

CHAPTER 1

Introduction to Chemistry

Keywords

- Chemistry
- Chemical technology
- Scientific method
- Personal protective equipment
- Safety in the laboratory
- Management of laboratory accidents

What will you learn?

- 1.1 Development in Chemistry Field and Its Importance in Daily Life
- 1.2 Scientific Investigation in Chemistry
- 1.3 Usage, Management and Handling of Apparatus and Materials

Bulletin

Chemistry helps us to understand matter and the reactions that they go through. Lately, the field of chemistry, especially nanochemistry has been developing rapidly. Nanochemistry focuses on the learning and knowledge of synthesis and properties of particles in nanoscale (as tiny as 10^{-9} m). In this field, chemists study the properties and uniqueness of the atoms and molecules in nanoscale. Nanochemistry combines nanotechnology, biotechnology, chemistry, biology, physic and mathematic into one single field. The discovery of nanochemistry has benefited humans tremendously, including in the field of medicine, health, agriculture, electronics, sources and energy, manufacturing industry and others.

Knowledge in chemistry is the basis for mastering nanochemistry. All applications in the world of nanochemistry begin with the knowledge of chemistry learned at school. Therefore, mastering the fundamental concepts of chemistry in secondary school is the beginning of the expansion of knowledge related to chemistry.

What is the meaning of chemistry?

What are the careers that require the knowledge of chemistry?

What are the correct methods to store chemicals in the laboratory?



1.1**Development in Chemistry Field and Its Importance in Daily Life**

Based on Figure 1.1, what do you understand about chemistry?

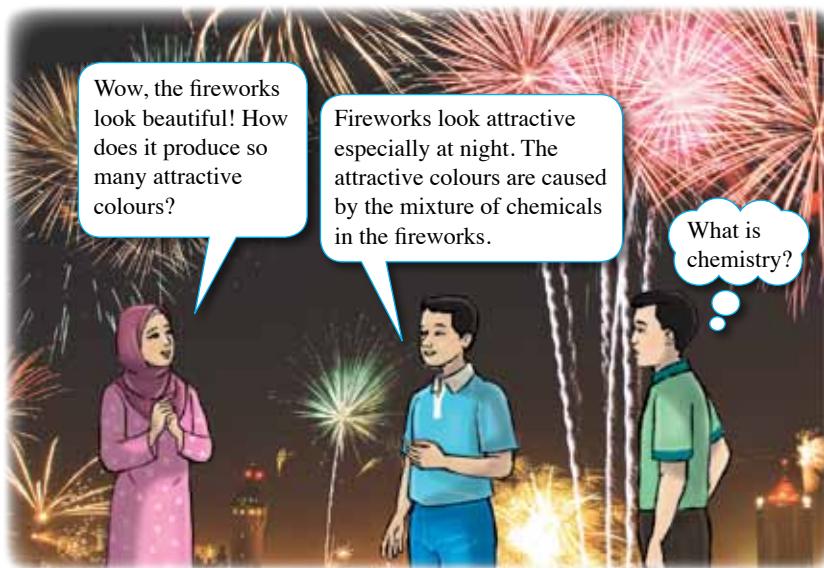


Figure 1.1 Fireworks and chemistry

Learning Standard

At the end of the lesson, pupils are able to:

- 1.1.1 State the meaning of chemistry
- 1.1.2 State examples of chemicals commonly used in daily life
- 1.1.3 Generate ideas on the development of chemistry field and the contributions of chemical technology towards mankind
- 1.1.4 State examples of careers related to chemistry field



Activity 1.1



21st Century Skills

Discussing the meaning of chemistry based on students' understanding

1. Carry out the Round Table activity.
2. Take turns to state the meaning of chemistry according to your understanding on a piece of blank paper based on:
 - (a) The science knowledge that you have learned from Form 1 to Form 3
 - (b) Your experience outside the classroom
3. Present your group findings to your classmates.

Meaning of Chemistry

Chemistry is a field of science that studies the structures, properties, compositions and interactions between matters. Learning of chemistry is not limited to chemicals found in the laboratory but also substances commonly found in daily life such as salt and soap. Chemistry helps us to understand matter around us. The word chemistry originated from the Arabic word 'al-kimiya'. Carry out Activity 1.2 to study the origin of the word chemistry and its meaning.

Father of Arabic chemistry

<http://bit.ly/2gruQIF>





Activity 1.2



Collecting and interpreting the origin of the word chemistry and its meaning

21st Century Skills



1. Carry out the Think-Pair-Share activity.
2. Surf the Internet or refer to reading materials from various printed media to gather information and discuss the following issues:
 - (a) Origin of the word chemistry
 - (b) Meaning of chemistry
3. Present your group discussion results in multimedia form in front of your class.

Chemicals in Daily Life

All substances around us are made up of chemicals. The activities that we carry out daily involve chemical reactions as well. Figure 1.2 shows the chemicals commonly used in foods, medicine, agriculture and industries.

Drugs contain chemicals

[http://bit.
ly/2Mx4M7B](http://bit.ly/2Mx4M7B)



Food

- Preservative
- Colouring
- Flavouring
- Antioxidant
- Stabiliser

Chemicals in daily life



Medicine

- Antibiotic
- Antiseptic
- Vitamin
- Chemotherapy
- Analgesic

Agriculture

- Herbicide
- Pesticide
- Fungicide
- Fertiliser
- Hormone

Industry

- Paint
- Polymer
- Glass
- Ceramic
- Detergent
- Colouring
- Alloy

Figure 1.2 Commonly used chemicals

The Development in Chemistry Field and the Contributions of Chemical Technology

Researches in various chemical fields are constantly being carried out covering various disciplines. For examples, biochemistry, botany and forensics which require chemical knowledge to solve problems. The need for chemical technology to solve problems spurs the development of chemical technology. Technologies used in the 60s and 70s might not be suitable to be applied in this era. Based on your knowledge, what are the contributions of chemical technology to mankind? Carry out Activity 1.3.

