Science Fact file 1

For Secondary Classes

Teacher's Guide

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Introduction

Teaching science effectively

Today we no longer question the importance of science in everyday life. Each of us knows that scientific discoveries have drastically altered the dimensions of our lives, our world, and our universe.

To a scientist, trained and with directed curiosity and a thirst for knowledge about the unknown, science means much more than the products of discovery and invention. To him, science is a body of organized and tested knowledge. It is also a way of thinking and working that is helpful in solving problems. Thus science has both content and method.

Most educators agree that the purpose of education is to change the way in which people think, feel, and act. In other words, education aims to modify behaviour. Every science teacher should therefore try to answer this question: How can I teach science so that it will become a way of living, of reacting to the environment, of interpreting the world in which we live? Science taught in this way is not just a collection of facts about our world; it creates a behavioural pattern.

When we teach to bring about such changes in the behaviour of our students, we should test our results by asking: Can the students think scientifically? Do they understand what science is all about and how scientists go about their work? Do they have a positive feeling towards science and scientists? Are they likely to read scientific books in later life with enjoyment and understanding?

Learning and teaching

Learning is most likely to occur when a student has a definite purpose. Science teaching should be focused on the nature, methods, and aims of science. Science differs from other school subjects because it involves a method of discovery based on experimentation. Experiments help to answer questions by observing the effects of making systematic changes. New concepts must be based on an adequate background of first-hand experiences.

The task of the teacher is to set up a learning situation in which the student carries out activities focused on understanding. The learning activities must also be adapted to the individual needs of the students. In order to produce an active response from different students, different types of activities should be offered. Making observations, performing experiments, planning ways to find out something, interpreting pictures and diagrams, reading science content, etc. call for different types of thinking and skills. A variety of activities help students to grasp concepts from different directions and therefore results in a greater depth of understanding.

The teaching cycle

According to psychologists, learning focused on understanding must pass through a definite cycle. The steps in learning may be termed:

1. ***Stimulus or raising questions and problems***

   Effective learning starts with a stimulus. To raise a question or problem, the situation must be meaningful to the student; that is, it must be connected with his or her personal experience. The situation must also be concrete and interesting enough to challenge him/her to find a solution.

2. ***Assimilation or achieving experience***

   This step is a search for the information needed to answer the question or solve the problem. Students perform experiments, go on field trips, use visual aids, interview people, refer to books, etc. In short, students use any source of information that will provide them with the facts needed to support their enquiry.

   Much of the information gathered by the student is specific because it has been derived from particular experiences. However, these facts are useful only in identical situations. To be useful in other situations, specific facts must be generalized.

3. ***Reaction or using the generalization***

   Practice in the application of the new understanding must now be provided. There should be many situations in which the student can use the generalization to explain, predict, and plan.

Organization of the book

The *Science Fact file* series provides a well-balanced and organized course in science, emphasizing the acquisition of knowledge to be used as a guide for intelligent behaviour in daily life. It is not only a collection of facts about the world around us. Instead the content is focused on the acquisition of general concepts. These general concepts are developed through several problem-solving methods.

To help the students develop thiking skills, appropriate study materials should be organized and concepts developed so that they follow the patterns of effective thinking. Though the units are developed in various ways, they all share the same general plan or structure. The pictures and text are designed to orient and motivate the students. They help them understand the content of the unit and its importance. The layout has been designed to arouse an active, inquiring interest in the unit.

Experiments and observations are introduced whenever the student may obtain information by direct experience. At the end of each page there is a set of self-testing exercises. These test the student's comprehension of the concepts that have been presented.

About the teachers guide

Science Fact file Teacher's Guide 1, 2, and 3 have been written to help the teacher develop effective science teaching. The guide goes through each unit, giving suggestions for teaching procedures and supplying answers for questions and solutions for exercises and problems.

Background information

This section will prove very helpful to teachers as it contains the scientific knowledge necessary to teach a particular unit.

Unit introduction

Below are some of the ways in which a unit can be introduced. Most of them can also be used to start new problems within the unit.

1. ***Ask questions about the students' experiences in relation to the Unit.***

   This method provides an inventory of past experiences and is thus, in effect a pretest. Ask the students questions such as: Have you ever seen…..? What did it look like? Have you ever made a …? Have you ever heard about…? Have you ever watched someone …? The purpose of these questions is to obtain some facts from the students' past experiences.

   Any questions that cannot be answered should be written on the board under the heading 'Questions we cannot answer'.

