OpenLearn

The Open University

Health and safety in the laboratory and field

About this free course

This free course provides a sample of postgraduate study in Science: http://www.open.ac.uk/courses/find/science.

This version of the content may include video, images and interactive content that may not be optimised for your device.

You can experience this free course as it was originally designed on OpenLearn, the home of free learning from The Open University - www.open.edu/openlearn/science-maths-technology/science/health-and-safety-the-laboratory-and-field/content-section-0.

There you'll also be able to track your progress via your activity record, which you can use to demonstrate your learning.

Intellectual property

Contents

Introduction 4
Learning Outcomes 5
1 Overview 6
- 1 History of health and safety 6
- 2 Legal requirements of health and safety in the UK 6
- 3 Office safety 8
- 4 First aid and emergency procedures 8
- 5 General laboratory health and safety 12
- 6 Chemical health and safety 14
- 7 Hazards, risk and the process of risk assessment 18
- 8 Biological health and safety 25
- 9 Field-work health and safety, UK and abroad 28
- 10 Risk assessment exercise 32

Conclusion 32
Keep on learning 32
Acknowledgements 33

Introduction

This course is designed to introduce you to the concepts of health and safety within a science laboratory or in the field. There are a number of legal requirements that must be adhered to before carrying out work in a laboratory. One of these is the necessity to carry out risk assessments on the chemical and biological agents that are to be used as part of your practical work activities. As part of this process you may be required to think about minimising exposure of yourself and colleagues to these chemical and biological agents. The following background and information is intended to make you more aware of health and safety aspects of your laboratory and field-based research work.

This OpenLearn course provides a sample of postgraduate study in Science.

Learning Outcomes

After studying this course, you should be able to:

- understand the legal framework of the Health and Safety at Work etc. Act 1974 and Regulations associated with it
- understand the employers', employees' and visitors' duties
- evaluate hazards and risks in order to carry out a risk assessment
- understand the legal requirement to report any accident or dangerous occurrence
- develop risk assessments for scientific laboratories that use chemicals or biological organisms or both.

1 Overview

1 History of health and safety

The discipline of health and safety is relatively modern, only developing in the last century. However, throughout the ages people have voiced their concerns about people being exposed to harmful substances. Hippocrates mentions in the 4th century BC that lead miners and workers tended to suffer from diseases. The phrase ‘mad as a hatter’ was coined because mercury used in the hat industry caused mental illness. In 1775 Pott reported that chimney sweeps suffered a high incidence of scrotal cancer; in the 1900s coal miners were found to suffer from lung disorders; and, by the 1930s asbestos was known to cause asbestosis, a form of lung cancer.

In 1976 in Italy, at a place called Seveso, there was an explosion at a chemical factory manufacturing pesticides. This released a cloud of 2,4,5-trichlorophenol that also contained 3,4,8,9-tetrachlorodibenzo-1,4-dioxin, which is highly toxic. A number of children exposed to these chemicals suffered from chloracne, and were hospitalised, and about 3000 farm animals died. As a result of this incident the European Union later introduced the Seveso Directive in an effort to prevent accidents in large chemical factories.

In 1984, the worst ever chemical factory disaster occurred in Bhopal, India: 45 tonnes of methyl isocyanate ($CH_3N=C=O$) gas escaped from two underground storage tanks at a Union Carbide pesticide plant. This highly toxic gas resulted in the deaths of 6000 people, 300 000 were injured and 7000 animals also died.

2 Legal requirements of health and safety in the UK

The Health and Safety at Work etc. Act (HSWA) 1974 states that:

- It is the duty of every employer, so far as is reasonably practicable, to ensure the health, safety and welfare at work of all employees (this includes students).
- It is the duty of every employee while at work to take reasonable care of himself (herself) and of other persons who may be affected by his (her) acts or omissions at work.
- The employees must cooperate with the employer with regard to health and safety procedures.

This covers all types of employment within the United Kingdom.

The Health and Safety at Work Act 1974 applies to all work activities, whether for profit or not. The main sections of the Act are quoted in the paragraphs below:

Section 2: General duties of employers to employees

1 It shall be the general duty of every employer to ensure, as far as is reasonably practicable, the health, safety and welfare at work of all of his employees.

Section 3: General duties of employers and self-employed to persons other than their employees

1 It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health and safety.

Section 4: General duties of persons concerned with premises to persons other than their employees

Translated into plain English, this section describes the duty of the employer to minimise the risks from equipment and substances to those who are not employed, e.g. undergraduate student, visitors, maintenance contractors, members of the public, etc., also to ensure that these people have a safe entry to and exit from the premises of the employer.

The Management of Health and Safety at Work Regulations 1999 (updated 2002) are the most significant regulations in the current health and safety legislation. They are accompanied by an Approved Code of Practice (ACOP) and Health and Safety Executive (HSE) guidance.

