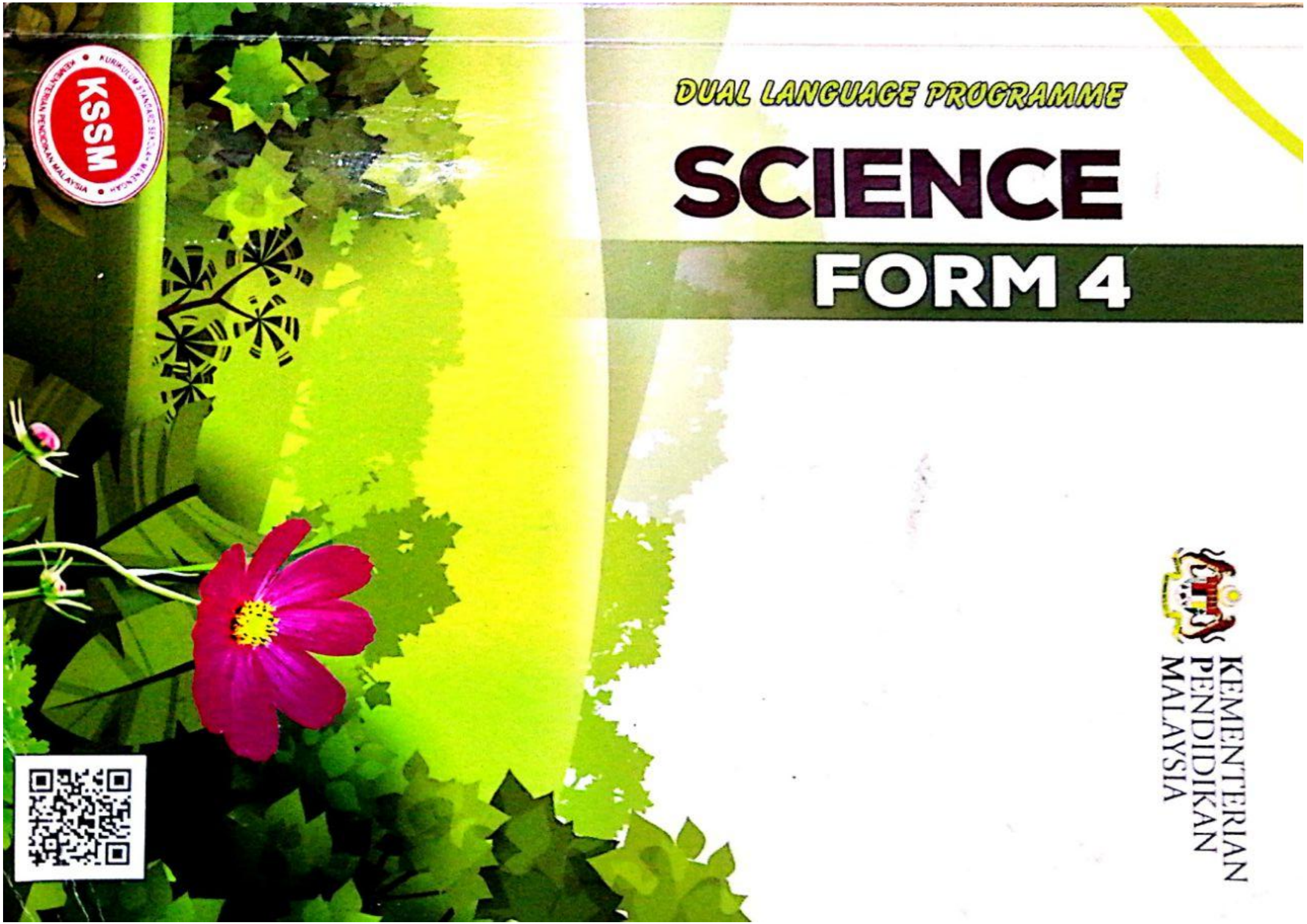
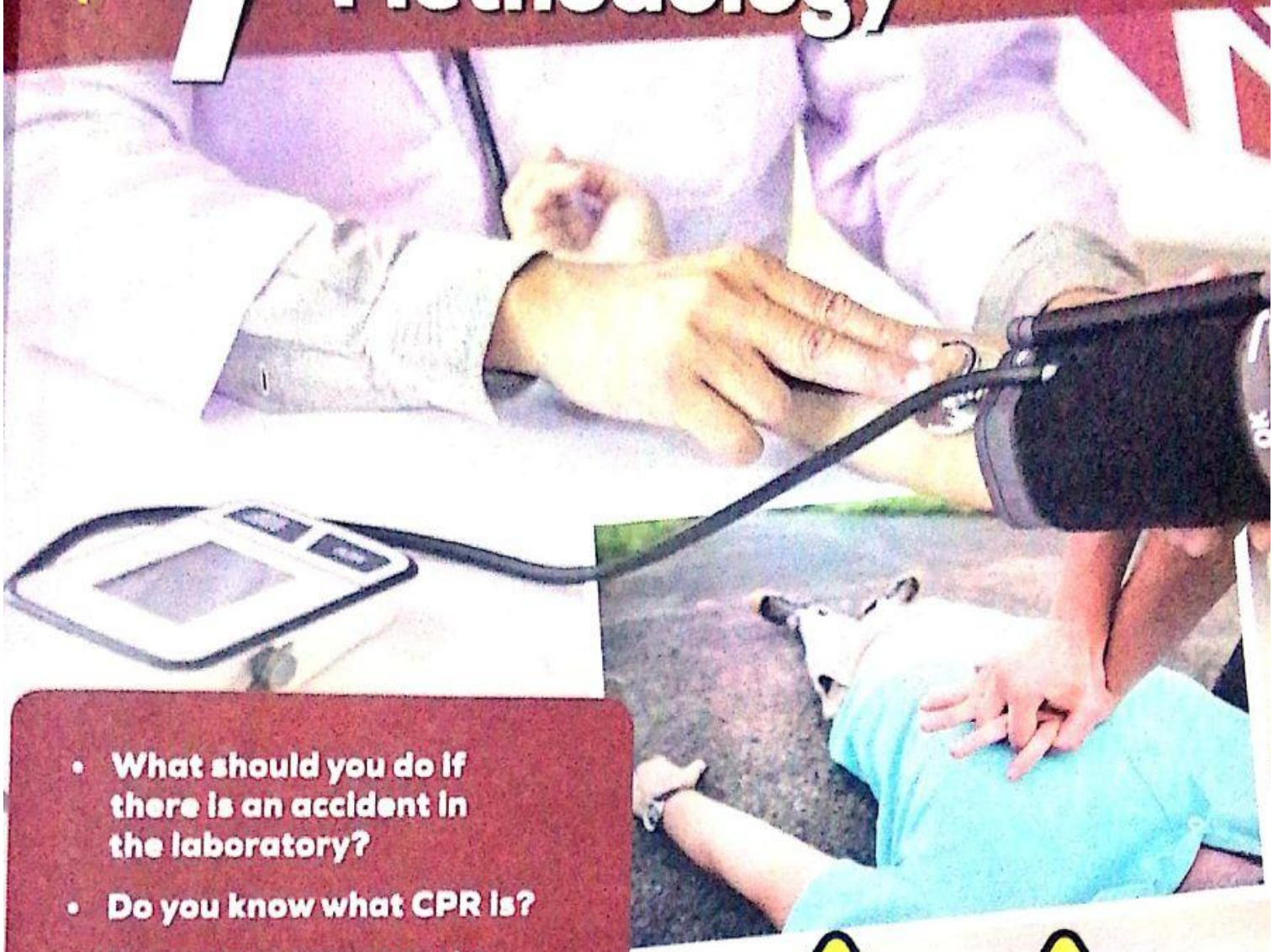

