computers in the general classroom or in purpose-built technology rooms will give students greater access but the space constraints hamper organisation of equipment.

All schools must cater for students of different sizes. Although it may be difficult to set up ergonomically-designed workstations to suit all students, it is important that students are not under physical stress while using equipment. The way students work with computers differs between primary and secondary schools. Computer areas should be designed to suit the range of students who use them, the tasks being done, and the equipment being used. In the early years of schooling, students may spend less time working with computers. It is important that young students are taught the importance of good posture as soon as they begin working with computers or playing screen-based games at home.

As students get older, they may spend more time at computers performing more complex tasks and making more extensive use of the keyboard. Students will often use computers at home, and some will spend many hours looking at monitors or television screens, often in awkward positions. Older students will be expected to take greater responsibility for ensuring that their posture is correct and that they follow guidelines to avoid hazards stemming from extended use of computers.

9.2.1 Furniture for learning technologies

Furniture bought for schools should meet the relevant Australian Standards. (Refer to 3.2.6 *The learning environment*, Furniture, for details). Furniture and equipment should be positioned to avoid overcrowding and tripping hazards. Teachers can refer to the principles in Victorian WorkCover Authority, *Officewise* for information on office layout, workstations and equipment. *AS 3590.2-1990* Screen-based workstations – Workstation furniture also provides information.

It is important that furniture does not hamper good posture. Students must be shown how to adjust their work areas to suit themselves and to ensure that they are comfortable and maintain good posture while they work. Furniture designs should suit the health and safety needs of all users. Furniture designed to meet ergonomic needs is becoming increasingly available. Standard classroom furniture may not be suited for computer use and the extra equipment required. Consider buying adjustable furniture.

It is important to choose tables and chairs of heights that suit different size students and of correct height for healthy posture and safety. Students need enough legroom under workstations or tables taking into account the footrests used by some students. Providing adjustable tables and chairs will solve many problems. Students can then adjust heights and positions at the computer.

Desktops just at or below elbow height when sitting correctly suit most people. Adjustable desks are available but it is easier to change chairs and computer position than table or workstation height.

Table height is important for notebook computer users. A comfortable position can be found by placing the notebook on something to raise it. Away from the classroom, a stable object such as a book on the user's lap will raise the notebook. A footrest can also be useful.

9.2.1.1 Chairs for learning technologies

Adjustable, stable chairs are recommended for use with computers. They should suit students' sizes and have an adjustable backrest and a seat-height mechanism. Students must be able to adjust them easily. Armrests can hamper arm movement and prevent chairs being moved close to the table.

Adjustable chairs that swivel and roll around take a good deal of strain. Check them regularly to ensure that there is gas in the lifting mechanism and that screws, bolts and castors are tight. Replace them when necessary.

If non-adjustable chairs are used, the principles of good posture when using computers should be applied (refer to 9.4 *Ergonomic guidelines*). Back supports, seat wedges or footrests can make chairs more suitable.

9.2.2 Lighting for learning technologies

AS 1680.2.2-1994, Interior lighting – Office and screen-based tasks sets out recommendations for the lighting of offices and screen-based tasks. It is intended to be read with the recommendations in *AS 1680.1-1990* Interior lighting – General principles and recommendations.

Students must work in suitably lit environment. Good lighting enables students to see clearly and safely perform their work without straining eyes. Poor lighting can lead to headaches and muscle pains if students adopt awkward postures or need to focus intensely to see the screen image. The amount, type, and location of room lighting and whether there are reflective surfaces can affect the clarity of the screen image. When assessing the adequacy of lighting, consider the amount of light in the area, the number, type and position of light sources, and the types of activities students will be doing.

Glare and reflection are main problems caused by lighting. Two types of glare reduce lighting quality: disability glare and discomfort glare. Disability glare is light that masks an object (for example, light reflecting off the monitor screen). Discomfort glare is an uncomfortable light source directly in the field of view (for example, the sun shining through a window directly behind the computer). Avoid having a window directly behind the computer or shining directly onto the computer. Glare can be reduced by:

- repositioning the computer to reduce light falling on the screen and work surface
- controlling natural light from windows with blinds or curtains
- reducing general lighting to suit task being performed
- having a matte finish on walls, ceilings and hardware to prevent indirect glare from reflective surfaces.

Glare can be lessened with anti-glare filter screens but they reduce screen display quality and require regular cleaning. If lighting is inadequate and cannot be altered, separate lighting can be used to illuminate work. This should not be brighter than the monitor illumination.

Reflected light from surfaces can make the screen hard to see. The source may be overhead lighting or other sources of light such as windows. Reflections can be reduced by:

- a non-reflective screen surface
- positioning screen side-on to light source
- changing screen background to lighter colour.

Avoid extreme differences in light levels in the work area and between room lighting and screen illumination. Overhead lighting should be even or diffused to reduce the possibility of glare. Downlights may be preferable to harsher forms of lighting such as fluorescent tubes.

Fluorescent lighting may flicker when malfunctioning. Replace if this happens. Lights above ceiling fans create an annoying flickering effect when the fan is on.

9.2.3 Cabling

Information on cabling can be found in *Local Area Networks in Schools* at http://www.sofweb.vic.edu.au/ict/lan/index.htm. Ergonomic issues must be considered when planning the arrangement of learning technologies equipment and cabling. The increase in networking, the use of peripheral equipment such as scanners, and the need to connect these devices to mains power has increased the amount of cabling required to run school computer systems.

Schools will arrange learning technologies equipment to suit the use of the equipment, students' ages, and the school setting. In a primary classroom, computers and other equipment may be clustered in one area, away from tables. In a computer laboratory, equipment may be arranged on benches around the room or on island benches. How equipment is arranged will influence whether cables are run under the floor and brought up through the centre of the table or dropped from the ceiling.

Powerboards and power leads should only be temporary measures. Their tendency to become a permanent solution to cabling problems should be avoided. Planning cabling and equipment arrangement carefully will enable power points to be well positioned and avoid the need to use power boards and power leads.

Cabling should only be installed by qualified personnel. (Teachers should also refer to 9.3 *Hazards involved in using learning technologies*, 9.3.2 Electrical shock and 9.3.3 Tripping).

9.3 Hazards involved in using learning technologies

Increased computer use brings with it potential hazards. These should be identified and controlled to achieve safe use of learning technologies. Schools must understand ergonomic issues of students using computers and notebook computers for extended periods and which may be exacerbated by home use. Physical complaints included irritation (red, teary or dry eyes), fatigue (tired, aching heaviness of the eyelids), difficulty focusing (blurriness in seeing near or far objects), headaches, and other musculoskeletal discomforts. Most of these problems are caused by poor ergonomics of the work space, inadequate lighting, glare and reflection, type and intensity of work, and quality of monitor display. General hazards when using learning technologies are:

- manual handling injuries caused by incorrect handling
- electric shock from incorrect use or faulty equipment
- tripping over cords or furniture
- incorrect posture causing occupational overuse syndrome
- eyestrain due to long periods at the computer or poor lighting
- inhalation of fumes from toners
- spillage of toners.