Regulation 3: Risk assessment

In plain English, this means the employer must carry out a risk assessment whenever people are employed and this must take into account all the statutes and ACOPs, including fire precautions, which all persons must be told about.

The host employer must provide these persons with adequate information regarding the risks to their health and safety.

In view of the fact that Acts of Parliament take a long time to be enacted, and health and safety is an ever-changing subject, the HSWA 1974 allows for regulations to be introduced and regular updates to these regulations to be made.

Table 1 lists the legal requirements that must be conformed to when working in most universities.

Table 1 Legal requirements

Health and Safety at Work etc. Act (1974)
Fire Precautions Act (1971)
Fire Precautions (Workplace) Regulations (1997)
Management of Health and Safety at Work Regulations (1999)
Health and Safety (Display Screen Equipment) Regulations (1992)
Manual Handling Regulations (1992)
Control of Substances Hazardous to Health Regulations (2002) (COSHH)
Electricity at Work Regulations (1989)
Provision and Use of Work Equipment Regulation (1998) (PUWER)
Noise at Work Regulations (1989) (2003)
Genetically Modified (Contained Use) Regulations (1992)
Health and Safety (Training for Employment) Regulations (1990)

Ionising Radiations Regulations (1999)
Personal Protective Equipment at Work Regulations (1992)
Health and Safety (First Aid) Regulations (1981)
Chemicals (Hazard Information for Packaging and Supply) Regulations (2002)

These statutes and regulations are all enforced by the HSE or Environmental Health Officers (Local Authority) and could result in criminal prosecution or in improvement notices for lesser offences. It should be noted that criminal liability cannot be insured against by employers, directors or employees.

3 Office safety

The relevant safety legislation for offices includes the Display Screen Equipment Regulations, which concern computer monitors and workstations. If electrical devices are used, then the Electricity at Work Regulations will apply. See Appendix A for a list of potential safety problems and considerations for offices and Appendix B for a checklist.

Click to open Appendix A.

Clickto open Appendix B.

4 First aid and emergency procedures

4.1 First aid

It is not required that students be trained in first aid. It is, however, important that a first aid kit is carried when you are likely to be away from immediate assistance. First aid must be rendered at once, and medical and relief help should be sought if necessary. It is important that appropriate first aid skills for use in the field are understood by those who might need them and that the procedures for enlisting help are known.

Figure 1 A first aid kit

A first aid box must be provided in a laboratory and a first aid kit must be provided by the leader of each field trip and, in addition, a small personal first aid kit is recommended for all members of a party travelling in remote areas (students included). Table 2 lists what a typical first aid kit for the field, which is small enough to be carried with you in a pocket or rucksack, should contain.

All untoward incidents, as well as all accidents, may have to be reported to various authorities, so the circumstances should be noted down as soon as possible after initial help has been rendered. A report should subsequently be made to the Head of Department and the Occupational Health Section (or the appropriate persons for your institution).

Table 2 Personal basic first aid kit (minimum); items to be in a small waterproof container

		Quantity
	Assorted stretch-fabric plasters	1 dozen
	Crepe bandage 3″	1
	Triangular bandage	1

	Standard dressing (lint) no. 9	2
	Non-stick dressing (‘Melolin’)	1
	Cleansing wipes (in foil sachets)	6
	Safety pins	6
	Small packet of salt and sugar	1 each
	Savlon, or similar antiseptic cream	1
	Small note book and pencil	1
Optional:	Scissors 5″ (blunt ended)	1