KSSM
DUAL LANGUAGE PROGRAMME
SCIENCE
FORM 4
KEMENTERIAN PENDIDIKAN MALAYSIA

THEME

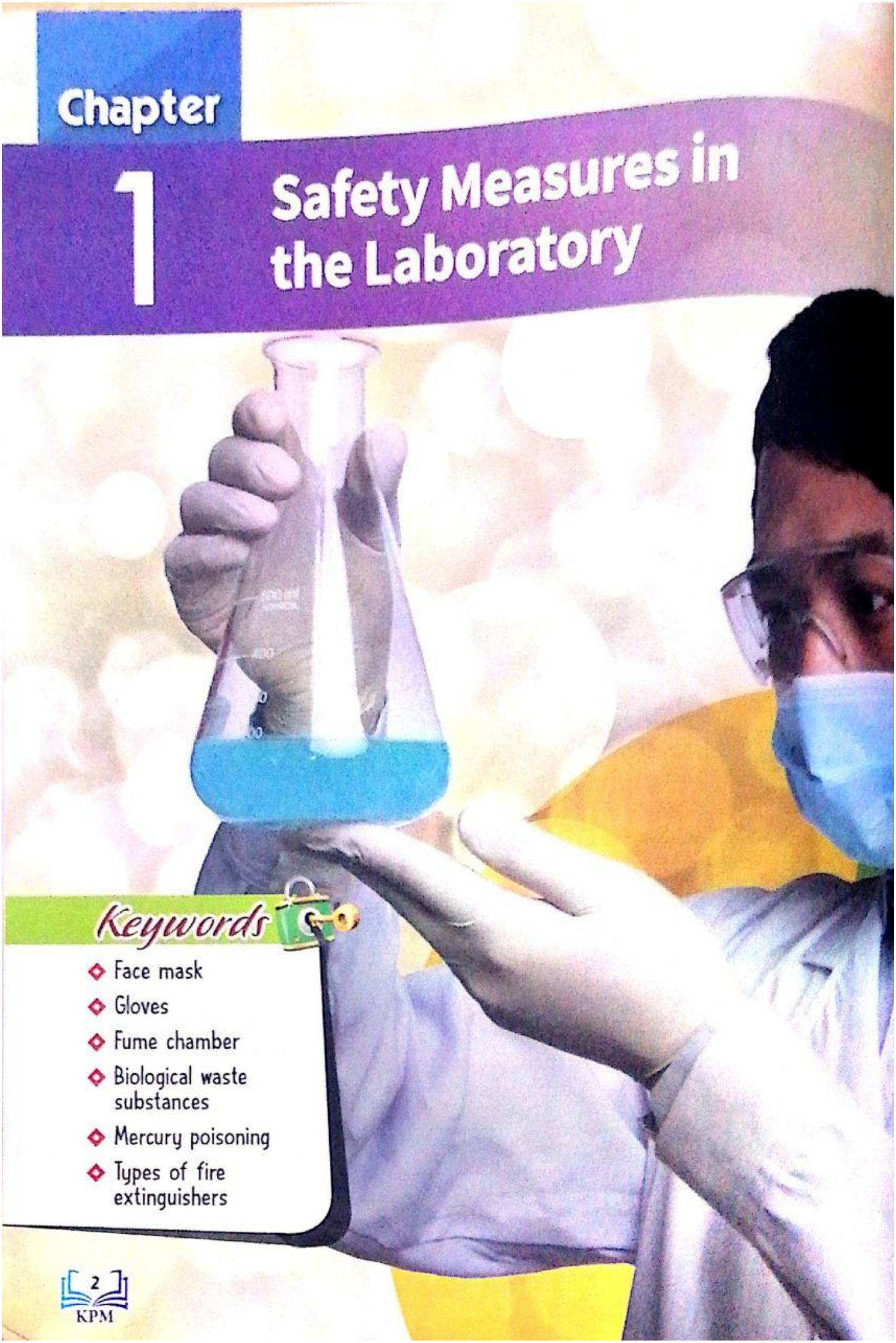
# 1 Scientific Methodology



- What should you do if there is an accident in the laboratory?
- Do you know what CPR is?
- How do we measure the health level of our body?