   While questioning, the teacher should bear in mind that the purpose is not to get the correct answers. It is to find out what the students know and how they think. Another purpose is to get the students to ask their own questions. As the discussion progresses, the main points of the answers may be recorded on the board. The students can then read the text to check their responses and also find answers to the questions.

2. ***Using pictures***

   Pictures make it possible for the students to learn indirectly from other people's experiences. Students should be encouraged to study the pictures on the opening pages of a unit. To provide help to develop the concept, several thought-provoking questions should be asked about the pictures.

3. ***Reading and discussion***

   Reading is a necessary and desirable activity for learning science, but too often it is the only activity. This is probably because reading is the medium most familiar to teachers, who feel more at ease when using it. Though science concepts are best developed through first-hand experience, sometimes, it is impossible to provide experiments that are simple enough for secondary level students, or they require laboratory facilities far beyond the resources of the average school. It is equally impossible to organize actual observations of all living things in their natural habitats.

   Though pictures can often substitute for direct experience, not everything can be illustrated. Therefore, the text must provide factual information. The text has been planned to guide the student's thinking and help him organize his ideas. Thus reading is a means to an end and not an end in itself. The text should not be thought of as a mere body of facts to be memorized by the student and then recited to the teacher on demand.

4. Experiments and observations

These can be experiments given in the book or provided by the teacher. The purpose is to explore phenomena that require explanation. There are various ways in which the teacher may use the experiments and observations depending on the time and the materials available, and the size of the class. Ideally each student should do his own work; but this is not possible in many schools. Satisfactory results may be obtained by having groups perform the experiments and make observations. However, the teacher should make sure that each student has an opportunity to work within a group. If an activity takes several days to prepare or carry out, the group should be selected in advance.

Before any experiment or observation is performed, ask questions such: what is the purpose of this experiment? What are we trying to find out? Why? This is effective as the teacher can discover from the answers whether the students understand what is going to be done.

When the results have been observed and recorded, ask the students what was done in the experiment and what happened. Do the results answer the questions posed at the start of the experiment? How do they explain what happened?

The students should understand that it is highly unscientific to generalize from a single instance. Explain to them that it may not be possible to do many additional experiments in the science class, but reputable scientists insist upon performing many experiments before a general conclusion is reached and accepted.

Whenever possible, students should obtain facts by first-hand observation. These facts will require explanations. Ask students to collect and bring to class specimens of materials and living things. They can then examine the specimens and look for the similarities and differences between them.

5. Field trips

Another means to provide opportunities for first-hand observation is through field studies. To decide what to observe and what questions to ask, the teacher should first study the unit thoroughly, then take a walk to find out what first-hand information is available to help solve problems raised in the unit. Make a list of the things that can be seen and the questions that can be asked. Then take the students on the trip and have them make their observations. When they return to class, ask them questions that bring out the facts obtained and call for explanation of these facts.

Teaching procedure

After the unit has been introduced, the students will have questions. The teacher should now develop the concepts that can be understood before the students can answer the questions.

Different concepts require different methods of development. If the concept involves the characteristics of a group of living things, materials, etc., various members of the group are described and the characteristics common to all members pointed out. If a relationship concept needs to be developed, examples of the relationship are discussed and a generalization about this relationship is made from the examples. If the concept is a principle by which a device or process works, the development can be carried out in the following steps:

i) what does the device or process do or what it is used for?

ii) what are its parts and how are they arranged?

iii) how does the device or process work?

iv) a step-by-step explanation of what happens when it works

In the *Science Fact file* series, the concepts are developed through the use of three important media:

i) first-hand experiences such as experiments and observations because students learn most effectively through 'doing' and being actively involved.

ii) visual aids such as pictures, diagrams, graphs, and charts

iii) text or reading material

Any or all of these media may be used to develop an individual concept.

When the study of the unit has been completed, the students should discuss the unit as a whole in order to organize their ideas.

Answers

These provide, where possible, the expected results of any activity and answers to any questions present in the units, including the *Test yourself* section. They also contain answers to questions in the workbook.

Problems to solve and multiple choice questions

Additional questions have been provided for reinforcement purposes. A set of multiple choice questions is also available at the end of each unit to check understanding of concepts. The teachers can also develop their own multiple choice questions.

Projects and activities

A variety of projects and activities have been included in the teachers' guide to meet the needs and interests of different students in different localities. There are suggestions for planning and carrying out experiments and observations, taking field trips, collecting specimens, assembling scrap books, building models, making charts and drawings, and using reference books.