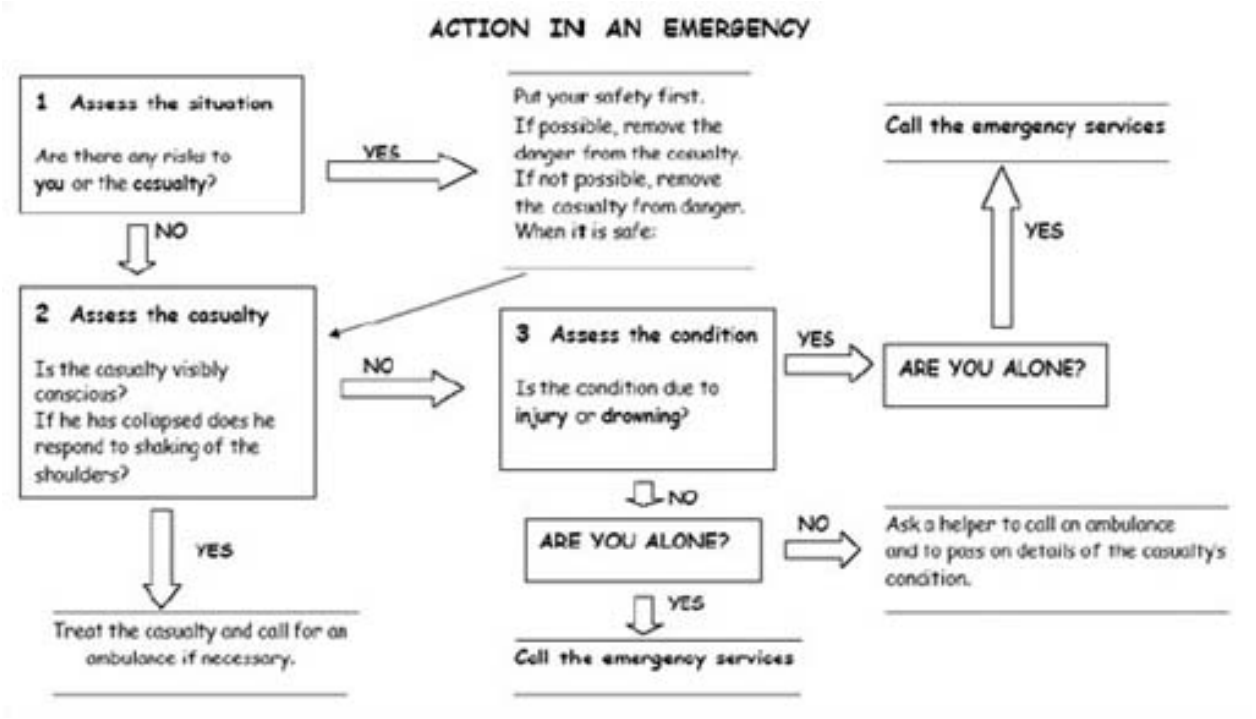

Figure 2 Action to take in case of emergency

If you are in the laboratory there are first aiders on site and you should know who the first aider is for your area.

If you are going on field-based research it could be very beneficial for you to attend one of our 1-day emergency first aid courses.

To give you an idea of the kinds of thing that are covered in a 1-day course, we suggest you visit the following sites:

- Red Cross
- St John's Ambulance

Unfortunately, there has been a lot of misinformation and misunderstandings about first aid, so let us start off with a definition.

The aims of first aid are to:

- preserve life;
- prevent the worsening of any injuries;

- promote recovery.

4.2 Why do I need to know about first aid?

It takes only 3 to 4 minutes for a blocked airway to kill someone, but it can take more than 8 minutes for an ambulance to arrive on the scene. A simple procedure like opening an airway can save someone's life while you are waiting for professional help to arrive.

If you are working with harmful substances (chemicals, biological agents and dusts) you must know the first aid treatment if you are exposed. Do not expect a nurse or a doctor to know everything about every harmful substance. This will be part of the risk assessment process that is carried out. If you need to seek medical assistance, take a copy of the risk assessment with you. For further information see Croner's *Substances Hazardous to Health Emergency First Aid Guide*.

Figure 3 The contents of a first aid kit

For small spills or exposure you must carry out a degree of self-treatment. For example, if you spill two drops hydrochloric acid on your hand you would go to the sink and wash your hand with running water for 5 minutes.

For more serious accidents contact your local first aider or appointed person.

5 General laboratory health and safety

5.1 Basic do's and don'ts and lone working

Some basic ‘do's and don'ts’ are:

- Laboratory coats must be worn at all times.
- When handling chemicals or sharps (any sharp object that can cause injury, particularly to the hands), observe good laboratory practice by wearing gloves. Latex or nitrile gloves are best, depending on the application.
- There should be no eating, chewing gum, drinking, smoking or applying cosmetics in any laboratory.
- No pipetting by mouth; always use pipette filler.
- All broken glass must be placed in a labelled bin (Broken Glass); **nothing else should go in that bin**.

Figure 4 Different kinds of gloves

Lone working

Lone working is defined as working alone after hours on weekdays or at weekends.

- The student should inform their supervisor and security that they are intending to work alone in laboratories and inform security when finished.
- If the work involves any hazards then the student should carry a lone worker alarm and again inform security of their whereabouts.

5.2 Cryogenic liquids and ionising radiation safety

5.2.1 Cryogenic liquids

There are a number of hazards associated with cryogenic liquids, the main one being that when accidentally released the liquid expands hugely to form a gas (600 times in the case of nitrogen). The formation of such a large volume of gas can lead to asphyxiation in confined areas.

The other main hazard is cold burns (frostbite).

- Always wear the correctly specified gloves when handling cryogenic liquids.
- Wear a full face mask.
- Never travel in a lift with cryogenic liquids.
- When dispensing in confined spaces it is advisable to have a low-oxygen alarm system, either fixed or portable.

5.2.2 Ionising radiation safety

Anyone wishing to work with radiation must be registered via your Radiation Protection Supervisor (RPS). Allow time for your registration to be processed; you may need to attend a training course or provide your exposure and training records from your previous employer.

Figure 5 Radiation labelling in a fume cupboard

Local rules describe the procedures for ordering, storage, handling, disposal and record keeping for radioactive sources in each department. A copy is issued to you on registration, and copies are displayed on the Radiation Notice Board.