Activity 1.3

Searching for information and making a poster

21st Century Skills



- Carry out the Gallery Walk activity.
- Gather information on the following aspects:
 - Contribution of chemists
 - Development of chemical technology
 - Careers in the field of chemistry
 - Chemicals in daily life
- Prepare the results of your group in an attractive poster.
- Display your group's results in the class.
- Each group has to move around to look at the other groups' posters. Write your comments about the results of the other groups on sticky notes and paste them on the posters.

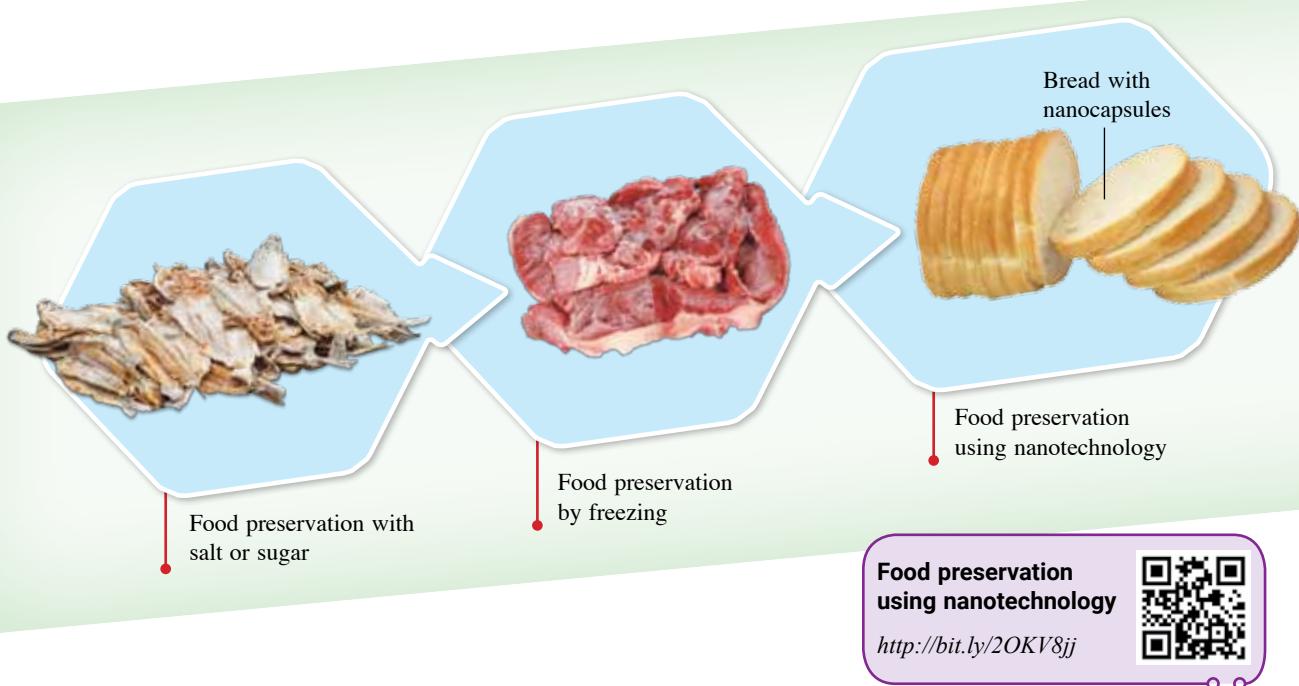


Figure 1.3 Development of technology in food preservation

Careers Related to Chemistry

In the era of rapid industrial development, most careers require knowledge in chemistry. For example, careers in the cosmetics, pharmaceutical, biotechnology, nanotechnology and green technology fields are shown in Figure 1.4.