9.3.1 Manual handling of learning technologies equipment

Lifting or transporting learning technologies equipment may pose a hazard. Equipment such as monitors, central processing units, datashow projectors, scanners, printers, and computers may need to be moved at times. Equipment such as notebook computers, video equipment and digital cameras are carried. (Teachers should also refer to 3.2.12 *The learning environment,* Manual handling).

Equipment can be heavy and awkward to move. Care must be taken even when moving it short distances. If students lift equipment, ensure that they use correct lifting procedures to avoid strain or other injury. When using a trolley to move equipment, the weight must be positioned so that it does not cause the trolley to overbalance.

Students should be shown the correct and safe way to carry notebook computers to avoid muscle strain and damage to the computer. The weight of the notebook should be shared between both hands or it should be carried in a backpack. Notebooks should never be carried unless the screen is properly closed. Notebook computers can be stacked on a shelf but the stack must be unpacked to reach those lower down.

Ensure that equipment is unplugged from mains electricity and cables are disconnected from computers when moving them. Roll up cables and power cords to transport them to avoid tangling or tripping.

Use of large or heavy items should be planned so as to avoid the need to transport them. Frequently used equipment should be stored within easy reach.

9.3.1.1 Trolleys

Trolleys allow equipment to be moved around the school safely, reducing manual handling hazards. They assist in the scheduling of activities in classrooms without certain equipment as it can be wheeled in.

When choosing a trolley, ensure that it is strong, stable and easily wheeled. Some trolleys are specially built to handle the weight of a monitor. Check that wheels are large enough to handle bumps or small obstacles. Rubberised wheels allow trolleys to be wheeled over concrete. Ensure that the wheel base is wide enough to prevent the trolley overturning.

Trolleys can be unstable when transporting tall or heavy items. Strapping down the monitor with luggage straps can increase stability. Lock wheels when stationary. Leave regularly transported items on a trolley while in storage.

9.3.2 Electrical shock

Poor cabling layout, incorrect connection, fraying or internal fracturing of wires can create a risk of electrical shock. In turn this can damage equipment through damage to cables or shorting.

Mains power cords must be unrolled when in use. Excessive heat can be generated in rolled cords, which can cause the insulation to melt. Check manuals for the maximum length of cables for external devices connected to the computer. Beyond these the equipment may not operate satisfactorily. Trolleys and chair castors or legs can easily damage cords, turning them into electrical hazards.

Where extension cords are used, they should be linked to powerboards with built-in safety fuses and switches for each outlet. Care should be taken that powerboards are not overloaded through excessive power drain. Check cords and connections at regular intervals for damage. Extra care with transformers and electrical cables must be taken where water or other liquids are present.

9.3.3 Tripping

Poor cabling layout can create tripping or tangling hazards. Cabling may need to be run through plastic channels. These are taped on both sides and secured to the floor in such a way that they cannot be tripped over. Cables should be secured to table legs to avoid being a hazard and should be attached to hardware with a locking mechanism. Some furniture provides channels for cables.

Electrical power cords, powerboards or extension cords can be cause a tripping hazard if they lie across walkways. Trolleys and chair castors or chair legs can be caught on cords, causing them to tip over when moved.

9.3.4 Incorrect posture

Teachers need to instruct students about the importance of correct posture, lighting, seat adjustment and exercise at regular intervals when using the computer. An understanding of good practices should be developed from an early age. Encourage students to follow them at home as well as at school.

Students should taught how to sit with good posture, and how to position the computer and organise their work. Encourage the understanding that adopting a comfortable and correct seating position and adjusting the workstation to suit their needs is a personal responsibility. Students can transfer this knowledge to using computers at home. From an early age, students should be taught to:

- ensure that they feel comfortable at the computer
- take regular breaks from the computer
- stretch and move bodies
- exercise eyes
- use touch-typing skills.

Special consideration should be given to students working with *notebook computers*. Refer to 9.6.5 *Notebook computers* for information.

9.3.5 Eye strain

Eyestrain is the common term for symptoms of discomfort or fatigue after long periods of looking at a monitor. Symptoms include:

- problems focusing
- sore, throbbing eyeballs
- headaches
- neck and arm pain
- adoption of awkward postures to see monitors.

Supervise the length of time students spend looking at the monitor. Long periods will cause eyestrain. If computers are set up in general classrooms, the curriculum should encourage a variety of activities so that the time spent at the computer is broken.

Eye strain can be caused by continuously focusing on objects the same distance away, undue rotation of the eyes caused by documents being too far from the screen, the screen at an unsuitable distance from the student, an unstable image (flickering), or poor colour balance or resolution.

Encourage students to refocus their eyes during computer use. In normal use, the eye focuses on objects at varying distances. A monitor in the middle of the room means students can look away from it and refocus on distant objects. If students face a wall, a mirror or a picture of a distant view can help them refocus. When setting up workstations for the first time, consider the need to exercise the eyes.

Ensure that students sit at a comfortable distance from the screen. Research shows that it is better to have the screen too far away than too close. The eyes have a resting point of accommodation. This is the distance at which the eye focuses when there is nothing to look at. The average resting point is about 80cm. Prolonged focus on a monitor closer than your resting point of accommodation increases eyestrain.

The type size can be set to be read easily or the screen view can be zoomed in. Some font types are easier on the eye. They can be used for keying in text, then changed when the document is finished. Research shows that eyes focus better when looking down. This has implications for the viewing angle. The screen should be at a viewing angle of 15–35 degrees below your horizontal eye level.

Use a monitor with contrast and brightness controls and adjust to a comfortable level. Adjust screen intensity to sharpen images. Unsuitable brightness and contrast makes it difficult to focus on the image. Too much contrast in the field of view (for example, a bright light or having the workstation against a bright window) makes iris adjustment difficult and can result in eye muscle fatigue. Background and character color can influence eye comfort. Choose colors with a high level of contrast.

Work should be positioned to avoid the need to rotate eyes and head. Monitors can be adjusted to stop flickering (refer to 9.6.1 *Monitors*).

9.3.6 Inhalation or spillage of toners

When changing the toner cartridge in laserjet printers, ensure that powder is not inhaled and does not contact clothing or skin. Wear gloves when changing toner. Toner dust is extremely fine and can irritate and cause coughing and sneezing if inhaled. Some printers or photocopiers allow small quantities of toner dust to become airborne during normal copier operation. This can be due to toner dust being spilled inside the machine and passing out through the vent fans into the room or by the waste toner compartment filling and causing toner to back up inside the machine.