Radiation laboratories are controlled areas with specific access requirements. All radioactive material **must be accounted for**. University research laboratories have been prosecuted by the HSE for losing radioactive material.

6 Chemical health and safety

6.1 Control of Substances Hazardous to Health (COSHH) Regulations

For those companies involved in the handling of chemicals and/or biological material there are a number of additional regulations. These are known as the Control of Substances Hazardous to Health (COSHH) Regulations. These were introduced in 1988, and the last update was in 1999. These regulations apply to chemicals, biological hazards and dusts.

The essential requirements are that the employer must:

- make an assessment of the health risk to employees;
- prevent or control exposure to employees.

6.1.1 What is the definition of hazard under COSHH?

'Hazard' is defined as the inherently dangerous properties of a chemical or biological organism.

What is the definition of risk under COSHH?

'Risk' is defined as the likelihood of a chemical causing harm to people or to the environment.

Figure 6 A fume cupboard

In a risk assessment, therefore, the employer has a duty to consider the risks to health from work involving exposure to hazardous substances and then must decide on any further action that might be needed to remove or reduce those risks. This also means looking at the extent and likelihood of a substance causing harm, in the actual circumstances of the work. This is different from looking at the hazard of a substance, which is its potential for causing harm.

A low hazard can present a high risk if control is poor. For example, wood presents a low hazard, but if a sawmill or factory is continually full of wood dust, then this presents a risk of nasal cancer to the work force. The COSHH 1999 regulations require an assessment of

risk and then consideration of the steps that need to be taken to achieve and maintain adequate control.

6.2 Chemical Classification, Labelling and Packaging (CLP) Regulation

These regulations were first introduced in 1992 and known as CHIP1, and have since been revised numerous times to keep up with developments in the field of health and safety. The CLP Regulation (EC 1272/2008) came into force on 20th January 2009. The Regulation was implemented in all EU Member States and the United Nations' Globally Harmonised System (GHS) for classification and labelling. It introduced new classification criteria, hazard symbols (called 'Hazard Pictograms') and labelling phrases (known as 'Hazard Statements' and 'Precautionary Statements'). The CLP Regulation applied directly in all EU Member States, requiring no national transposition. Its provisions were phased in over a number of years and came fully into force on 1st June 2015 – by which point all plant protection products (PPPs) placed on the market had to have been classified and labelled in line with CLP.

Figure 7 CLP hazard pictograms

The aim of these regulations is to help protect people and the environment from the ill effects of chemicals. They apply to both single substances and mixtures of substances (often called preparations). This is done by providing information about their properties and ensuring they are packaged safely. If users know about the chemicals and how to

control them then they are less likely to do things with them that will harm themselves, other people or the environment.

The following are definitions in the regulations that must be made clear:

- Category of danger is a description of hazard type, e.g. highly flammable.
- Classification is the precise identification of a chemical by assigning a category of danger and a risk phrase using set criteria.
- Risk phrase (R) is a standard phrase that gives simple information about the hazards of a chemical in normal use.
- Safety phrase (S) is a standard phrase that gives advice on safety precautions when using the chemical.

It is now a legal requirement that all containers of chemicals are labelled correctly. This ideally should also include volumetric flasks for standards and buffers and round-bottomed flasks containing samples.

7 Hazards, risk and the process of risk assessment

7.1 Health problems associated with using chemicals

As described in Section 6.2, hazard is defined under COSHH as the inherently dangerous properties of a chemical or biological organism, and risk is defined as the likelihood of a chemical causing harm to people or to the environment.

There are several, more specific, known health problems associated with using chemicals. Advice on safety precautions when using a specific chemical are given in its associated safety phrase(s), which are described below.

7.1.1 Sensitising chemicals

Sensitising (Se) substances are known to cause allergic reactions in some people. These allergic reactions can be respiratory, and range from hayfever-like symptoms through to occupational asthma, for example, as caused by formaldehyde.

Other chemicals may cause skin allergies, which may lead to eczema, for example nickel and turpentine.

7.1.2 Carcinogenic chemicals

Several chemicals are known or suspected to cause cancer in humans and animals. These are known as carcinogenic (Ca) substances and under CHIP are divided into three categories:

- categories 1 and 2 are defined as **toxic**, e.g. benzene;
- category 3 is defined as **harmful** – this is often applied to chemicals that are suspected as being carcinogenic, e.g. dichloromethane.

7.1.3 Mutagenic chemicals

This is the term given to substances that are known to cause or are suspected of causing inherited changes. A mutagen is a substance that causes an increase in the rate of change in the genes (subsections of the DNA of the body's cells). These mutations can be

passed along as the cell reproduces, sometimes leading to defective cells or cancer. Again there are three categories:

- categories 1 and 2 are **toxic**, e.g. iodomethane;
- category 3 is **harmful**, e.g. vanadium pentoxide.