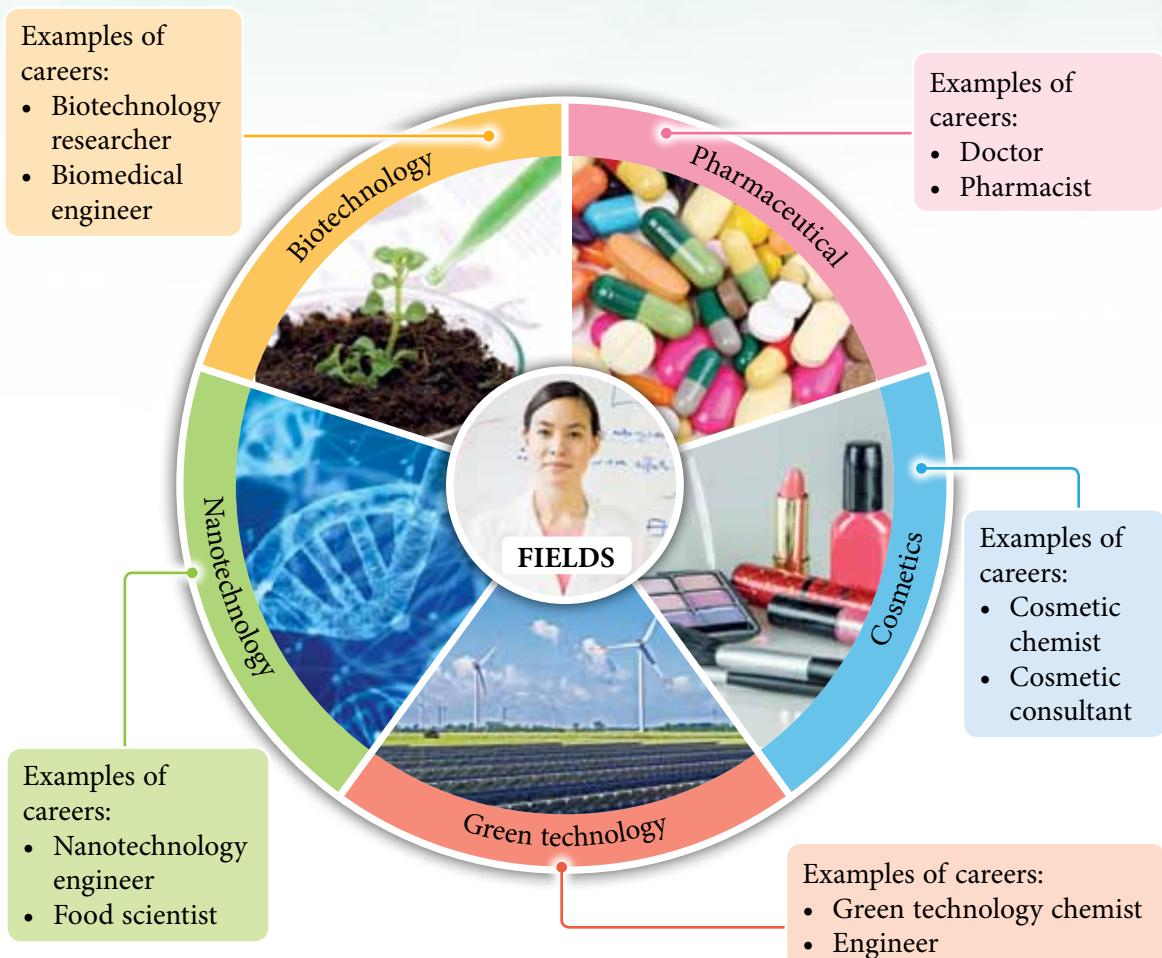


Figure 1.4 Several careers related to chemistry

Activity 1.4

Role-playing activity on careers in the field of chemistry

- Carry out the Role-Play activity.
- Gather information from suitable reading resources or websites on careers in the field of chemistry.
- Assign the members of the groups to various careers.
- Prepare the acting script and suitable props.
- Present your group's act in front of your class.





Test Yourself 1.1

1. What is meant by chemistry?
2. List out five types of chemicals used in daily life.
3. Give one example of development of chemistry in industries.
4. List out at least three careers related to chemistry in the following situations:
 - (a) Searching for an antidote for dengue fever
 - (b) Producing palm trees with a high content of oil

1.2

Scientific Investigation in Chemistry

A scientific investigation is a scientific method used in solving problems in science. Generally, a scientific investigation begins with the observation of a problem. Look at Figure 1.5 and identify the problem that occurs. We can carry out an investigation to solve the problem by using a scientific method.

Learning Standard

At the end of the lesson, pupils are able to:

- 1.2.1 Design an experiment to test a hypothesis
- 1.2.2 Investigate through experiment the effect of temperature on the solubility of salt in water using a scientific method



Figure 1.5 The solubility of salt in hot water

Try to recall the steps in a scientific method that you have learned in Form 1.



Scientific Method

Scientific method is a systematic method used by scientists or researchers to solve problems related to science. This method involves several general steps to solve a problem using the correct methods.

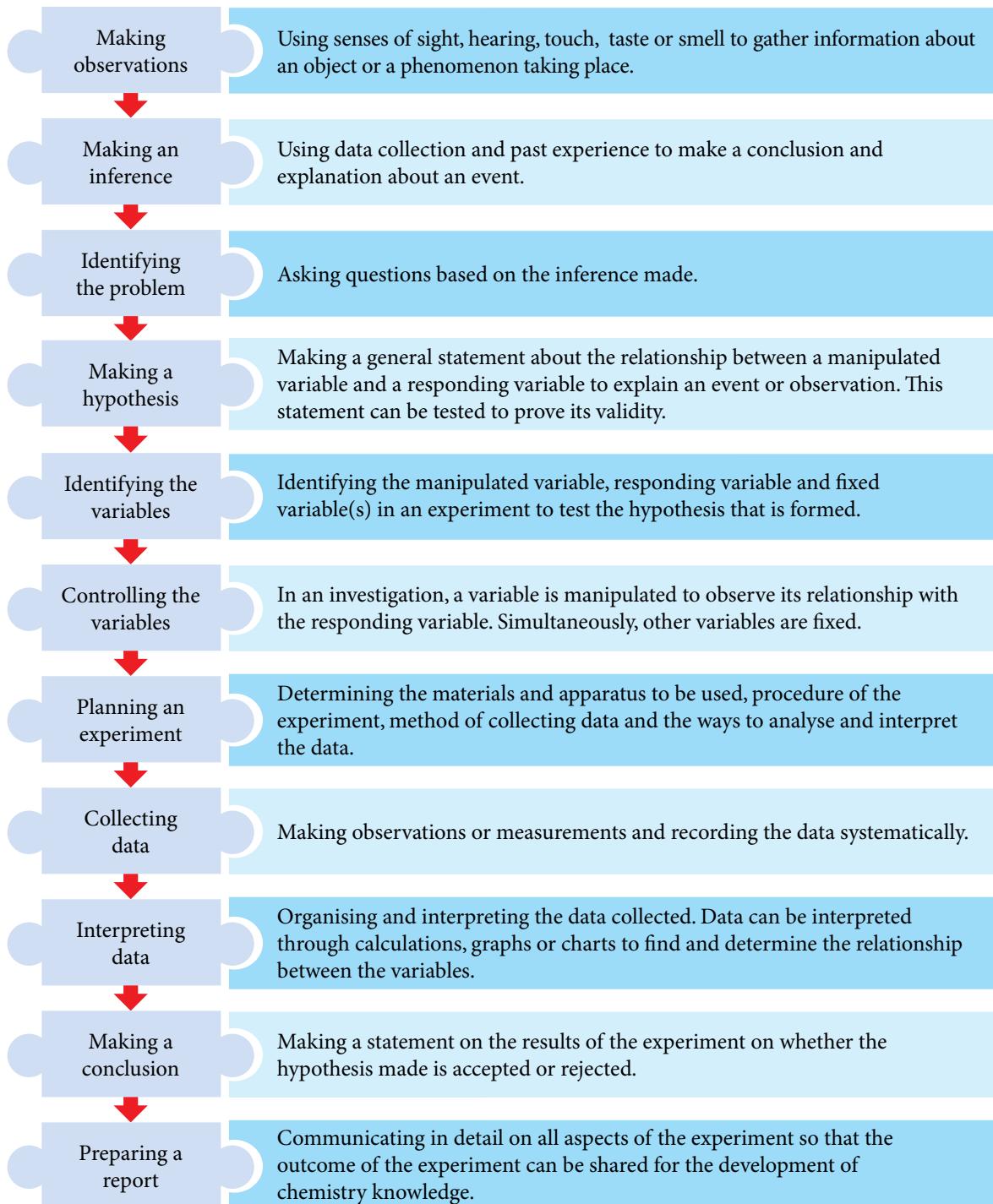


Figure 1.6 Steps in a scientific method

Based on the scientific method that you have learned, carry out Experiment 1.1 to study the effect of temperature on the solubility of salt in water.