Toner dust is considered a nuisance dust and should not have adverse health effects. Teachers should obtain Materials Safety Data Sheets (MSDS) for hazardous substances. These identify and assess hazards related to the toner being used.

Computers generate heat. Rooms with several computers, printers and other equipment can become warm and stuffy and atmospheric contaminants can build up. Ventilation will be needed to provide fresh air. If windows are covered to prevent glare on monitors, ventilation may need to be provided by electric exhaust systems or air conditioners.

9.4 Ergonomic guidelines

Students can follow procedures to avoid problems when using computers. Schools should develop practical and achievable guidelines. Students will not be exposed to the same level of risk as those who work on computers all day. Guidelines can be in the form of posters or handouts with text and illustrations. Presentation should suit the age of the students.

Refer to *Officewise: A Guide to Health and Safety in the Office*, Appendix B: Setting up your workstation. Suggested guidelines are:

- Adjust the workstation to suit you. Sit squarely in front of the keyboard so that there is not need to twist or rotate. The keyboard should be placed at the front edge of the work space.
- Position the monitor at head height, tilted slightly downward and away from sources of glare. The top of the screen should be at eye level.
- Put work on an angled copyholder close to the side of the screen or between the keyboard and the screen.
- Adjust the chair so that the backrest supports the curve in your lower back. Sit comfortably on the chair with feet resting on the ground. Smaller students should use a footrest to keep upper legs horizontal. Hips, knees and elbows should be at a comfortable angle close to 90°.
- Shoulders should be down and relaxed. Back should be straight and sloping slightly backward from the hips. Your lower back should be against the chair's backrest.
- Hands should rest comfortably on the keyboard with upper arms vertical and forearms horizontal. Your wrists should be bent slightly upwards.
- Position the mouse and mouse mat close to the keyboard to avoid having to reach away from your body.
- Work directly in front of the screen and the keyboard. This allows your head and neck to be comfortable. You should be able to see the monitor and the work without turning your head.
- Take a break from the computer every 20–30 minutes. When working, change position frequently. When taking a break, do stretching exercises for muscles under stress. Postures such as leaning back when not keying are suitable. It is important to vary posture while working at computers for long periods.

9.4.1 Stretching exercises

It is important that students understand the need to reduce build up of tension in muscles through exercising. Stretching reduces risk of muscular pain, fatigue and stiffness and the risk of computer-related injuries such as neck pain and tendinitis. Stretching exercises can easily be included in times when students use computers. Reminders that prompt students to stretch after a certain time at the computer are useful. Students should understand the importance of following this practice at home. No matter where they work on a computer, students should follow good posture rules and modify their work environment to suit.

Students must be taught the correct way to stretch. Stretching should not cause pain. Information regarding safe stretches can be obtained from Australian Physiotherapy Association (refer to 10.1 *Organisations*). The following stretches should be held for five to ten seconds while working, or up to 60 seconds if done at home.

Chin tuck

Create a double chin and gently tuck it in and out five times.

Head tilt

Take a deep breath. While you exhale, slowly tilt your head sideways until you feel a slight stretch. Hold for 10 seconds, then repeat on the other side.

Head turn

Keeping your shoulders steady, slowly turn your head to the left until you feel a slight stretch. Hold for 10 seconds and repeat on the other side.

Shoulder roll

While you inhale, draw your shoulders up towards your ears. Exhale and roll your shoulders back and down in a half circle. Repeat 3-6 times.

Hands behind back

Hold hands behind back, then lift arms with straight elbows holding shoulders and head back.

Arm stretch

Hold hands above your head and stretch arms towards the ceiling.

9.4.2 Ergonomic aids

9.4.2.1 Copyholders

Copyholders are designed to hold work material in positions that suit the user's visual needs. Reading source documents resting on the desk may cause neck and shoulder strains. Work and copyholders should be in line of sight. Some can be fitted between keyboard and computer, others hold work just to one side of the monitor. They should be positioned to reduce the need to turn the head. Positioning work at a suitable distance will also assist in reducing eyestrain.

9.4.2.2 Footrests

A footrest is useful for students whose feet do not reach the ground when they are in the correct position to view the monitor. A footrest keeps upper legs horizontal and shares body weight evenly between thighs and feet, reducing fatigue. Footrests can be bought or made.

9.4.2.3 Wrist rests

Wrist rests are designed to support wrists while pausing between keying. Using the wrist rest while keying can increase the risk of tendon strain and mechanical friction on tendons. Hands should be free to move over the keyboard during keying. The wrist rest may also push the keyboard further away.

9.4.2.4 VDU stands

VDUs should be raised above desk height. A stand can position the VDU top level with the user's horizontal eye level. In some cases, the hard disk case on which the VDU stands raises the VDU too high. A separate VDU stand will then be required, with the hard disk positioned to one side.

9.4.2.5 Docking stations

Docking stations allow portable computers to be used in a variety of locations. They permit easy connections between the computer and peripheral devices such as a conventional keyboard and VDU screen. This can improve the user's posture and comfort.

9.5 Appropriate use of the Internet

Issues of safety and privacy must be addressed when students use the Internet or fax and telephone. Students must be protected from contact with undesirable information and people. It is impossible to preview everything students might be exposed to on

electronic media, especially the Internet, so it is recommended that schools develop a code of practice for using electronic networks. Refer to *SOFWeb: Using the Internet: Taking Care* http://www.sofweb.vic.edu.au/internet/takecare.htm Apart from providing guidance for teachers and students on what is acceptable practice, the code should provide guidelines for issues such as privacy, harassment, verbal attacks, unsuitable material, and contact with undesirable people. The Department has published *Internet Acceptable Use Policy* available at http://www.det.vic.gov.au/det/resources/policies.htm and *SafetyNet: Internet Usage Guidelines for Schools*, available at http://www.sofweb.vic.edu.au/internet/safety.htm.

Teachers should discuss the risks of using the Internet with students and introduce rules that suit their age. The rules can be kept next to the computer. Students should be warned:

- Do not to give out personal information about yourself or your parents, guardians, friends or teachers (such as surname, address and telephone number).
- Use different passwords for school and the Internet and don't tell anyone your passwords.
- Push the back button and immediately tell teachers or parents or guardians if you come across unsuitable information on the Internet.
- Tell guardians, teachers or parents if you receive unsuitable messages online.
- Do not meet someone you have contacted online in person unless you have discussed this with your parents and have been given permission. It is best to meet in a public place.
- Do not to send a photo of yourself to anyone unless your parents or guardians have given permission.
- Follow the rules set down by the school or your parents or guardians about the times you can be online, the length of time, and the sites you are allowed to visit.