7.1.4 Teratogenic chemicals

These chemicals are toxic to reproduction. A teratogen is an agent that can cause malformations of an embryo or a foetus. Once again there are three categories:

- categories 1 and 2 are **toxic**, e.g. chromium trioxide;
- category 3 is **harmful**, e.g. nandrolone (19-nortestosterone), a banned anabolic steroid.

If the substance is a category 1 or 2 carcinogen, mutagen or teratogen, **all work must be carried out in a fume cupboard or equivalent**. A category 3 carcinogen, mutagen, teratogen or sensitising substance is not so dangerous but it would be prudent to handle such a compound in a fume cupboard if one is available.

7.2 Information sources

7.2.1 How do I find the information required to carry out COSHH risk assessments?

The best source of information is the material safety data sheet (MSDS). By law (CHIP3) this should accompany any chemical that is purchased. However, if this is not available, or the chemical is old, then copies can be obtained from the manufacturer's website or information can sometimes be found in the catalogue. Further information can be obtained from the HSE.

7.2.2 Incompatibility

If two or more chemicals are to be mixed together as part of your procedure, then you must consider the possibility of incompatibility, which may lead to toxic fumes or even an explosion. This information is often given in the MSDS, e.g. acetic acid with chromic acid.

7.2.3 Materials not on the database

What should you do if you are preparing a material that is not commercially available? For novel chemicals or isolated reaction intermediates for which there are no published safety data, hazards should be predicted from the characteristics of similar compounds or from starting materials.

7.3 Disposal requirements

Figure 8 Disposal canister

When carrying out a risk assessment, you must consider disposal requirements. For example, any chemical dangerous to the environment should not be disposed of down the sink, for obvious reasons. Likewise, volatile organic solvents should not be disposed of down the sink; most are immiscible with water. There have been a number of documented fires and explosions associated with people disposing of volatile solvents down the sink. Each laboratory will have local rules regarding the disposal of chemicals; it is important that you read these or find out about them. Usually, solvents are put into labelled bottles (Winchesters); halogenated, non-halogenated and water-miscible liquids are normally separated, because each category is disposed of in a different way.

7.4 Emergency procedures

7.4.1 What do you do if a chemical catches on fire?

It is important to know which fire extinguisher is appropriate for the chemical you are using. The four commonly used extinguishers are carbon dioxide, dry powder, foam, and water.

Figure 9 Examples of different types of fire extinguishers

For example, water should not be used for a sodium fire; nor an electrical fire, because it conducts electricity.

Carbon dioxide is recommended for electrical fires and solvent fires, but not for sodium metal or lithium aluminium hydroxide.

Dry powder extinguishers are best for reactive metal fires.

The information on which extinguisher to use will be in the MSDS. It is recommended that you undertake some form of training before using any fire extinguishers because there are hazards associated with their use.

Figure 10 Fire extinguisher symbol chart

7.5 Control measures

7.5.1 Control measures to avoid exposure

There are four main methods of exposure to chemicals:

1 **Inhalation** – This is the main method of exposure to volatile solvents and gases.

2 **Skin absorption** – Certain chemicals possess the ability to penetrate through pores of skin (for example, mercury compounds and hydrofluoric acid).

3 **Splashes to the eye** – The eye is one the most sensitive organs, and splashes of chemicals can cause severe pain and, in extreme, cases blindness.

4 **Ingestion** – Residues of chemicals can be left on your hand and then be transferred to the food that you eat. This is why it is important to wash your hands after carrying out laboratory work.

There are a number of ways to reduce or eliminate exposure to chemicals. The most common method utilised is a fume cupboard (also called local exhaust ventilation, LEV).

Some chemicals have adverse reactions when exposed to air or moist air; these have to be handled under an inert atmosphere, usually oxygen-free nitrogen or argon. For highly toxic or unstable chemicals these may require a dry box or negatively pressurised containment.

7.6 Personal protective equipment

Figure 11 Personal protective equipment (PPE) for working with highly corrosive liquids

In most laboratories, laboratory coats and safety glasses (goggles) are compulsory. For those who wear glasses, over-glasses or prescription safety glasses can be used. These have side protection that normal glasses do not have. Additional personal protective equipment may include rubber gloves, UV glasses if working with UV radiation, heat/cold-resistant gloves or a full face mask.

Figure 12 Goggles should be worn on entering a laboratory

If you are working with radioactive chemicals then lead shielding may be necessary.

7.7 Physical hazards

In any laboratory, potential hazards arise from the use of electrical equipment. The legal requirements relating to the use and maintenance of such equipment are contained in the 'Electricity at Work Regulations 1989' (EAW). The regulations require certain safety objectives to be achieved but do not prescribe in detail the measures to be taken. Instead, precautions should be selected appropriate to risk depending on particular work activities.