Experiment

1.1



Aim: To study the effect of temperature on the solubility of salt in water.

Problem statement: Does the temperature of water affect the solubility of salt in water?

Hypothesis: The increase in temperature of water will increase the solubility of salt in water.

Variables:

- (a) Manipulated : Temperature of water
- (b) Responding : Solubility of salt in water
- (c) Fixed : Volume of water, mass of salt, time

Materials: Distilled water and salt

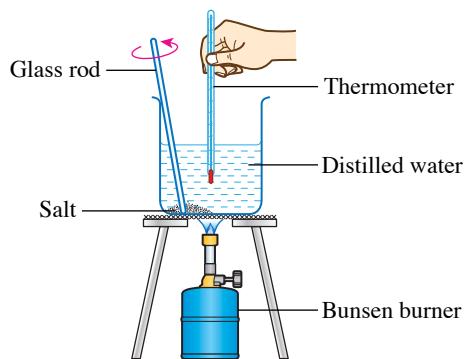
Apparatus: 150 cm³ beaker, 100 cm³ measuring cylinder, thermometer, electronic scale, glass rod, Bunsen burner, stopwatch, wire gauze and tripod stand

Procedure:

1. Measure 50 cm³ of distilled water at temperature 10 °C with a measuring cylinder and pour it into a beaker.
2. Add 40 g of salt into the beaker and stir the solution with a glass rod for 2 minutes.
3. Observe the solubility of salt in the beaker.
4. Repeat steps 1 to 3 with distilled water heated at 30 °C and 80 °C.
5. Record your observations in Table 1.1.

Brain Teaser

How can you obtain distilled water at 10 °C?



Results:

Table 1.1

Temperature (°C)	10	30	80
Observation			

Interpreting data:

At which temperature does all the salt dissolve in water?

Conclusion:

Is the hypothesis acceptable? What is the conclusion of this experiment?



Prepare a complete report after carrying out this experiment.

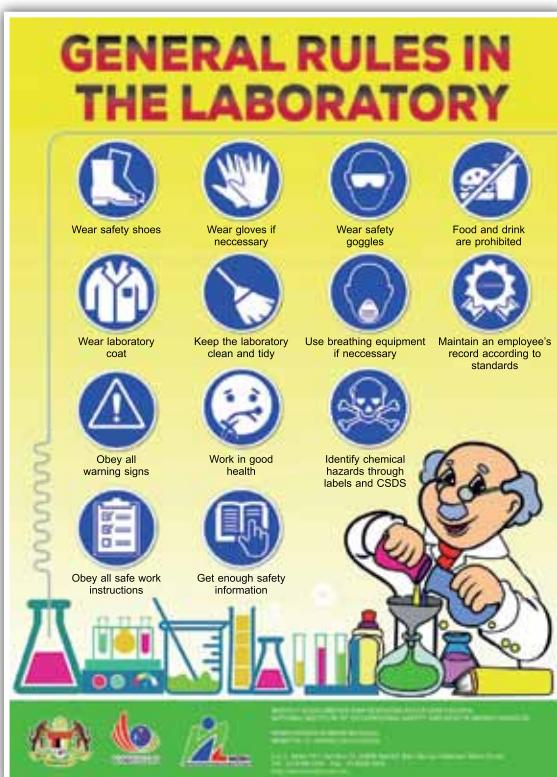

Test Yourself 1.2

- What is meant by scientific method?
- Why is a scientific method important in chemistry? State your opinion.
- You are given a bucket of ice cubes, a little sugar, a measuring cylinder and a stopwatch. Plan an experiment to determine whether sugar increases the melting rate of the ice.


1.3

Usage, Management and Handling of Apparatus and Materials

The laboratory is an important place for learning chemistry, and it is a dangerous place too. All the rules and safety measures in the laboratory should be obeyed. Do you still remember the rules and safety measures you have learned in Form 1? Figure 1.8 shows a poster of general rules in the laboratory.



Learning Standard

At the end of the lesson, pupils are able to:

- Explain the types and functions of self protective equipments and safety in the laboratory
- Demonstrate methods of managing and handling apparatus and materials
- Communicate about emergency management procedure in laboratory

Chemistry Lens

CSDS (Chemical Safety Data Sheet) is a data sheet that gives information about chemicals to assist consumers in managing the risks of using dangerous chemicals. This data sheet contains complete information on chemical poisoning besides providing information on management and storage methods, and handling methods during an emergency.

Figure 1.8 A poster of general rules in the laboratory

(Source: National Institute of Occupational Safety and Health (NIOSH), Malaysia)

Personal Protective Equipment

Wearing personal protective equipment while carrying out experiments in the laboratory is necessary to protect yourself from accidents. Figure 1.9 shows personal protective equipment in the laboratory and their functions. Other than the personal protective equipment, the chemistry laboratory is also equipped with various safety equipment. Figure 1.10 shows the safety equipment in the laboratory and their functions.