Lesson plan and test paper

A sample lesson plan and test paper have been provided at the end of the guide.

Finally a word about what we would like to achieve through this course. Our aim is to give students information about themselves and the world they live in, upon which they can base opinions, derive judgements, and determine courses of action in later life. We certainly do not see our suggestions as mandatory. We hope they will supplement and support the teacher's own professional practice. After all, no book can replace a good teacher!

Chapter 1

Science Skills

Unit flow chart

Science is everything about us

↓

Scientists observe and record results

↓

Scientists use instruments to make measurements

↓

Scientific information is recorded in the form of data

Aims and learning objectives

- To enable students to carry out scientific investigations with due regard for health and safety
- To make measurements accurately using appropriate apparatus
- To carry out appropriate calculations
- To present the results of an investigation in an appropriate way.

Background information

The purpose of this unit is to give the students an idea of how scientists think and work. It is highly desirable for students to understand how scientists solve problems about the world in which we live.

Furthermore, the students should see that the method of thinking employed by scientists applies equally well to the thinking of the individual in solving the problems of every day life. In stressing that scientific problem-solving is a common-sense way of finding answers, the teacher may help to create a better understanding of the role of scientists.

This is an orientation unit and it is meant to be read, discussed, and illustrated so that the general meanings are comprehended. Only then will its full significance become clear to students as they study the succeeding units.

A number of the students may be familiar with some of the common scientific instruments such as thermometer, telescope, scales, etc. which can form a basis for discussion. However, the way in which scientists think and use instruments to make discoveries may be new to the students. This unit requires careful guidance as the steps of scientific thinking and practice in applying them to solve everyday problems cannot be reviewed too often.

Unit introduction

Most pupils have a lively interest in natural phenomena so their first formal lesson in a laboratory should maintain and strengthen this interest. The initial activities should capture their imagination and offer some indication of still more interesting work to come. Start the activities with as little delay as possible and try to keep any introductory discussion brief. Tell the students that they must ask questions and look for answers as they are already scientists, and they must carry out all scientific investigations carefully and thoughtfully.

Teaching procedure

Start the lesson by asking the following questions, and explaining them after listening to the responses from the students:

- *What is science?*

  Explain that science is a way of searching for information that would give us a better understanding of our world.

- *Where do scientists find problems?*

  Explain that scientists find problems everywhere in our world; they solve problems about the Earth, materials, force and energy and living things. Some scientists work with problems that are in more than one group. Often, a team of scientists work on a difficult problem together, each contributing some special knowledge or skill.

There is nothing mysterious about the ways in which scientists think and work. A scientist is just a good thinker. When a scientist has a problem to solve, he follows the same steps that any good thinker would.

Steps that a scientist usually follows in solving a problem:

1. A scientist defines the problem that he wants to solve.
2. He thinks of as many ways as he can to solve it.
3. He chooses the best possible solution or explanation.
4. He plans an experiment to see whether the chosen solution or explanation is correct.
5. If the experiment shows that the option is suitable, he proves it by doing further experiments.
6. Careful scientists always verify their discoveries.

Ask the students questions such as how do instruments help scientists make discoveries? Why do scientists use instruments? Explain that with instruments scientists can observe some facts more accurately than they can with their senses alone.

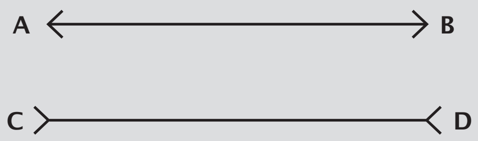
Take the students to the laboratory. Explain to them the safety rules that should be kept in mind whilst working there. Display a chart of safety rules in a prominent place in the laboratory. Show students the various measuring instruments for quantities such as distance, weight, temperature and time. Explain to the students that with scientific instruments they can make records of the facts they observe.

Before carrying out the experiments below, ask the students whether we can rely on our senses for making measurements.

Experiment 1: To investigate whether or not our senses are reliable for taking measurements

Method 1:

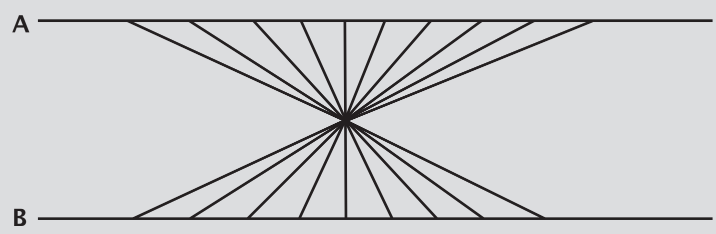
a)



Are the two lines equal in length?