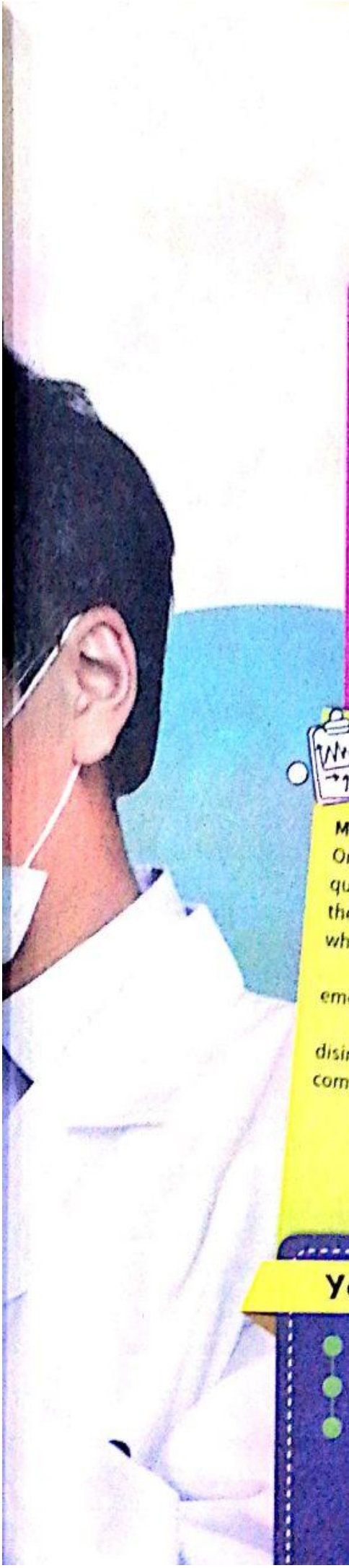
Chapter

# 1 Safety Measures in the Laboratory



## Keywords

- Face mask
- Gloves
- Fume chamber
- Biological waste substances
- Mercury poisoning
- Types of fire extinguishers



**What are the examples of personal protective equipment and their functions?**

**What are the characteristics of substances that cannot be disposed into sinks?**

**How should biological waste substances be managed?**

**How should accidents in the laboratory be handled?**

**How many types of fire extinguishers are there?**

## Science Digest

**Mercury Spill in School Laboratory**

On Wednesday, 2 May 2018, a total of 21 students and a teacher were quarantined for about 20 minutes due to a mercury spill from a broken thermometer at a secondary school. The incident occurred at 2.20 p.m. when the students conducted an experiment in the science lab.

A team of 10 firefighters was rushed to the scene after receiving an emergency call at 2.24 p.m.

The firefighters responded quickly to quarantine the area, before the disinfection process took place. The disinfection work at the scene was completed at 3.30 p.m.

*Source: myMetro*

## You will learn about:

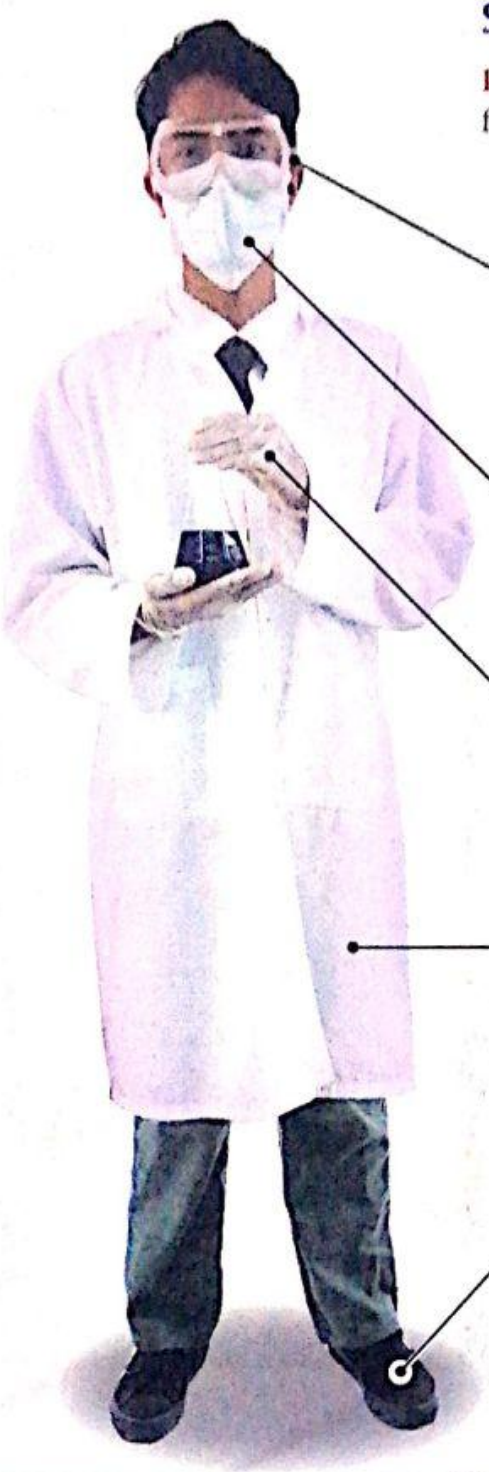
- personal protective equipment
- disposal of waste
- fire extinguishers

# 1.1 Personal Protective Equipment

You learned about safety rules and measures in the laboratory in Form 1. In order to keep you safe in the lab, there is a variety of protective equipment that you need to know and use correctly.

## Personal Protective Equipment on a Student and Their Functions

**Personal protective equipment** is needed to protect the wearer from danger.



**Goggles**

Protect the eyes from hazardous chemical substances such as acid, bromine, ammonia and reactive metals.

**Face mask**

Protects the nose and mouth from inhaling pungent and volatile chemical substances and dust.

**Gloves**

Gloves made of rubber protect the hands from hazardous chemical substances.

**Lab coat**

A lab coat is made up of safety layers and is easily removed if there is an emergency. The lab coat is important to protect clothing from damage.