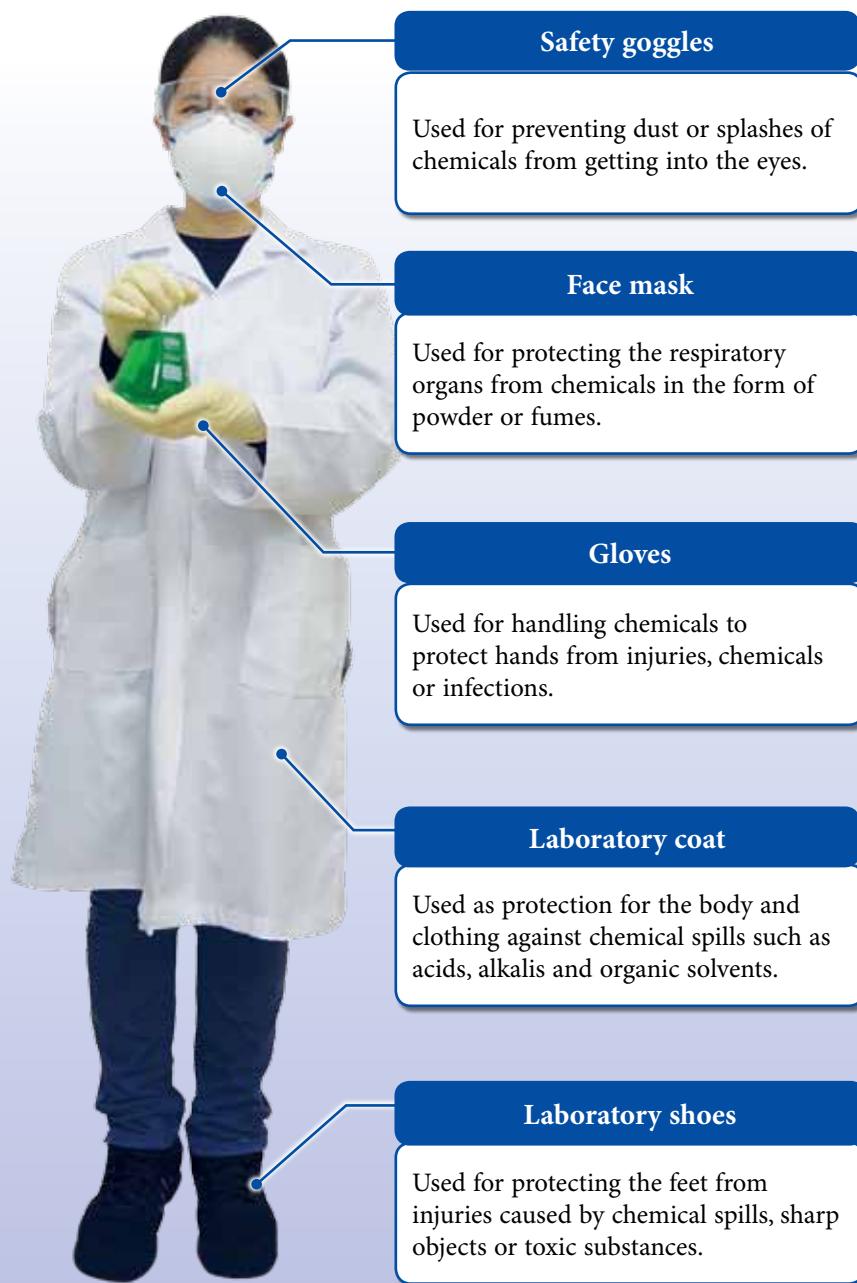


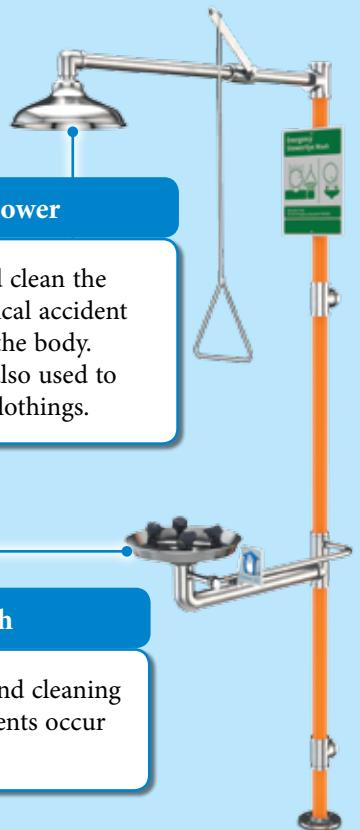
Figure 1.9 Personal protective equipment in the laboratory and their functions

**Fume chamber**

A specially designed equipment to carry out experiments that release toxic vapours, cause combustions or produce pungent smells.

**Fire extinguisher**

Used for extinguishing fire in the laboratory.

**Safety shower**

Is used to wash and clean the body when a chemical accident occurs on parts of the body. This equipment is also used to extinguish fire on clothings.

Eyewash

Used for washing and cleaning the eye when accidents occur on parts of the eye.

**Hand wash**

Used for removing chemical substances, oil, dirt and microorganisms from the hands.

Figure 1.10 Safety equipment in the laboratory and their functions

Examples of substances that release toxic vapour, cause combustion or produce pungent smell:

- Concentrated sulphuric acid • Chlorine gas • Ammonia gas • Bromine gas • Alcohol • Benzene

Methods of Managing and Handling Apparatus and Chemicals

Skills in using and handling apparatus and materials are important and very useful in carrying out a scientific investigation. Carry out Activity 1.5 to find out the correct methods of managing and handling apparatus.

Activity 1.5

Using and handling apparatus correctly

- Carry out this activity in groups.
- Each group should take turns in carrying out the four activities according to the stations by using and handling apparatus and chemicals with the correct methods. Visit the website or scan the QR code for each station.

(a) Station 1 - Weighing and heating of solid

Station 1

[http://bit.ly/
2MzE6Do](http://bit.ly/2MzE6Do)



(c) Station 3 - Electrolysis, gas collection and gas test

Station 3

[http://bit.ly/
2MzEMbU](http://bit.ly/2MzEMbU)



(b) Station 2 - Filtration and distillation

Station 2

[http://bit.ly/
2pI0scC](http://bit.ly/2pI0scC)



(d) Station 4 - Titration

Station 4

[http://bit.ly/
2W3RLpl](http://bit.ly/2W3RLpl)



Storage and Disposal of Chemicals

What do you understand about the storage and disposal of chemicals based on the conversation in Figure 1.11? Most chemicals in the laboratory are hazardous.