Teacher supervision is very important when students are using the Internet or watching videos. Unsupervised students may view and share unsuitable material. It does not take long to save material to disk for viewing at a later time. If all students and screens are clearly visible to others, this will encourage students to self-monitor the material they access.

It is important to stress to students that information about hazardous substances obtained on the Internet can cause them serious harm. They must realise that the publishers of information may not explain or mention safety issues. Students should be told to treat such information with extreme caution.

The code of practice, agreed to by students, can be used as a guide against which to judge situations. Students should learn to discriminate between what is and what is not suitable. They should be guided in ways to deal with unsuitable material.

The choice of Internet service provider (ISP) will influence a school's ability to minimise risk of exposure to unsuitable materials. The Department has developed the Victorian Education Channel that provides a safe, controlled Internet resource base to more than 200,000 sites. These sites include curriculum information as well as general resources. It is available at www.education.vic.gov.au

9.6 Safe use of learning technologies equipment

Before using learning technologies equipment, students should be taught about the inherent dangers of using electrical appliances and the appropriate procedures to follow when using them. In primary schools, students should only plug electrical items into mains electricity

under the direct supervision of a teacher. It is the primary teacher's responsibility to set up computers and connect peripherals to the computer.

Students will develop skills in troubleshooting as they progress through primary school. They will be able to judge whether a cord has been disconnected and detect other problems with cabling or connection to mains electricity. However, it will still be the teacher's responsibility to assess the situation and decide on suitable action. If teachers are satisfied upper primary students have been properly instructed, they can be allowed to connect keyboards, the mouse and other items to the computer.

Secondary students will take greater responsibility for maintaining the equipment they use. They will know how to install programs and CD-ROMs, and will be able to set up equipment. Teachers must still be told of problems with equipment. Secondary students may also use a greater range of software. They will use applications such as computer aided design packages, computer aided manufacturing hardware, control technology using output devices and interfaces controlled by sensors, and presentation software.

9.6.1 Monitors

Use and description

Monitors or visual display units (VDU) produce an image generated on a coating of luminous material. Schools should ensure that their monitors are the best quality they can afford. Refresh rates, which should be at least 70 times per second to control flicker, are higher on better quality monitors. Resolution and radiation emission should be in accordance with international standards.

The monitor set-up will have a direct effect on viewing comfort. In general, the monitor top should be aligned with horizontal eye level when the user is seated. Brightness and contrast can be adjusted through monitor controls or via the computer's operating system software. Refer to 3.2.9 *The learning environment*, Lighting and 9.3.5 *Hazards involved in using learning technologies*, Eyestrain.

Visual display units produce radiation in amounts not believed to be large enough to cause harmful effects to users. Computers also produce extremely low frequency electrical and magnetic fields (ELF-EMF), which are other forms of radiation. It is recommended that the user sits about an arm's length away from the monitor.

Maintenance and storage

Monitors electrostatically attract dust. Wipe monitors regularly with a moist cloth to enhance fine detail on the screen. Screen cleaner can be bought for this purpose. If using a filter on the monitor, this must also be cleaned back and front. Covering the monitor when not in use keeps of dust. Refer to 9.3.1 *Hazards involved in using learning technologies*, Manual handling of learning technologies equipment.

9.6.2 Computer casings and internal parts

Use and description

The computer's central processing unit (CPU) is housed inside the computer or in a separate unit on which the computer sits. The CPU contains the computer's processing hardware such as the memory, motherboards and hard disks. If the CPU and monitor is a single unit, no screen adjustment will be possible. In separate systems, the monitor can usually be adjusted. Notebooks, by definition, are single units, but the hinged screen's angle can be adjusted.

Students should not open the computer casing and care should be taken when connecting and disconnecting cables. Food or drink should be banned near computers. These can cause electrical damage if they get into the computer casing.

Maintenance and storage

Teachers need to ensure that both the CPU and external devices (such as scanners, external hard drives and printers) are turned off before they are connected. This will ensure that damage does not occur to the motherboard or to the devices themselves. Cover units when not in use to prevent dust entering. Ensure the unit is not connected to mains electricity when cleaning and ensure that cleaning liquids do not enter the casing. Refer to 9.3.1 *Hazards involved in using learning technologies*, Manual handling of learning technologies equipment.

9.6.3 Keyboards

Use and description

Keyboards are the main input devices for CPUs. They come in different designs and sizes and should be chosen to suit students' needs, their ages, and the amount of keyboarding they are likely to do. Encourage students to develop touch-typing skills in primary school. Keyboards should have angled feet on the base for adjustment. The keys should have a good feel. They should be 'springy', allowing fast typing. When a key is pressed, there should be a sound. All keys should require the same pressure. Regularly check the keyboard for 'sticky' keys. Some schools have found standard keyboards to be too large for young primary students. Other sizes should be investigated.

Where standard furniture is used for computers, ensure that CPUs, monitors and keyboards are positioned to prevent straining hands and eyes. Place reference documents, notes and books where students do not have to turn their heads or rotate their eyes extensively. Use copyholders that keep work in line of sight (refer to 9.4.2 *Ergonomic aids*, Copyholders).

Extended keyboards and wrist supports are useful for reducing fatigue where students work at keyboards for long periods.

Maintenance and storage

Cover keyboards when not in use to prevent dust, liquids, and items such as paper clips getting on or between the keys. Ban food and drink near keyboards due to the risk of electrical damage. Clean keyboards regularly to maintain good hygiene. Encourage students to wash hands before using the keyboard. Occasionally tip up the disconnected keyboard and gently shake to remove particles lodged between keys. Spray-cleaning products may be used. Clean wrist rests with a damp cloth and a safe household cleaner.

9.6.4 Mouses

Use and description

The mouse is the device that allows the computer user to interact with the monitor. Moving the mouse activates a track ball underneath that moves the cursor on the screen. The mouse can have one or two function buttons that allow the user to interact with computer programs. The user presses or 'clicks' the buttons to operate them.

Encourage students using the mouse to support arm weight on the table or chair armrest. This prevents undue pressure on the wrist or elbow. The wrist should be kept flat during use and the fingers allowed to rest on the push buttons between actions. Place the mouse mat as close as possible to the keyboard to avoid having to reach to operate the mouse.

Young students can learn to use the mouse with either hand to reduce or prevent discomfort. Students are reluctant to try this initially, but can surprise themselves as to how easy it is to manipulate the mouse with either hand. On some models, the mouse can be plugged into either side of the keyboard. The mouse button configuration can be altered through the computer's control panel to suit left-and right-handed users. Older students can be encouraged occasionally to use their non-preferred hand to operate the mouse.

Ensure that activities do not cause students to use the mouse for extended periods.