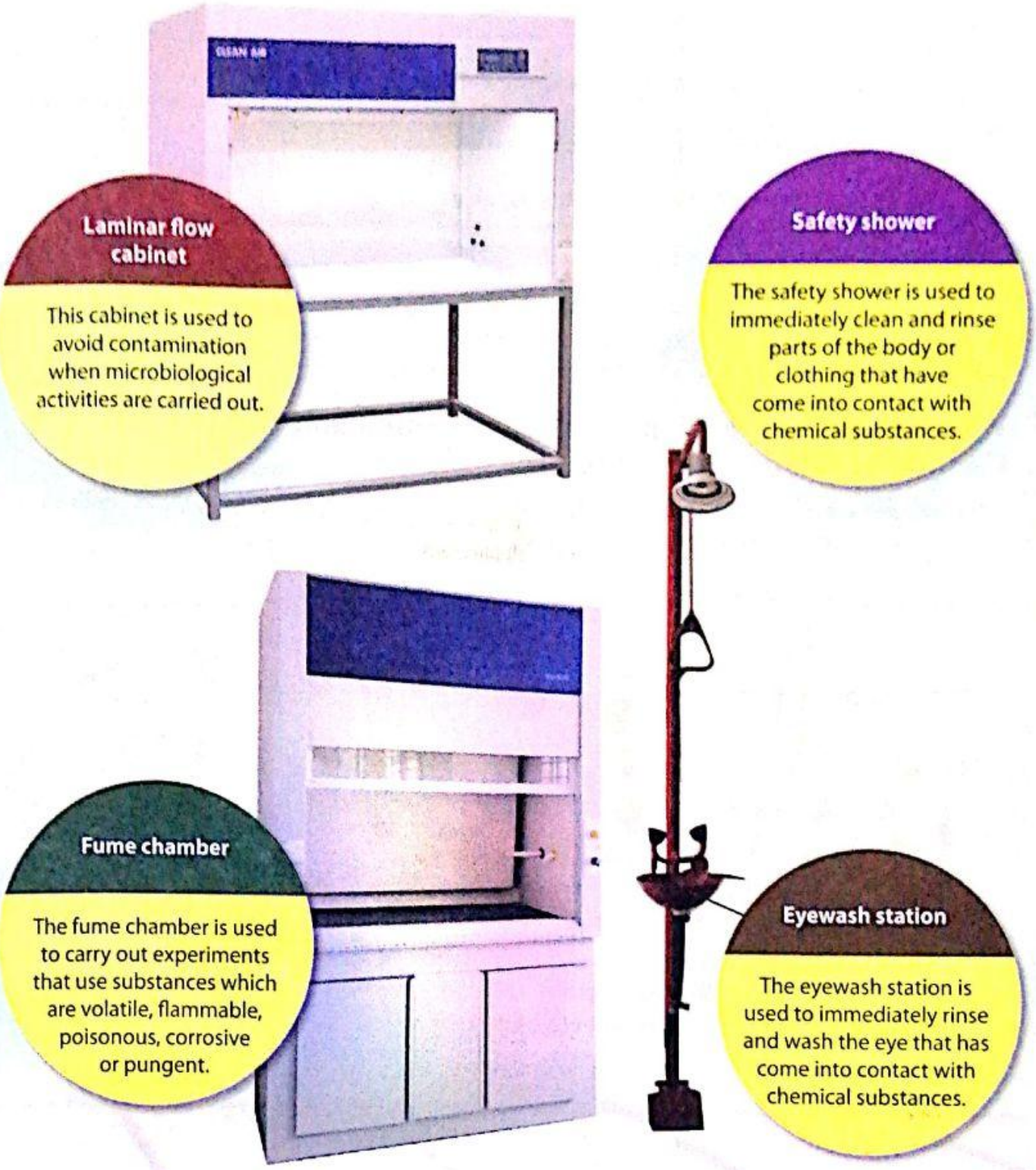
**Closed shoes/safety shoes**

Closed shoes must be worn in the laboratory. Their function is to protect the feet from chemical substance spills and glass splinters.

**Photograph 1.1** *Personal protective equipment on a student*

## Personal Protective Equipment in the Laboratory

Personal protective equipment that is available in the laboratory includes the safety shower, eyewash station, fume chamber and laminar flow cabinet. Even though there is personal protective equipment in the laboratory, every accident or injury in the laboratory must be reported immediately to the teacher.




**Photograph 1.2** *Personal protective equipment in the laboratory*

## FORMATIVE PRACTICE 1.1

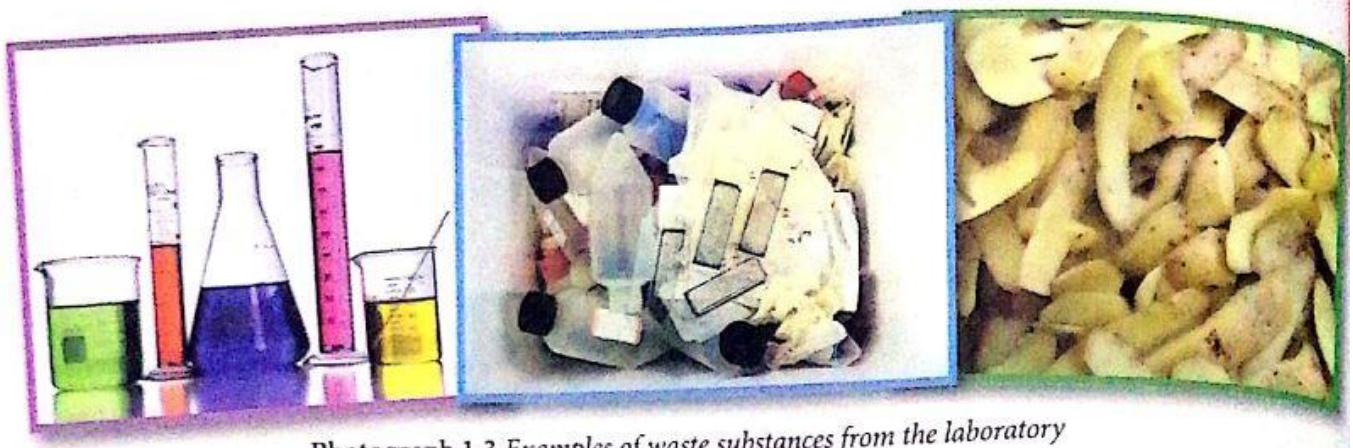
1. Give **three** examples of personal protective equipment that must be worn in the laboratory.
2. Hariz's eye was accidentally splashed with dilute sulphuric acid. What action does Hariz need to take?
3. Tick (✓) for the right action.

| | |
|---|---|
| (a) Amardev wears goggles when mixing acid and water. | |
| (b) Aqil wears slippers while carrying out an experiment. | |
| (c) Mira cleans the spilled chemical substance on the laboratory table using her hands. | |

# 1.2 Disposal of Waste

## Waste that Can be Disposed of into Sinks and Waste that Cannot be Disposed of into Sinks

After you have carried out an experiment, how should you manage the waste from the experiment? Can all waste substances be disposed of into sinks?