Chemicals should be stored properly so that they do not endanger the user nor cause accidents. Therefore, chemicals should be stored in their designated places according to their categories.

Disposal of chemicals is equally important as the storage of chemicals. Disposal of chemicals without following the correct disposal procedures not only causes environmental pollution but also destroys the habitats of flora and fauna and endangers human health as well. Hence, the storage and disposal of chemicals should be taken seriously by all parties.

How can the chemicals in the laboratory be stored or disposed of?

Different types of chemicals should be stored and disposed of using different methods.

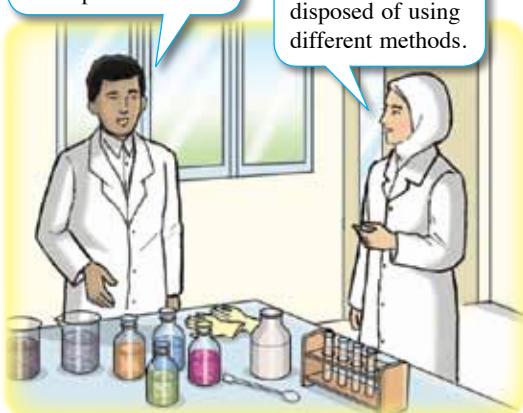


Figure 1.11 Storage and disposal of chemicals

Storage of Chemicals

Chemicals have specific storage methods according to the types of substances. Look at the following examples:

Reactive substances

Reactive metals such as lithium, sodium and potassium are stored in paraffin oil to prevent reaction with the moisture in the air.



Photograph 1.1 Sodium in paraffin oil

Hydrocarbons and organic solvents

Volatile and inflammable liquids like hydrocarbons and organic solvents should be stored in shady areas far from sunlight and heat source.



Photograph 1.2 Hydrogen peroxide stored in a dark bottle

Substances that decompose easily

Substances that decompose easily in the presence of light, for example concentrated nitric acid, hydrogen peroxide solution, silver nitrate solution, liquid bromine and liquid chlorine are stored in dark bottles.

Substances with pH<5 and pH>9

Corrosive chemicals ($\text{pH}<5$ and $\text{pH}>9$) are usually stored in special storage cabinets that are kept locked.



Photograph 1.3 Cabinet for keeping corrosive chemicals

Guidelines on storage of hazardous substances

<http://bit.ly/2MfxBoT>



Disposal of Chemicals

Laboratory wastes have specific disposal methods according to the types of substances.

Hydrogen peroxide

Hydrogen peroxide wastes with a low concentration can be poured directly into the laboratory's sink. However, hydrogen peroxide with a high concentration has to be diluted with water and added with sodium sulphite for the decomposition process to take place before being poured into the sink.

Solid wastes

Solid wastes like glass and rubber have to be disposed into special containers.

Brain Teaser

Can all the chemical wastes in the laboratory be disposed of into the sink or dustbin? Justify.



Organic solvents and hydrocarbons

Most organic solvents and hydrocarbons are toxic, carcinogenic, volatile and inflammable. This type of wastes cannot be disposed directly into the sink or the laboratory drain because it would pollute the water source and the environment. Organic solvent and hydrocarbon wastes should be kept in special containers made of glass or plastic.

Substances with pH<5 and pH>9

Substances with a pH value of pH<5 and pH>9 are strong acids and strong alkalis respectively. Strong acid and alkali wastes can cause damage to the sink and react with water to release high heat and toxic gases. Strong acid and alkali wastes should be kept in closed labelled containers during disposal.

Photograph 1.4
A closed container for disposing hazardous wastes

Heavy metals and toxic substances

Solutions containing heavy metals and toxic substances have to be kept in plastic bags and the solutions be left to evaporate in the fume chamber. Then, the bag of heavy metal residue is tied carefully and is put into the container of heavy metal waste. This type of substances should be discarded and disposed according to standard procedures.

Chemistry Lens

According to Malaysian regulations, chemicals that are classified as listed wastes should be disposed according to standard procedures. The guidelines for listed wastes can be obtained from the Department of Environment of Malaysia.

Volatile substances

Substances such as alcohol, ammonia and bromine are volatile, that is easily converted to gas at room temperature. Some of the gases produced from volatile substances are hazardous to humans and can be fatal if inhaled in large amounts. Volatile wastes should be stored in closed containers and kept away from sun and heat.



Chemical wastes and apparatus contaminated by chemicals should be disposed of into bins or bottles labelled with the types of wastes. Then, the waste will be sent to disposal centres.



Photograph 1.5 Bin and bottle for chemical waste disposal

Emergency Management Procedure in the Laboratory

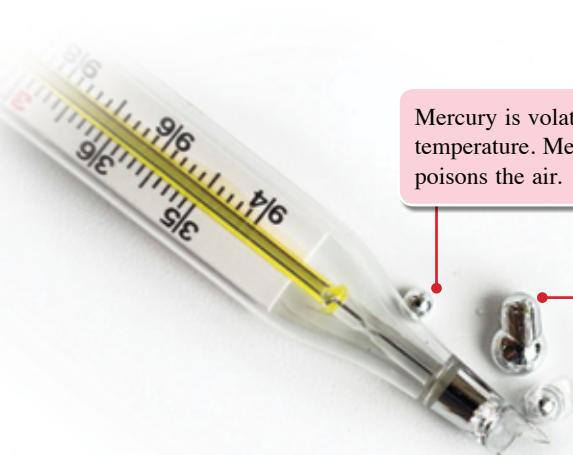
Waste spills continue to occur in laboratories even with safety measures in place. When these accidents happen, you should act according to the correct procedure as shown below:

- 1 Inform your teacher or the laboratory assistant about the accident immediately.
- 2 Prohibit other students from entering the accident site.
- 3 Stop the spill from spreading to other areas by using sand to border it.
- 4 Clean the chemical spill.
- 5 Dispose of the chemical spill by following the correct procedures.