Maintenance and storage

Encourage students to wash their hands before using the mouse. Clean the mouse case with a damp cloth. Clean the tracking ball when it is not rolling smoothly after disconnecting it from the CPU or keyboard. A section of the mouse can be removed to wipe clean the tracking ball. The rollers inside should be cleaned as the build-up of dirt prevents the tracking ball rolling smoothly. Do this with a damp cotton bud. Take care to remove any particles that may fall into the cavity inside by gently shaking the mouse. If the keyboard is covered when not in use, place the mouse under this too.

9.6.5 Notebook computers

There are other ergonomic issues associated with using notebook computers. Curriculum design should set limits to periods of use because of problems with posture, eyestrain and manipulation of the tracking ball.

Use and description

Notebook computers are portable computers with a base that holds the CPU and keyboard and a hinged screen. The notebook screen angle can be adjusted for ease of viewing. Notebook computers require high-quality screens. Active matrix is recommended.

Notebooks differ from standard desktop computer. The keyboard is smaller and is at a fixed distance from the monitor. The trackpad, trackball, or glidepoint is part of the body of the notebook and relies on finger control rather than whole hand movement as with a standard computer mouse. These devices may cause thumb or wrist strain. Notebook computers are designed for use almost anywhere and will often be used in less than ideal conditions.

The Department has produced *Using Your Notebook Safely* to help teachers with notebook computer use, including best posture, eye fatigue, and best carrying and handling methods. Find the booklet on SOFWeb at www.sofweb.vic.edu.au/ict/notebooks/docs/ohs.doc

Long periods of notebook use should be avoided and should certainly not exceed two hours. Students should swap between keyboarding and other activities. Make sure students understand the importance of following ergonomic guidelines when using the notebook computer (refer to 9.4 *Ergonomic guidelines*). They should vary their sitting posture while aiming to maintain good posture. Avoid situations where correct posture is not possible (such as sitting on the floor for long periods). Consider the following points when using notebook computers.

- Because notebooks are portable, they are often used where their height cannot be adjusted, such as on a lap or table. To compensate for the unsuited height, adjust the screen angle or put something under it to raise the notebook (refer to 3.2 *The learning environment*, 3.2.6 Furniture and 3.2.4 Work areas).
- Position the notebook computer to avoid glare and reflections. Avoid a screen angle that causes students to bend their necks to view it. This can cause muscle soreness and injury if done for long periods.

- Ensure that the notebook computer is used in a well-lit area and that work can be read easily. Position work so that it is in the line of sight.
- Due to the nature of the screen and its size, it is recommended that students do not share notebook computers. Poor posture and muscle strain can result.
- The inbuilt pointer (mouse, trackball or trackpad) on notebook computers is small and often difficult to manipulate. Some students may find this frustrating. A standard mouse should be used at all times other than for short tasks.
- Where long periods of work are required on computer, encourage students to transfer data to a desktop computer or use a docking station that is ergonomically arranged.
- Connecting the notebook to other equipment may create a tripping hazard. Take care that cables are kept clear of walkways. Minimise equipment connected to the notebook and try to keep these on the same workspace. Pendant power points can be installed or students can use battery power.

Maintenance and storage

Take care in disconnecting and reconnecting cables when transporting notebook computers. Computers should be turned off when moving them.

Charging stations for notebooks and their batteries may be needed. These stations should provide safe electrical connections and be situated so that there is no risk of them falling or being knocked over. Refer to 9.3.1 *Hazards involved in using learning technologies*, Manual handling of learning technologies equipment.

9.6.6 Printers

Use and description

Schools will generally use laser and inkjet printers. The laser printer is similar to a photocopier in that it generates an electrostatic charge and deposits carbon-based ink by means of a heat process. The inkjet printer produces the text or image with ink sprayed through microjets. Printers will be located in places such as classrooms, laboratories, officer areas, and libraries.

Inkjet printers have no heated parts. There is low risk from the ink given normal care. Laser printers must be handled differently. Care must be taken not to touch the hot elements inside the printer when clearing printer jams or changing toner cartridges.

Printers should be positioned so that air can circulate around them and their air vents are not covered. Avoid having the air from of the laser printer blow directly onto students.

Maintenance and storage

Refer to 9.3 *Hazards involved in using learning technologies*, 9.3.1 Manual handling of learning technologies equipment and 9.3.6 Inhalation or spillage of toners.

It is expected that there will be limited need to move printers once set up.

Teachers are responsible for changing ink cartridges or toner cartridges. Follow manufacturer's instructions carefully. There is minimal risk from the ink used in inkjet printers.

Dispose of empty toner cartridges according to manufacturer's instructions. Try to recycle toner cartridges and to buy remanufactured toner cartridges. Toner cartridges are sometimes discarded in landfills, wasting valuable resources and adding potential hazards to the environment. Schools should maximise recycling programs and increased the use of recycled products.

9.6.7 Data show projectors

Use and description

Data show projectors are devices connected to the computer (often a notebook computer) that project the monitor image onto a screen. This allows it to be viewed by an audience. Data projectors are excellent for demonstrating software and student projects to a class or group.

Avoid using multiple power cables by placing the data projector on a trolley with a powerboard. Position the notebook computer to use the same trolley and powerboard. Lighting should be subdued but not totally dark. Adjust blinds and curtains to prevent reflections.

Maintenance and storage

Projectors need to be handled with care. After use, they should not be moved until the projector bulb has cooled. Refer to 9.3.1 *Hazards involved in using learning technologies*, Manual handling of learning technologies equipment.

9.6.8 Digital cameras

Use and description

Quicktake or digital cameras are light and versatile and store images in digital form. These can be downloaded into a computer. Quicktake cameras take photos under a wide variety of light conditions, enable very rapid feedback once images are downloaded into the computer, and don't require film. Students can manipulate images on computer.

Digital cameras pose minimal risks although care should be taken that students do not walk into obstacles or fall over obstructions while using them.

Maintenance and storage

Digital cameras can be carried and stored in carry bags available from camera shops. Batteries should be handled and stored suitably and power cords correctly attached.

9.6.9 Scanners

Use and description

Scanners produce a digital image stored in the computer. They are similar to photocopiers in that a bright light source is reflected from the original to produce the copy in digital form. Scanners are increasingly being used by students as software programs and increased memory size allow for the use of graphics in web page development and in hard copy publications.

Hazards in using a scanner are limited to potential injury from breaking the glass top and viewing the strong light source. Both can be avoided through instructions on the safe use. Emphasise the need for care when placing objects on the glass top for scanning and the importance of closing the cover to avoid viewing the bright light. Photocopies of heavy items can be scanned.

Maintenance and storage

Scanners have a locking device to prevent the scanning mechanism from moving during transit. Keep scanners covered and do not stack anything on top of them. Refer to 9.3.1 *Hazards involved in using learning technologies*, Manual handling of learning technologies equipment.