**Photograph 1.3** *Examples of waste substances from the laboratory*

Waste substances can be divided into two types:
(i) substances that can be disposed of into sinks
(ii) substances that cannot be disposed of into sinks

Substances that can be disposed of into sinks are substances that have low concentration and are non-hazardous such as neutral substances, weak acids and weak alkalis.

Examples of substances that cannot be disposed of into sinks are:

- solid waste
- substances with pH value lower than 5 and more than 9
- organic solvent compounds
- chemical substances (acid, grease, oil, oil paint, hydrogen peroxide)
- toxic substances
- heavy metals
- organic waste substances (microbes, carcasses)
- radioactive waste
- volatile substances
- reactive substances

These substances can pollute the environment and are hazardous to living things.

## Activity 1.1

Result Showcase

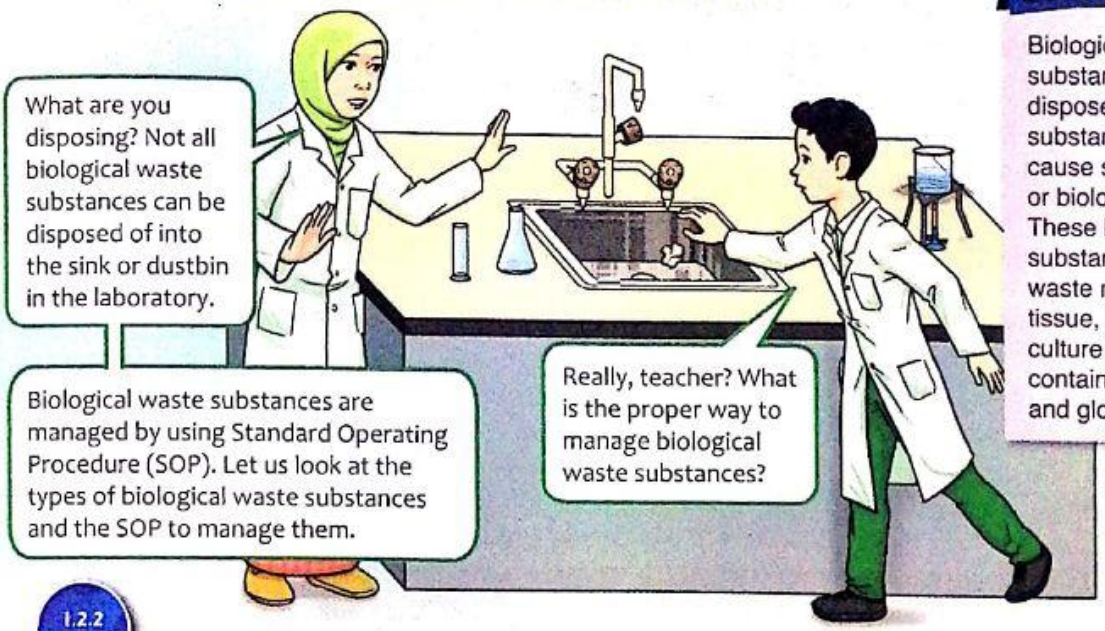
21st Century Skills

**Aim:** To search for the effects of disposing substances that cannot be disposed of into the sink.

**Instructions:**

1. Carry out this activity in groups.
2. Find the effects of disposing the following substances into the sink:
   - solid waste
   - substances with pH less than 5 and more than 9
   - grease and oil
   - heavy metals
   - organic waste (microbe and animal carcass)
3. Use various resources such as the Internet and the library to obtain relevant information.
4. Present the results of your discussion in class.

## Managing Biological Waste Substances




**Science Gallery**

Biological waste substances include disposed biological substances that can cause serious harm or biological hazards. These biological waste substances include waste materials, tissue, carcasses, culture medium, plastic containers, glass and gloves.

1.2.2
1.2.3

The Standard Operating Procedure (SOP) for the disposal of biological waste products is the procedure that is used for the purpose of managing biological waste substances in a laboratory.

**Table 1.1** *Standard Operating Procedure for disposal of biological waste substances*

| Waste substance category | Category A | Category B | Category C | Category D |
|---|---|---|---|---|
| Type of biological waste substance | Sharp equipment | Non-sharp solids | Carcasses, organs | Liquid |
| Examples | • Syringe<br>• Needle<br>• Scalpel blade | • Gloves<br>• Tissue<br>• Culture medium | • Lab animals<br>• Experimental animals | • Blood<br>• Serum |
| Biological waste management | • Placed in special containers (sharps waste bins)<br>• Not autoclaved<br>• Container is stored in a safe place before disposal | • Packaged and placed in biohazard plastic bags<br>• Autoclaved and placed into biohazard bins | • Wrapped in absorbent material (tissue paper), packaged well in a biohazard plastic bag and frozen before disposal | • Decontaminated by autoclave<br>• Disposed of directly into sewage system through the sink or toilet |