'Portable' electrical equipment – that is, equipment that is not part of a fixed installation and that can be connected to a fixed power supply by means of a flexible cable and plug – is by its nature particularly susceptible to damage or misuse. Examples of this type of laboratory equipment include hot-plate stirrers, pH meters, ovens, certain types of furnace, spectrophotometers, free-standing computer equipment, and so on. The condition of the plug, electrical lead and apparatus casing should be checked each time before the item is used. Any damage should be reported immediately and the equipment should be taken out of use. Most organisations carry out regular 'portable equipment testing' in which a thorough inspection of the equipment is carried out, including testing the earth continuity and insulation resistance.

7.7.1 Furnaces and ovens

Materials used in the construction of furnaces and ovens are heat resistant so that their electrical properties are not impaired at elevated temperatures. The gloves and tongs provided should always be used when taking samples in or out of a furnace or oven. Furnaces and ovens are designed to minimise the risk of electric shock if metal tongs are used. The main hazards from furnaces and ovens are burns; in addition, paperwork and other flammable material should be kept out of the working area. A hot crucible taken from a furnace or oven must be placed on a designated heat-resistant surface and allowed to

cool before being handled. It is essential that there is plenty of room to manoeuvre when handling hot materials.

7.7.2 Compressed-gas cylinders

Gases are usually supplied to laboratories compressed in metal cylinders of various sizes. The cylinders are painted in distinctive colours to aid identification; for example, hydrogen and some other flammable gas cylinders are red in colour. However, the primary means of identification is by a label attached to the shoulder of the cylinder.

In most cases, cylinders are fitted with a regulator to reduce the gas pressure from the cylinder pressure to a suitable working pressure for the laboratory equipment. **You should not attempt to obtain gas from a cylinder unless you have been instructed on how to use a regulator**. Cylinders should **never** be moved with a regulator attached. It is recommended that regulators are tested every two years. As a precaution against the wrong regulator being connected, the cylinder outlet threads for fuel gases (for example, hydrogen and propane) have a left-handed thread, whereas oxygen and inert gases have a right-handed thread.

7.7.3 Lasers

A laser produces an intense, highly directional beam of light, and exposure to this beam can result in damage to the eye and skin. Safe exposure limits for nearly all types of laser radiation have now been established and these are referred to as maximum permissible exposures (MPEs) by professionals in the field. However, based on experience, a more general system of laser hazard categories or classifications has been developed; basically, lasers are assigned to one of four general classes (1–4, where 4 is the highest class). The higher the class of a laser, the more stringent are the control measures required.

An He–Ne laser, for example, is a Class 2 laser. A brief description of this category of laser (taken from information published by the Laser Institute of America) is as follows:

> A Class 2 laser or laser system must emit a visible laser beam. Because of its brightness, Class 2 laser light will be too dazzling to stare into for extended periods. Momentary viewing is not considered hazardous since the upper radiant power limit of this type of device is less than the MPE for momentary exposure of 0.25 second or less. Intentional extended viewing, however, is considered hazardous.

It follows from this description that you should avoid looking into a direct Class 2 laser beam and also make sure that the beam cannot be reflected by material inadvertently placed in its path. If the laser beam does enter your eye, say by an unintended reflection, you should move your head away immediately.

8 Biological health and safety

8.1 Syringes and sharps

- Observe good laboratory practice by wearing gloves; latex or nitrile gloves are best.
- **Do not** re-sheath needles or sharps unless **unavoidable** due to the nature of the work.

- Remove scalpel blades with a **specific** scalpel-blade-removing tool.
- Dispose of all syringes and sharps in designated containers (labelled ‘sharps’); when these are full they should be taken for commercial disposal by incineration.

Figure 13 Sharps box

8.2 Working with bio-hazardous material (human material, microbiological agents, plant pathogens)

Under COSHH Regulations in the Advisory Committee on Dangerous Pathogens (ACDP) guidelines, a risk assessment must be performed on **all** projects involving bio-hazardous material.

In addition to the general laboratory working practices, the following should be observed:

8.2.1 For unscreened human material

- Work in the Containment Level 2 laboratory, which has restricted access.
- Wear a laboratory coat and gloves.
- Avoid sharps (e.g. needles, glass Pasteurs) where possible.
- Work only in the clearly identified, designated safety cabinets.
- Dispose of all solid waste in autoclave bins by autoclaving and then via the clinical waste route.
- Dispose of liquid waste by adding Virkon (or equivalent sterilising) powder to a concentration of 1%, mix, and leave for a minimum of 10 minutes, and wash down the drain with copious amounts of water.
- Disinfect the work area after use with 1% Virkon solution by wiping over and leaving to dry.
- Disinfect all contaminated glassware using freshly made 1% Virkon solution before placing for wash-up.
- Centrifuge only in sealed safety buckets.