Mercury thermometers are often used to carry out experiments in the school laboratory. If the mercury thermometer breaks, a pupil faces the risk of mercury spill. Although the quantity of mercury in the thermometer is very minimal, it is enough to cause mercury poisoning. Mercury poisoning occurs when a person is exposed to mercury in certain amount.

News on mercury spill

[http://bit.ly/
2MxQZh9](http://bit.ly/2MxQZh9)



Mercury is volatile at room temperature. Mercury vapour poisons the air.

Do not touch mercury spill because it can absorb into your body through the skin.

Symptoms of mercury poisoning:

- Nausea
- Coughing
- Vomiting
- Diarrhoea
- Chest pain
- Sore throat
- Difficulty in breathing
- Headache
- Eye irritation
- Vision problem
- Increase in blood pressure

Figure 1.12 Mercury spill

Steps to be taken the moment mercury spill occurs.

- 1** Inform your teacher or the laboratory assistant about the accident.
- 2** Make the spill site as the prohibited area.
- 3** Sprinkle sulphur powder to cover up the spill.
- 4** Contact the Fire and Rescue Department for further action.



If you are exposed to mercury poisoning, you should:

- ★ Stay away from the mercury source to prevent further exposure to it
- ★ Go to the hospital for treatment

Guidelines on handling mercury spill

[http://bit.ly/
2MJRqng](http://bit.ly/2MJRqng)



Activity | 1.6

Discussing the emergency management procedures in the laboratory

21st Century Skills



1. Carry out the Gallery Walk activity.
2. Surf the Internet to gather information on the types of accidents that commonly occur in the laboratory and emergency management procedures.
3. Prepare a presentation of your information.
4. Display the information in the class.
5. Each group should move to observe the information of the other groups. Write comments on the other groups' information on sticky notes and paste them.

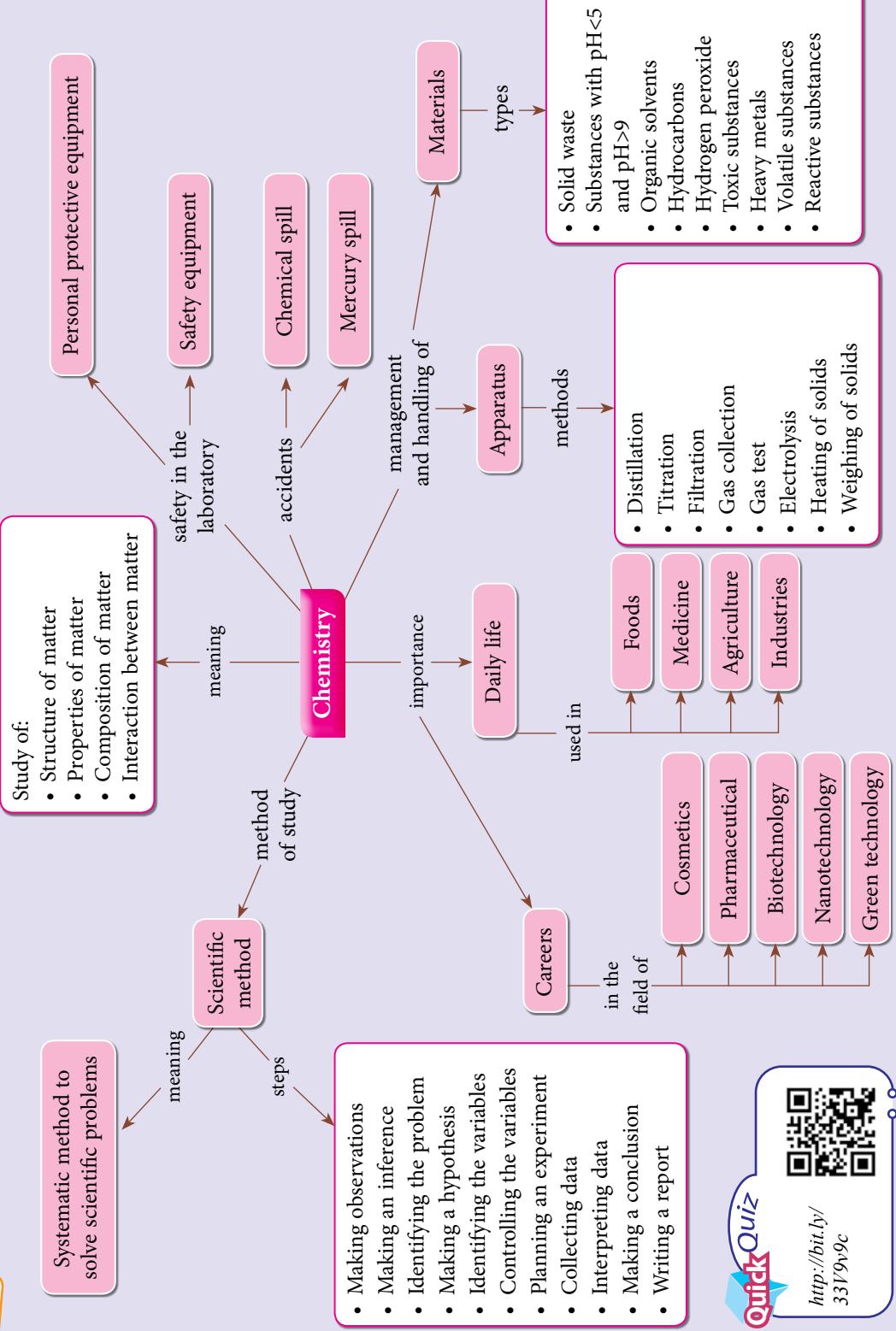


Test Yourself | 1.3

1. List out three safety steps while in the laboratory.
2. Give the functions of the following equipment:
 - (a) Fume chamber
 - (b) Safety shower
 - (c) Laboratory coat
3. How would you manage solid wastes such as glass and rubber in the laboratory?
4. Explain how you would test the presence of oxygen and hydrogen gases.
5. Explain how you can get the most accurate reading in titration.