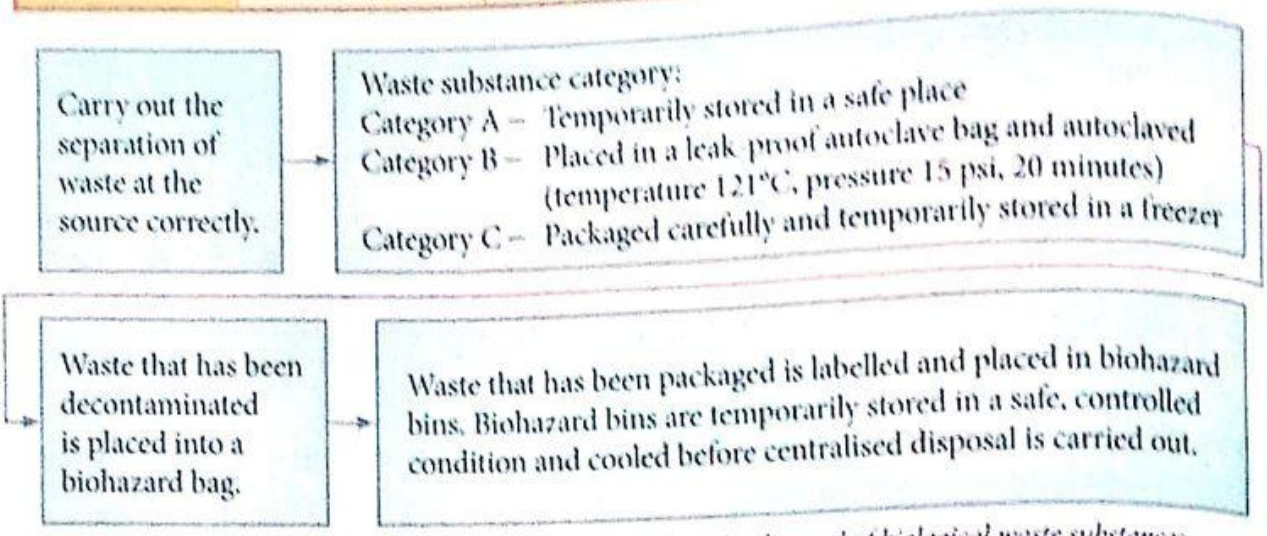



**Figure 1.1** *Flow chart of Standard Operating Procedure for disposal of biological waste substances*
*(Source: Laboratory Management, Department of Chemistry, Faculty of Science, UTM)*

## Activity 1.2

Result Showcase

21st Century Skills

**Aim:** To create a multimedia presentation about new ideas to manage biological waste substances in the future.

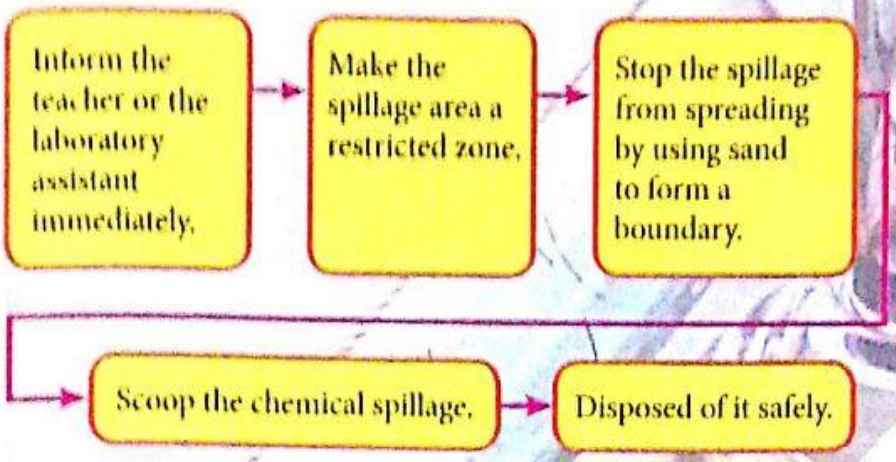
**Instructions:**

1. Carry out this activity in groups.
2. Discuss new ideas on how to manage biological waste substances that cannot be accommodated by Earth in the future, such as inventing disposal equipment or future incinerators.
3. Present the results of your group discussion in the form of a multimedia presentation.

## Steps to Handle Accidents in the Laboratory

Accidents can happen in the laboratory because of carelessness, negligence, events beyond expectation or lack of skills or knowledge in carrying out a science experiment.

When carrying out an experiment, your friend spills a type of chemical substance on the table. What should you do?




**Science Gallery**

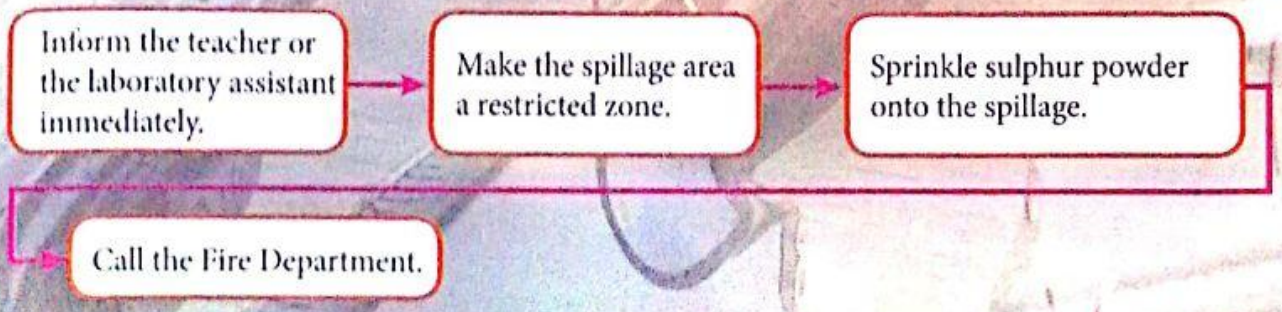
Types of accidents that commonly occur in the laboratory:

- Hand cut by glass splinter
- Hand splashed by concentrated acid or alkali
- Small fire
- Contact with residue from the reaction of reactive metals
- Broken thermometer
- Gas leak
- Electric shock

**Brain Teaser**

What is the first step that you should take if your friend's eye comes into contact with a chemical substance?

A thermometer that is dropped and broken will cause mercury spillage. Do you know about the dangers of mercury? Mercury poisoning happens when someone touches it or it absorbs through the skin in certain quantities. Mercury can attack the nervous system, digestive tract, reproductive system and kidneys. Thus, attention must be given to handle mercury safely. What should you do if there is a mercury spillage in your school science laboratory?




Example of organisation that manage and prepare safety modules in the laboratory:

INFORMATION

**National Institute of Occupational Safety and Health (NIOSH)**
http://bukutekskssm.my/Science/F4/Pg9

## FORMATIVE PRACTICE 1.2

1. Asri wants to dispose of concentrated hydrochloric acid with a pH value of 3 into a sink, but he is stopped by Selvi. Is Selvi's action correct? Why?
2. Tick (✓) for the substances that can be disposed of into a sink.

   Distilled water ☐ Concentrated acid ☐ Radioactive substance ☐
3. Explain briefly the disposal of carcasses.
4. What should be done if a thermometer breaks in the laboratory?