Figure 14 Waste bag for clinical waste

8.2.2 Centrifuges

- Correct usage of centrifuges and rotors must be observed.
- Ensure that you are trained by a competent person.
- Hazards are caused by incorrect balancing of tubes, leakage from a broken or collapsed tube within the rotor or aerosol production from the tubes themselves.
- Sealed buckets should be used for hazardous material in a centrifuge without an airflow (check the manual).
- Allow 2 minutes after a rotor comes to rest before opening the lid of the centrifuge, to allow any aerosol to settle.
- Appropriate decontamination (based on the agent involved) should be carried out.

8.3 Genetically modified material

8.3.1 Genetic modification

You must ensure that your department is registered for genetic modification work.

All **new** GM projects must be submitted to the departmental GM Safety Committee (GMSC) on a GM Risk Assessment form for approval before commencement of the work.

The GM labs will be identified and the following procedures should be followed:

1 Wear laboratory coat and gloves.
2 Decontaminate all **liquid** waste by adding Virkon powder to a concentration of 1%, mix, leave for a minimum of 10 minutes and dispose via the drains with copious amounts of water.
3 Dispose of all **solid** waste in autoclave bags in the grey bins provided and then by autoclaving and then via the clinical waste route.
4 There is a weekly autoclave run – see the Biological Safety Adviser for details.
5 Training in the use of the autoclave will be given by BRU staff.
6 Spillage must be contained by absorbent material and disinfected appropriately, based on the GM Risk Assessment form.

9 Field-work health and safety, UK and abroad

9.1 Field-work risk assessment

Field-work covers a wide spectrum of outdoor activities and takes place in almost every environment present both in the UK and abroad. It is acknowledged that there is an element of risk in much of this work. The Health and Safety at Work Act recognises that risk is inherent in some occupations and seeks to ensure that systems of work are in place to reduce risks to an acceptable level.

There has been increasing concern about the safety of field trips in the light of recent court cases involving fatalities of schoolchildren on organised field trips. What has been emphasised is the need for well-written risk assessments. Indeed, one education authority was prosecuted for not having produced written risk assessments.

For field-work, the Boy Scout motto ‘Be prepared’ is important, as one of the major hazards is inclement or changeable weather. One may start up a mountain in bright sunshine, but the weather can quickly change to a blizzard; this can result in a dangerous situation because of loss of visibility and cold, which may lead to hypothermia.

Figure 15 Observation of a rock face from the road

In arid areas there can be a problem with flash floods. People have decided to camp in a dried-up river valley which suddenly becomes a torrent. At the other extreme, when working in summer or hot, dry regions, there is the danger of sunstroke, sunburn and dehydration. Plan your work to **avoid the hottest time of the day, put suntan lotion on, wear a hat and take plenty of water with you**.

If you are working in any area that is tidal then you must be aware of the tide times to avoid being cut off or drowned.

When planning field trips it is important to be aware of the weather, in addition to weather forecasts. Information about potential local flooding can be obtained from the Environment Agency.

It is important to be able to communicate in an emergency, so a mobile phone or a VHF radio is important. Check the reception, however, because it can vary in remote areas. Alternatively, for very remote areas, a satellite phone can be used.

9.2 Other hazards

9.2.1 Stumbles, falls, etc.

Such minor accidents are always possible, especially on rough or uneven terrain. It is recommended, therefore, that boots should be worn to protect the feet and ankles, and that outer clothing should be of a suitable nature to minimise the chance of cuts, scratches, and abrasions being sustained. Wearing gloves will minimise damage to hands.

9.2.2 Falling rocks/debris, rock splinters, etc.

Protective headgear (hard hats) must be worn whenever this is advised by the party leader. Goggles or glasses should be worn when hammering or breaking rocks.

9.2.3 Cliff edges and high places, etc.

Whilst no climbing requiring the use of special equipment or aids will be undertaken, it is possible that in order to view interesting geological features it may be necessary to approach the edge of a cliff, or to stand in locations where a fall could result in serious injury. In such situations it is expected that individuals will exercise reasonable caution, and at all times will follow the instructions and advice of the party leader.

9.2.4 Quarries, mines and other industrial workings, etc.

Quarrying operations may involve blasting and the use of heavy earth-moving equipment. All quarry ‘faces’ should be regarded as unstable and liable to collapse. This applies to all quarries, whether working or otherwise. Similar hazards may be encountered in other industrial workings.

Visitors to working quarries and other industrial sites are legally required to comply with safety instructions issued by the owners and/or persons in charge of the workings. Therefore, it is essential:

1 to follow the instructions of the guide and/or party leader;

2 to keep in a close group;

3 not to straggle or wander off;

4 to be alert to the movements of vehicles and equipment.

In summary, be prepared; see Appendix C below for a list of equipment that may be required for field-work.

Click to open Appendix C.