Chain Concept



- Making observations
- Making an inference
- Identifying the problem
- Making a hypothesis
- Identifying the variables
- Controlling the variables
- Planning an experiment
- Collecting data
- Interpreting data
- Making a conclusion
- Writing a report

Quick Quiz

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SELF Reflection

Reflection

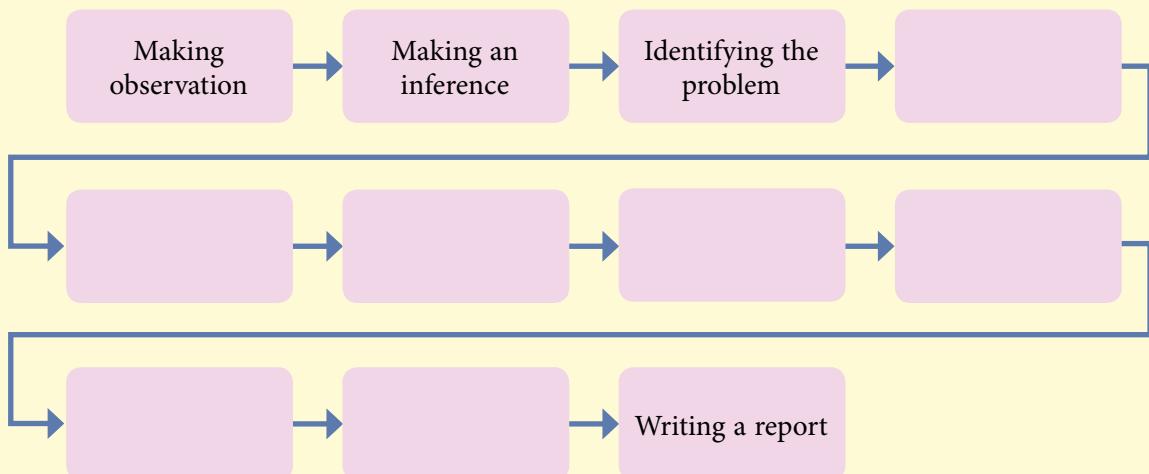
- What new knowledge have you learned in **Introduction to Chemistry**?
- Which is the most interesting subtopic in **Introduction to Chemistry**? Why?
- Why is the learning of **Introduction to Chemistry** important in the next chemistry lesson?
- Rate your performance in **Introduction to Chemistry** on a scale of 1 to 10; 1 being the lowest and 10 the highest. Why would you rate yourself at that level?
- What else would you like to know about **Introduction to Chemistry**?

[http://bit.ly/
2MEAuyw](http://bit.ly/2MEAuyw)

**Achievement****Test**

1

- Chemicals are substances that cannot be ignored in our daily lives.
 - State five types of chemicals that are commonly used in daily life.
 - For each chemical stated in (a), state its use.
- (a) Name three industries in Malaysia that use knowledge of chemistry.
 (b) How do the industries stated in (a) benefit our country? 
- List out three types of personal protective equipment and state the function of each equipment.
- Complete the following flow chart on the steps involved in a scientific method.



- State the safety measures that should be taken to overcome mercury spill accidents that occur in the school laboratory.

6. Three pieces of cloth with a size of $10\text{ cm} \times 10\text{ cm}$ each are sprinkled with 20 cm^3 of distilled water. Then, all the three pieces of cloth are folded in different styles and left to dry at room temperature. The time taken for each piece to dry is recorded.
- Explain why the three pieces of cloth are folded in different styles. 
 - Suggest a hypothesis for this experiment. 
 - Make an inference for this experiment.
 - Determine the variables involved in this experiment. 
 - Construct a suitable table to record the readings in this experiment. 

•Enrichment Corner

1. Figure 1 shows several examples of waste substances in the school laboratory.

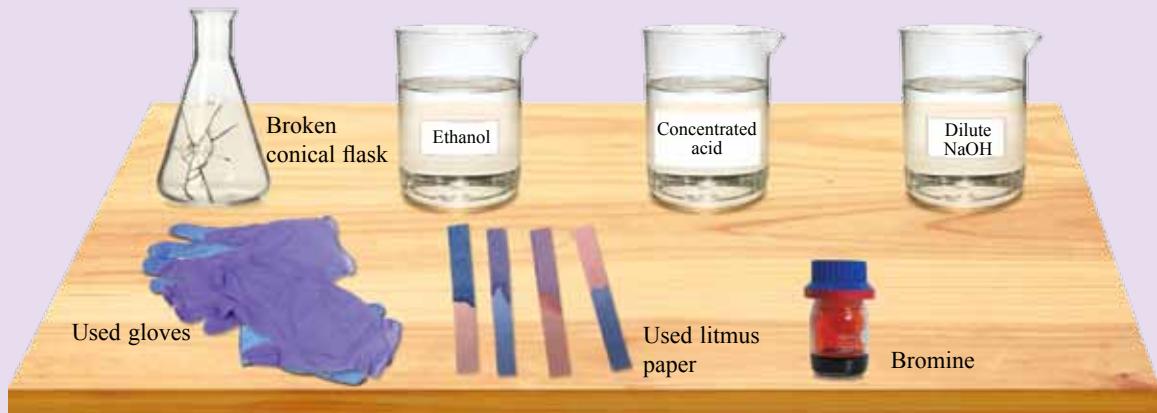


Figure 1

- Based on Figure 1, list out wastes that cannot be disposed of into the school sink or the rubbish bin.
 - Explain how to manage the waste substances listed in (a) correctly. 
2. Halim is a farmer. He plants various types of vegetables to supply the local market. However, lately, Halim realised that the produce was unsatisfactory and the growth of vegetables was stunted, or the vegetables had died off. He suspected the soil to be acidic. As a scientist, you are asked to help Halim to determine the most suitable pH value of the soil for planting vegetables. Suggest a suitable hypothesis and state briefly how you can control the variables in this experiment.  STEM



Check Answers

<http://bit.ly/3442zGX>