# 1.3 Fire Extinguishers

## Types of Fire Extinguishers

A fire extinguisher is a device that is used to control or extinguish fire. There are four types of fire extinguishers that are commonly used. Fire extinguishers are classified based on their medium. The types of fire extinguishers that are commonly used are shown in Figure 1.2 below.

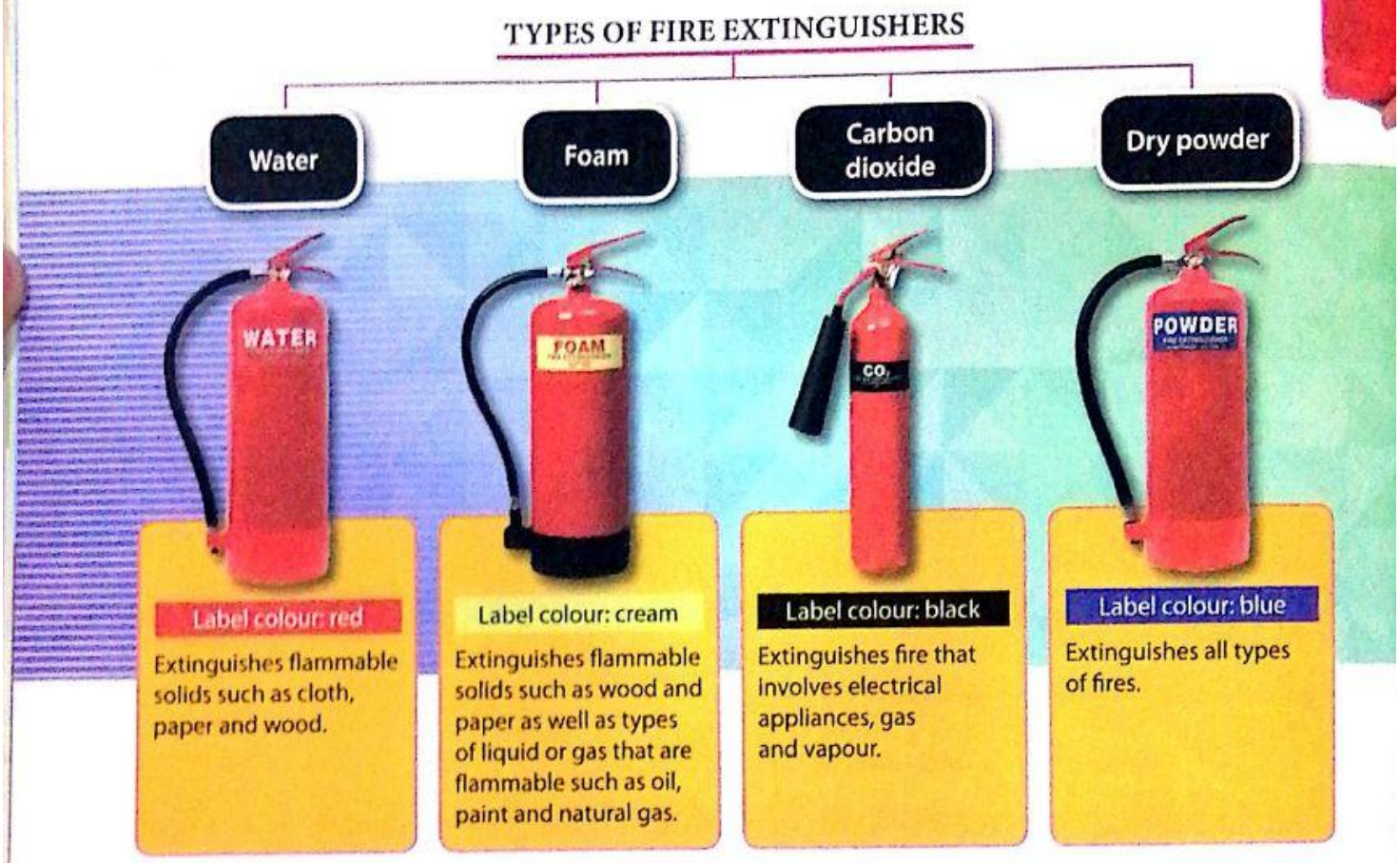



**Figure 1.2** *Types of fire extinguishers*

Fires can be divided into a few types based on the substance that burns. Fire extinguishers are used based on the potential sources of fire that are identified in a building or area. Table 1.2 shows the types of fires and the fire extinguishers that are suitable to be used.

**Table 1.2** *Types of fires and fire extinguishers that are suitable for use*

| Type of fire | Explanation | Type of fire extinguisher |
|---|---|---|
| Class A | Fires that involve flammable solids (except metals) such as wood, paper, cloth and any flammable material | • Water<br>• Foam<br>• Dry powder |
| Class B | Fires that involve liquids such as petrol, kerosene, diesel, paint, and varnish | • Foam<br>• Dry powder<br>• Carbon dioxide |
| Class C | Fires that involve gases such as LPG, LNG, and oxygen | • Dry powder<br>• Carbon dioxide |
| Class D | Fires that involve metals such as magnesium, aluminium, sodium, and potassium | • Dry powder |
| Class E | Fires that involve electrical appliances | • Dry powder<br>• Carbon dioxide |
| Class F | Fires that involve fats and oils | • Dry powder<br>• Carbon dioxide |

Other fire extinguishers that are used include the ABC fire extinguisher, fire blanket, sand and water. Sand can be used to extinguish early stage fire. Water can be used to extinguish fire except fire resulting from oil.


**ABC fire extinguisher**

- Can be used for all types of fires except fire that results from metals and gases that will not allow explosion
- Not harmful to human and animal
- Does not pollute the soil
- Easy to maintain (at least once a year)
- Moisture produced lasts longer, thus preventing fire from spreading again

**Photograph 1.4** *ABC fire extinguisher*

**Fire blanket**

- Made of two layers of glass fibres
- Able to extinguish small or moderate fires that are difficult to extinguish with water
- Extinguishes fire on the victim when it is wrapped around him


**Photograph 1.5** *Fire blanket*

## Science Gallery

Simple fire safety checklist:

- ✓ Install smoke detectors
- ✓ Ensure that there is an emergency plan and an emergency route from each room. All the occupants should be aware and also trained to use it.
- ✓ Use light bulbs with suitable wattage
- ✓ Store electrical appliances that produce heat at least 1 metre away from curtains, furniture and other flammable equipment
- ✓ Avoid charging electronic equipment on the bed or unattended
- ✓ Check electrical wiring from time to time to identify any damages in order to prevent fire resulting from short circuits
- ✓ Avoid making unauthorised extensions or overloading electrical circuits
- ✓ Place matches and lighters out of the reach of children
- ✓ Store containers filled with flammable liquid far from fire sources and children
- ✓ Keep one dry powder or ABC-type fire extinguisher at your home

# How to Use a Fire Extinguisher

Fire extinguishers are very easy to use. Nevertheless, we need to learn the correct way of using a fire extinguisher.