9.3 Health

The leader must be informed of any problems of mental or physical health that may affect safety during field-work. This may include, for instance, information on diabetes, asthma or epilepsy; students should also inform the leader if they require extra assistance. All work handling living organisms, soil or water may give some risk of infection, and protection in the form of gloves, masks, etc., may need to be carried. Supervisors should give advice concerning particular health hazards that may be encountered in the area(s) to be visited and, where necessary, persons planning to attend overseas field trips should contact the Occupational Health Department for appropriate first aid advice and vaccinations. If students are expected to be eating packed lunches, it may be appropriate to suggest they bring their own hand wipes if washing facilities are not available.

For further information on health issues when travelling, visit Masta Travel Health.

Additionally, you may telephone the ‘Travellers' Health Line’ on 0906 8224100.

9.3.1 Tick-borne disease

Ticks are most common in spring and autumn in bracken and long grass. The ticks become attached to skin or clothing and migrate to moist warm areas such as the axilla (armpit) or groin. Tick-borne illness is increasing, even in the UK.

In North America, the following diseases are caused by tick bites: Lyme disease, human granulocytic and monocytic ehrlichiosis, babesiosis, relapsing fever, Rocky Mountain spotted fever, Colorado tick fever, tularemia, Q fever, and tick paralysis. In Europe, the list is similar, but other diseases should be considered as well; these include boutonneuse fever (caused by a less virulent spotted fever rickettsial organism *Rickettsia connori*), and tick-borne encephalitis.

To avoid tick bites:

1 Avoid any unnecessary exposure. Keep to paths and avoid long grass.
2 Wear long trousers.
3 Wear thick socks outside trousers.
4 Insect repellents can be used to impregnate clothes that could be exposed.

Treatment

1 Remove ticks from body as soon as possible. Seek medical attention if necessary, or ask a field companion to help. If self-treating, use tweezers hooked under the tick's body, taking care not to pull off the tick's body and leave the head embedded.DO NOT use petroleum jelly, any liquid solutions, or freeze/burn the tick, as this will stimulate it to regurgitate its stomach contents, increasing the chance of infection.
2 Most tick bites do not result in transmission of infection; in the case of Lyme disease for example, only about 2–3 per cent of all persons bitten by *Ixodes scapularis* ticks in endemic areas develop Lyme disease.
3 If infected, 2–6 weeks after the bite a rash and pain in the joints can develop. Untreated, this infection can lead to health problems years later.
4 This infection is easily treated with antibiotics in the early stages.

9.3.2 Leptospirosis (Weil's disease)

Leptospirosis is an infectious disease caused by bacteria; it occurs particularly in rodents, but also in dogs and other mammals. Human infection occurs through exposure to infected animals' urine that has contaminated watercourses; the infection enters the skin through abrasions and mucus membranes (mouth, nose and eyes). The greatest risk is where there is standing water, such as water and pools in streams in arid regions. Hot springs are a common source of infection. The dilution that occurs in lakes/lochs and rivers makes the risk of infection rare.

Leptospirosis begins with 'flu-like' symptoms, 2–17 days after exposure. Medical attention should always be sought and the doctor informed of the recent field trip. This can be a serious illness, and prompt diagnosis is essential.

Prevention

1 Avoid exposure if possible.
2 If anticipating spending time wading in water, wear protective clothing.
3 Cover any skin lesions with waterproof plasters.
4 Avoid getting water in the mouth or eyes, and rinse out with fresh water if this occurs.
5 Always wash hands well before eating or drinking.
6 Shower well as soon as practicable after exposure.

10 Risk assessment exercise

After reading this course you might like to carry out a risk assessment of your office environment or a nearby office and one of the following:

1 a display-screen user risk assessment;
2 a laboratory-based risk assessment;
3 a field-work risk assessment for a proposed field expedition.

Conclusion

This free course provided an introduction to studying Science. It took you through a series of exercises designed to develop your approach to study and learning at a distance and helped to improve your confidence as an independent learner.

Keep on learning

Study another free course

There are more than **800 courses on OpenLearn** for you to choose from on a range of subjects.

Find out more about all our free courses.

Take your studies further

Find out more about studying with The Open University by visiting our online prospectus.

If you are new to university study, you may be interested in our Access Courses or Certificates.

What's new from OpenLearn?

Sign up to our newsletter or view a sample.

For reference, full URLs to pages listed above:

OpenLearn – www.open.edu/openlearn/free-courses

Visiting our online prospectus – www.open.ac.uk/courses

Access Courses – www.open.ac.uk/courses/do-it/access

Certificates – www.open.ac.uk/courses/certificates-he

Newsletter – www.open.edu/openlearn/about-openlearn/subscribe-the-openlearn-newsletter

Acknowledgements

Grateful acknowledgement is made to the following sources for permission to reproduce material in this course:

Course image: Esad Hajdarevic in Flickr made available under Creative Commons Attribution 2.0 Licence.

The content acknowledged below is Proprietary and is used under licence.

All written material contained within this course originated at the Open University

Don't miss out:

If reading this text has inspired you to learn more, you may be interested in joining the millions of people who discover our free learning resources and qualifications by visiting The Open University - www.open.edu/openlearn/free-courses