9.6.10 Video equipment

Use and description

Video equipment includes cameras, tripods, cables, battery packs. A video recording is produced with a video recorder (camcorder) that captures full motion. The video produced can be presented on a television or computer monitor. The video adapter sends signals to the display device. It is a board that plugs into a personal computer to give it display capabilities. Video adapters are also called video cards, video boards, video display boards, graphics cards, and graphics adapters.

Hazards in using video equipment depend on where they are used. Ensure that students do not walk into or fall over obstacles while using them.

Maintenance and storage

Store video equipment so that it does not get damaged and cords remain in good condition.

Older or more complex video equipment can be heavy to carry and use. Ensure that students use proper carry cases and only carry them for short periods. Tripods can be used to hold cameras. Refer to 9.3.1 *Hazards involved in using learning technologies*, Manual handling of learning technologies equipment.

9.6.11 Audio equipment

Use and description

Audio equipment includes, microphones, tape recorders. Hazards in using audio equipment depend on where they are used. Avoid having power cords running across walkways and causing a tripping hazard.

9.6.12 CAD/CAM

CAD/CAM (computer-aided design/computer-aided manufacturing) packages enable students to design and produce in an integrated and logical way. A CAD system is a combination of hardware and software that enables engineers and architects to design everything from furniture to airplanes. In addition to the software, CAD systems require a high-quality graphics monitor, a mouse, light pen or digitizing tablet for drawing, and a printer or plotter for printing design specifications. Computer-aided manufacturing helps to automate equipment such as sewing machines and lathes.

The equipment controlled by CAM programs can cause hazards. Teachers can refer to Chapter 6 for information on different equipment.

References

Department of Education & Training

Risk Management. Collect Information, Analyze Risks, Prevent Future Accidents (CAP)

eLearning Planning Guide

Australian Standards

AS 1680.1-1990 Interior lighting – General principles and recommendations

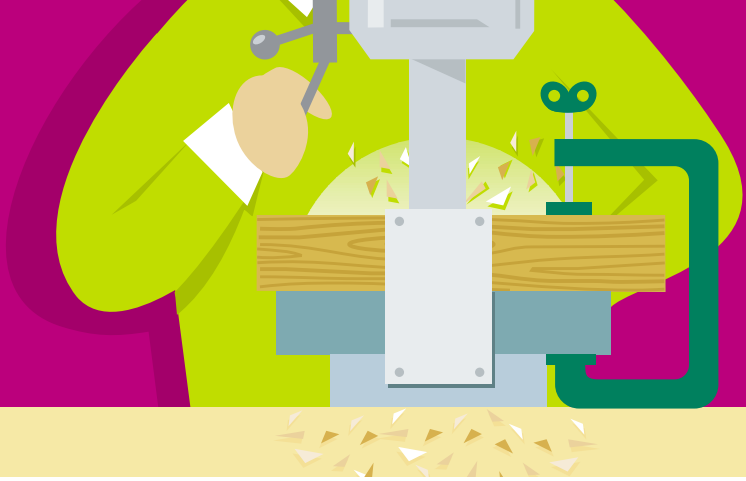
AS 1680.2.0-1990 Interior lighting – Recommendations for specific tasks and interiors

Victorian WorkCover Authority, Officewise, *Officewise. A Guide to Health and Safety in the Office*

Nigel Rose, *Fit to Sit, Fit to Live: In Today's Computer Age, Prevention is the Best Cure*. Nigel Rose, 1998.

Australian Physiotherapy Association, *10 Tips for Computer Users*. (sheet)

10 References



10.1 Organisations

Victorian WorkCover Authority

Level 24, 222 Exhibition Street
Melbourne VIC 3000
Phone: 9641 1555
Fax: 9641 1222
Internet: http://www.workcover.vic.gov.au/vwa/home.nsf
Legislation – Regulations
http://www.workcover.vic.gov.au/vwa/home.nsf/pages/so_regs
Legislation – Codes of Practice
http://www.workcover.vic.gov.au/vwa/vwacop.nsf/content/Codes+of+Practice

Worksafe Australia (National)

National Occupational Health & Safety Commission
GPO Box 58
Sydney NSW 2001
Australia
Phone: 02 9577 9555
Toll free: 1800 252 226
Fax: 02 9577 9202
Internet: http://www.nohsc.gov.au

Australia New Zealand Food Authority (ANZFA)

ANZFA is the statutory authority operating under the *Australia New Zealand Food Authority Act 1991*. It develops food standards and other regulatory measures.
Boeing House
55 Blackall Street
ACT 2600
Phone: 02 6271 2222
Fax: 02 6271 2278
Internet: http://www.anzfa.gov.au/

Australian Physiotherapist's Association

Unit 6, 651 Victoria Parade
Abbotsford VIC 3067
Phone: 9429 1799
Fax: 9429 1844

Victorian Farm Safety Training Centre

Rural Studies Department
PO Box 668
Ballarat VIC 3353
Phone: 5334 3510
Fax: 5334 2178

Victorian Farmers Federation

24-28 Collins Street
Melbourne VIC 3000
Phone: 9207 5512
Fax: 9207 5500
Phone: 9207 5564 Farm Safety Days
(Clare Claydon Education and Training Coordinator)

Farmsafe Australia Inc

Australian Agriculture Health Unit
PO Box 256
Moree NSW 2400
Phone: 02 6752 9203
Fax: 02 6752 6639

Human Services Department, Public Health Division

Regional Office
120 Spencer Street
Melbourne VIC 3000
Phone: 9637 4000

Environmental Health Enquiries
Phone: 9637 4156

Food Safety Victoria
Phone: 1300 364 352

Chief Electrical Inspector

Level 3, Building 2
4 Riverside Quay
Southbank VIC 3006
Phone: 9203 9700
Fax: 9686 2197

Monash University Accident Research Centre

Wellington Road
Clayton VIC 3168
Phone: 9905 1808

Technology Education Association of Victoria (TEAV)

Statewide Resource Centre
150 Palmerston Street
Carlton VIC 3053
Phone: 9349 1538
Fax: 9349 5591
Email: teav@mpx.com.au
Internet: http://www.teav.vic.edu.au

ICT in Education Victoria (ICTEV)

Statewide Resource Centre
150 Palmerston Street
Carlton VIC 3053
Phone: 9349 3733
Fax: 9349 5356
Email: ictev@ictev.vic.edu.au
Internet: http://www.ictev.vic.edu.au/

Art Education Victoria

Statewide Resource Centre
150 Palmerston Street
Carlton VIC 3053
Phone: 9349 5188
Fax: 9349 2050
Email: enquiries@aev.vic.edu.au
Internet: http://www.aev.vic.edu.au/index.html

Science Teachers Association of Victorian (STAV)