**1**

- Remove the safety pin from the fire extinguisher.
- Ensure that the fire extinguisher is positioned upright.

**2**

- Aim the nozzle of the fire extinguisher at the base of the fire.
- Ensure that you are at a distance of around 2.0 – 2.5 metres from the fire.

**3**

- Squeeze the handle on the top of the fire extinguisher.

**4**

- Spray evenly on the entire fire source by sweeping the nozzle from side to side.

## Activity 1.3

Role play

**Aim:** To demonstrate how to use a fire extinguisher.

21st Century Skills

**Instructions:**

1. Carry out this activity in groups. Each group consists of four members.
2. Choose a member who will play the role of a firefighter.
3. The student who plays the firefighter is given 5 minutes to read the instructions on how to use the fire extinguisher. The student can look up the information from the Internet, research or ask the laboratory assistant or teacher.
4. After 5 minutes, the student must play the role of a firefighter using the fire extinguisher. Observe the demonstration.
5. Choose another group member to be the firefighter and role-play until every member has successfully used the fire extinguisher.

## Carrying Out an Audit on Fire Extinguishers at School

Usually, a few fire extinguishers are available and placed around the school. However, can the fire extinguishers in your school function well if there is a fire?

How would you carry out an audit on the fire extinguishers at your school?


## Activity 1.4

Round Table

**Aim:** To carry out an audit on fire extinguishers at school.

21st Century Skills

**Instructions:**

1. Carry out this activity in groups. Each group should consist of four members.
2. Collect information about the fire extinguishers in the school compound.
3. Record:
   (a) the types of fire extinguishers
   (b) expiry date of fire extinguishers
   (c) pressure reading on the fire extinguishers
   (d) the number of fire extinguishers based on types
   (e) the location of fire extinguishers in the school's emergency route plan
4. Pass your respective records in a clockwise direction. The other members must correct your record if there is any error.
5. After 30 minutes, return to the laboratory and present your findings.

## Creating a Simple Fire Extinguisher

### Activity 1.5

STEM Project

The kitchen has a variety of flammable substances such as flour, sugar and oil. The existence of fuel can also be a source of fire at home.

Based on the problem statement above, create a simple fire extinguisher that works by using materials available at home.

The following are the basic steps of the STEM activity that must be carried out by students:

1. Raise questions and identify the problems
2. Develop and use a model
3. Plan and carry out an investigation in the form of inquiry
4. Analyse and interpret the obtained data
5. Use mathematical thinking and computational thinking
6. Create explanations and design solutions
7. Involve in debates and discussions based on evidence
8. Obtain information, then evaluate and communicate the information

### FORMATIVE PRACTICE 1.3

1. State four types of fire extinguishers.
2. What is the function of a fire blanket? Explain how it can save victims of small fires.
3. Arrange the correct sequence in using a fire extinguisher.

P Q R

# Summary

## SAFETY MEASURES IN THE LABORATORY

### Personal Protective Equipment

- Goggles
- Gloves
- Lab coat
- Lab shoes
- Face mask
- Safety shower
- Eyewash station
- Fume chamber
- Laminar flow cabinet

### Disposal of Waste

- Substances that can be disposed of into the sink
- Substances that cannot be disposed of into the sink
- Managing biological waste substances
- Steps to handle accidents in the laboratory

### Fire Extinguishers

- Types of fire extinguishers
- Using a fire extinguisher
- Auditing fire extinguishers
- Creating a simple fire extinguisher

## Self-reflection

After studying this chapter, you are able to:

**1.1 Personal Protective Equipment**

- ☐ Explain and give examples of personal protective equipment and their functions.

**1.2 Disposal of Waste**

- ☐ Explain with examples of substances that can be disposed of into the sink.
- ☐ Characterise substances that cannot be disposed of into the sink.
- ☐ Manage biological waste substances.
- ☐ Communicate steps to handle accidents in the laboratory.

**1.3 Fire Extinguishers**

- ☐ Identify the types of fire extinguishers.
- ☐ Explain how to use a fire extinguisher.
- ☐ Carry out an audit on fire extinguishers at school.
- ☐ Create a simple fire extinguisher.

## Summative Practice 1

QUIZ

Objective Questions
http://bukutekskssm.my/Science/F4/Q1

1. (a) Give three examples of personal protective equipment that can be found in your school laboratory.

- Laminar flow cabinet
- Fume chamber
- Safety shower / Eyewash station

(b) Why is the school laboratory regarded as a restricted area?

(c) Jasman disposed of lemon juice, the waste from a science activity, into the sink. Justify Jasman's action.

His action is correct because the pH value of lemon juice is less than 7.

b) There are dangerous substances in the school laboratory like, toxic, corrosive, flammable, and so on.

2. Figure 1 shows a fire that is happening in the science laboratory.


Figure 1

(a) Based on the picture given, state:

(i) the type of fire

(ii) the suitable fire extinguisher to stop the fire

(b) In your opinion, why did the fire occur?

(c) Azhar was at the scene when the fire happened. State the steps that Azhar should follow to extinguish the fire.

(d) As a precautionary step, fire extinguisher audits should always be carried out. State five things that should be observed when the audit is being carried out in your school.

## Mind Challenge

3. When you enter the laboratory, do you always have to wear a face mask? Explain your answer.

4. Haziq received a task to carry out an experiment to determine the boiling point of salt water. Explain how Haziq can ensure that all the safety measures in the laboratory are observed while he is carrying out the experiment.

5. Explain the correct steps to disposed of sharp objects that have been used in experiments in the science laboratory.