5 Munro Street
Coburg VIC 3058
Phone: 9386 6677
Fax: 9386 6722
Internet: www.stav.vic.edu.au

Victorian Home Economics and Textiles Teachers Association (VHETTA)

3 Windsor Avenue
Mount Waverley VIC 3149
Phone: 9888 2240
Fax: 9888 2241
Email: vhetta@peg.apc.org
Internet: http://www.vhetta.com.au

Plastics and Chemicals Industry Association (PACIA)

4th Floor, Royal Domain Building
480 St Kilda Road
Melbourne VIC 3004
Internet: http://www.pacia.org.au/

Environmental Protection Authority (EPA)

Herald & Weekly Times Tower
40 City Road
Southbank VIC 3006
Phone: 9695 2700
9695 2722 (Information Centre)
Internet: EPA Offices
http://www.epa.vic.gov.au/about/offices.asp

EPA Operations units
http://www.epa.vic.gov.au/Neighbourhood/Offices/opsunits.asp
EPA Operations units operate on a regional basis. They control and co-ordinate the discharge of waste and the generation, storage, treatment and disposal of industrial waste and noise emission. This is done through legislated powers and the implementation of State environment protection policies and industrial waste management policies.

EPA Industrial Waste Database
http://www.epa.vic.gov.au/industry/iwdb/
Locates industrial waste treaters, disposers and permitted transporters.

Standards Australia

The Standards Australia site http://www.standards.com.au/ provides information about Australian standards. Teachers can buy standards from this site in hard copy or electronic format. They can also shop in person at:
19-25 Raglan Street
South Melbourne VIC 3205
Phone: 9693 3533
Fax: 9696 1319
E-mail: research@standards.com.au
Internet: http://www.standards.com.au/

10.2 Resources

Acts, Regulations, Codes of Practice

Occupational Health and Safety Act 1985 (including amendments up to 1990)

Occupational Health and Safety (Manual Handling) Regulations 1988

Occupational Health and Safety (Machinery) Regulations 1985

Occupational Health and Safety (Plant) Regulations 1995

Occupational Health and Safety (Noise) Regulations 1992

Occupational Health and Safety (General Safety) Regulations 1985

Occupational Health and Safety (Asbestos) Regulations 1992

Occupational Health and Safety (Issue Resolution) Regulations 1989

Occupational Health and Safety (Hazardous substances) Regulations 1999

Code of Practice (First Aid in the Workplace) 1988

Code of Practice for Workplaces 1988

Code of Practice (Manual Handling) 2000

Code of Practice for Plant, Amendment No 1, No. 23, 1998

Code of Practice for Hazardous Substances. No. 24, 2000

Health (General Amendment) Act 1988

Health (Infectious Diseases) Regulations 1990

Dangerous Goods Act 1985

Dangerous Goods (Storage and Handling) Regulations Effective June 1 1990

Dangerous Goods (Storage & Handling) Regulations. Information kit.

Dangerous Goods (Prescribed List) Regulations 1985

Drugs, Poisons and Controlled Substances Act 1981

National Health and Medical Research Council, Standard for the Uniform Scheduling of Drugs and Poisons No. 7, Australian Government Publishing Service, Canberra, 1992

Department of Education & Training policy and support materials

Executive Memorandum 2000/015 re: Students safety in wood and metal technology

Executive Memorandum 473 re: 1.2 Dichloroethane (Etylene Dichloride)

Executive Memorandum 417 re: Student use of powered machinery in Technology Studies, Manual arts and practical studies

Department of Education & Training, e*Learning Planning Guide*

Department of Education & Training, *SafetyNet. Internet Usage Guidelines for Schools*, Victoria, 2000.

Department of Education & Training, *Victorian Government Schools Reference Guide*, 2002.

Department of Education, Victoria, Melbourne, *Safety Guidelines. Camping and Bush Activities. Safety In Outdoor Adventure Activities Series*, Victoria, 1998.

Department of Education & Training, *curriculum@work* CD-ROM.

Department of Education & Training, *Guidelines for the storage of science chemicals*, Second Edition 1999.

Department of Education, Employment and Training, *Managing School Emergencies. Minimising the Impact of Trauma on Staff and Students*, Victoria, 2001.

Department of Education, Employment and Training, Victoria, Melbourne, *Health and Well-Being at Work. A kit for staff in schools*, Second Edition, Victoria, 2000.

Board of Studies, T*echnology Curriculum and Standards Framework*, Victoria, 2000.

Department of Education, Victoria, *Learning Technologies Planning Guide for Schools, Using IT to Improve Teaching and Learning*, 1996.

Department of Education, Employment and Training, *Occupational Health and Safety Guidelines. Support Material for School*, 2000.

Department of Education, Employment and Training, Victoria, Melbourne, *Risk Management. Collect Information, Analyze Risks, Prevent Future Accidents (CAP)*, 2000.

Department of Education, Employment and Training, *Preventing Manual Handling Injuries*, Second Edition, Victoria, 2000.

Victorian Occupational Health and Safety Commission and the Victorian Curriculum and Assessment Board, Melbourne, *Health and Safety at Work. A Resource book for VCE Technology Studies*, 1991.

Directorate of School Education, School Safe. *An Occupational Health and Safety Program for Primary Schools*.

Research and Development, Education Department of Victoria, Curriculum Branch, West, K. *Code of Safety Practices. Technical Schools. Practical Studies*, 1984 (reprint).

Education Department of Victoria, Curriculum Services, Harrison, D. (compiler), *Working with Acrylics, Plastics Series Book 1. Technology Studies*, 1984 (reprint).

Curriculum Services, Education Department of Victoria, Harrison, D. (compiler), *Working with Adhesives, Plastics Series Book 2. Technology Studies*, 1983 (reprint).

Education Department of Victoria, Curriculum Branch, Keenan, T. *Safety Guidelines for General Woodwork and Building Practices*, 1983 (reprint).

WEST ED Education and Training, *Rural Injury Prevention Primary Education Resource (RIPPER)*
West Education Centre for Science and Technology
38 Kingsville Street
West Footscray VIC 3012
Phone: 9314 3011
Fax: 9314 1075

The Merck Publishing Group, *The Merck Index*, 1996 (12th ed) NJ USA.
The index is a one volume encyclopedia of chemicals, drugs and biologicals that contains more than 10,000 monographs.

Ajax Fine Chemical Reference Manual. (Asia Pacific Specialty Chemicals Limited.)

Farmsafe Australia Inc, Australian Agriculture Health Unit, Moree NSW, *Managing Farm Safety Program. A self-help program*. July 1994.

Victorian WorkCover Authority, *Officewise: A guide to Health and Safety in the Office, Fourth Edition, 2001*.

Occupational Health and Safety Authority, Melbourne, Shaw, A. et al, *Personal Protective Clothing and Equipment*, 1992.

Operative Painters and Decorators Union of Australia, Melbourne, Vic, Holmes, N. *Painters Hazard Handbook*, 1990.

M. Rossol, B. Bartlett, *Danger Artists at Work*, Thorpe Melbourne 1991.

Hall, L. McKenzie, M. Nott, *Artsafe Australia*, Periodical 1992. University of Melbourne, Melbourne.

Hall, B. (Department of Applied Chemistry, Royal Melbourne Institute of Technology), *Chemicals and the Artist*, 3rd ed 1993, revised 1997.

Department of Applied Chemistry, Royal Melbourne Institute of Technology, *Student Safety Guide*, revised 1997, reprinted 1998.

Ministry of Education, *Safety and Technology Education. A Guidance Manual for New Zealand Schools*, Wellington NZ, 1998.

Education Department of Western Australia and the Building Management Authority, *Noise Control Manual for Schools*, 1995.

Nigel Rose, *Fit to Sit, Fit to Live: In Today's Computer Age, Prevention is the Best Cure*. Nigel Rose, 1998.

Australian Physiotherapy Association, *10 Tips for Computer Users* (sheet).

Websites

SOFWeb: http://www.sofweb.vic.edu.au

Occupational Health and Safety: http://www.eduweb.vic.gov.au/hrweb/safetyhw/default.htm

@ the safety school: http://www.eduweb.vic.gov.au/hrweb/ohs/safetyschool.htm

Victorian WorkCover Authority: http://www.workcover.vic.gov.au/dir090/vwa/home.nsf

National Occupational Health and Safety Authority: http://www.nohsc.gov.au/

Standards Australia

General safety

AS 1470-1986	*Health and safety at work – Principles and practices*
AS 1485-1983	*Safety and Health and Workrooms of Educational Establishments*
AS 4360	*Risk Management*

Emergency procedures

AS 3745	*Emergency Control Organisation And Procedures For Buildings*

Fire safety

AS 1815.1	*Use and Maintenance of Fire Extinguishers*
AS 2444-1995	*Portable fire extinguishers and fire blankets – Selection and location*
AS/NZS 3504	*Fire Blankets.*

First aid

AS 1319 1994	*Safety Signs for the Occupational Environment*
AS 2675-1983	*Portable First Aid Kits for Use by Consumers*

Personal protective equipment

AS/NZS 1270:1999	*Acoustics – Hearing protectors*
AS 1336-1982	*Recommended practices for eye protection in the industrial environment*
AS/NZS 1337-1992/ Amdt 1-1994	*Eye protectors for industrial applications.*
AS/NZS 1338.1-1992/ Amdt 1-1994	*Filters for eye protectors – Filters for protection against radiation generated in welding and allied operations*
AS/NZS 1715:1994	*Selection, use and maintenance of respiratory protective devices*
AS/NZS 1716-1994	*Respiratory protective devices*

AS/NZS 1801:1997	*Occupational protective helmets*
AS/NZS 2161.2:1998	*Occupational protective gloves – General requirements*
AS/NZS 2161.3:1998	*Occupational protective gloves – Protection against mechanical risks*
AS/NZS 2161.4:1999	*Occupational protective gloves – Protection against thermal risks (heat and fire)*
AS/NZS 2210	*Occupational protective footwear*

Environment

AS/NZS 1269.1:1998	*Occupational noise management – Measurement and assessment of noise emission and exposure*
AS/NZS 2243:1997	*Safety in laboratories*
AS 2243.8-1992	*Fume Cupboards*
AS 2243.9-1991	*Recirculating Fume Cupboards*
AS 2982.1–1997	*Laboratory Construction*
AS 1680.1-1990	*Interior lighting – General principles and recommendations*
AS 1680.2.0-1990	*Interior lighting – Recommendations for specific tasks and interiors*
AS/NZS 4114.1:1995	*Spray painting booths – Design, construction and testing*
AS/NZS 4114.2:1995	*Spray painting booths – Selection, installation and maintenance*
AS/NZS 4610.2:1999	*Furniture – School and educational – Chairs – Strength, durability and stability*
AS/NZS 4610.3:1999	*Furniture – School and educational – Tables and storage furniture – Strength, durability and stability*
DR 99418	*Furniture – School and educational – Part 1: Functional, dimensional and marking requirements*

Engineering and electrical safety

AS 2030 Parts 1–4	*Gas Cylinders*
AS 3112-1993	*Approval and test specification – Plugs and Sockets*
AS 3191-1994	*Approval and test specification – Electrical and Flexible Cords*
AS/NZS 3760: 2001	*In-service safety inspection and testing of electrical equipment*
AS 4024.1-1996	*Safe guarding of machinery – General Principles*
AS/NZ 3000: 2000	*Electrical Installations (Australian/New Zealand Wiring rules).*
AS/NZ 3100: 2002	*Approval and test specification – General requirements for electrical equipment*

Procedures

AS 1627.5-1994	*Metal finishing. Preparation and pre-treatment of surfaces. Pickling, descaling and oxide removal.*

10.3 Providers of professional development, training, certification/accreditation

Noel Arnold & Associates (Consultancy Services)

Level 3, 818 Whitehorse Road
Box Hill VIC 3128
Phone: 9890 8811
Provide expert advice on health and safety for teachers. Run training programs and seminars for school staff, visit schools, and accredit schools to use previously banned equipment.

Holmesglen TAFE

Community and Industry Short Courses
Building 2, Level 2
Batesford Road
Chadstone VIC 3148
Phone: 9564 1804
Fax: 9564 1502
E-mail: shortcourses@holmesglen.vic.edu.au
Internet: www.holmesglen.vic.edu.au

DE&T approved training providers for first aid

Ambulance Officers Training Centre
69 Queens Road
Melbourne VIC 3004
Phone: 9200 0328

Australian First Aid

12 Main Street
Upwey VIC 3158
Phone: 9754 1022

Australian Red Cross First Aid Health and Safety Services

PO Box 536
South Melbourne VIC 3205
Phone: 9685 9990

Centre for Occupational Health and Safety Training

Swinburne University of Technology
PO Box 218
Hawthorn VIC 3122
Phone: 9214 8841

National First Aid Training

PO Box 650
Ocean Grove VIC 3226
Phone: 5255 5260

Premium Health

PO Box 142
St Kilda VIC 3182
Phone: 9596 1662

Pulse Education Centre

PO Box 2760
Rowville VIC 3178
Phone: 9752 8316

St John's Ambulance

Level 3, 341 Queen Street
Melbourne VIC 3000
Phone: 131394

Poisons First aid advice

Poisons Information Centre

Royal Children's Hospital
Flemington Road
Parkville VIC 3053
Phone: 9345 5680

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