The students should use their senses at first to estimate the length of lines above. Then they should measure to see if they were correct. The students will notice that the lines are of the same length.

b)



Are lines A & B straight?

Method 2: Take three bowls and mark them A, B and C respectively.

Fill bowl A with cold water, B with lukewarm water and C with very warm water. Put your right forefinger in A, and at the same time put your left forefinger in C. Count till 50, then take both fingers out and put them in B immediately. What do you feel? Why?

Remind the pupils of the inaccuracy of their senses, by asking them to determine the mass or length of some common items. Discuss what suitable instruments and units could be used to measure quantities such as weight, length, etc. Let them practise weighing with different types of balances. Explain the correct method of measuring when using a metre rule. Explain to the students how the volume of a liquid should be computed with a measuring cylinder. Ensure that the students understand what is meant by 'meniscus', which is the upper and the lower level of a liquid surface. Instruct students always to read the bottom meniscus.

Explain the SI system of measurements to the students. Clarify the sub-divisions, their abbreviated forms and what each is used to measure. Make the students practise conversions of measurements from smaller to bigger and bigger to smaller units. As a research activity, ask students to use an encyclopedia or search over the Internet to find out why the SI system of measurements was invented.

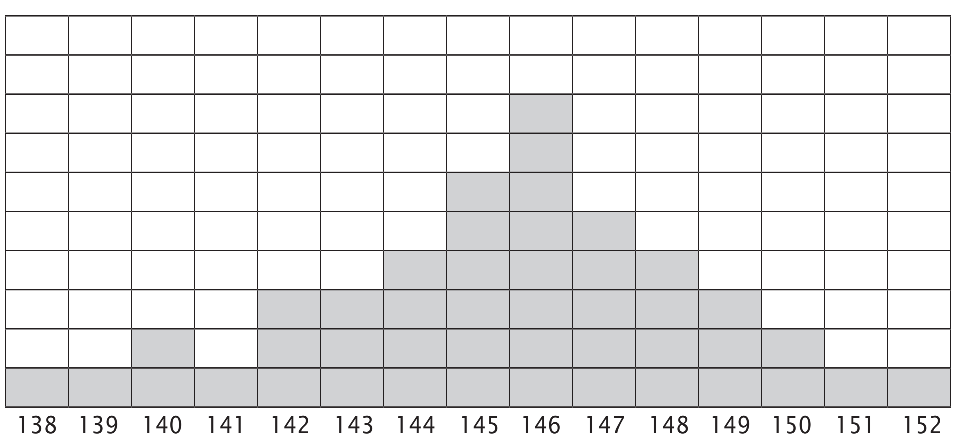
Ask the students if they have seen a cricket match on television. How does the scorer keep a record of the observations and results of the match? How is the information displayed on screen for the viewers to watch?

Discuss page 7 explaining that information can be displayed in different ways so that results can be seen at a glance and compared easily. Data can be in the form of tables, bar charts, and line graphs. Bar charts and graphs show the results in the form of pictures. They also help you to read values which you have not actually measured.

Train the students in collecting data. Help them to read and study graphs, to make tables, and draw bar charts as well as graphs. Show them the tables and graphs on pages 67, 84, 92, 100, 107, 112, 113 and 120 of the student's book.

Additional activity 1

Looking at a histogram.



Study the histogram carefully and answer the following questions:

a) What is the most common height in the class?

b) What is the height of the tallest student?

c) What is the height of the shortest student?

d) How many students are taller than 149 cm?

Additional activity 2

Drawing a histogram

1. Find out the body weight of the students in your class and complete the table below.

Weight (kg)	Number of students

2. Use the above data to draw a histogram.
3. Now answer these questions.
   a) What is the most common weight?
   b) What is the weight of the lightest pupil?
   c) What is the weight of the heaviest pupil?

Answers

***Taking measurements*: p 5**

1. Scientists use measuring instruments whenever they can as their senses cannot always give them accurate answers.
2. a) time b) temperature c) volume
3. a) litre, millilitre, cubic centimetre b) kilometre, metre, centimetre
   c) tonne, kilograms, gram d) hour, minute, second.
4. a) electronic balance b) tape measure c) measuring cylinder
5. Answers depend on students. Some examples include weighing scale, stop clock, measuring spoon, thermometer, etc.

***Making difficult measurements*: p 6**

1. 200/50 = 4 g is the mass of one nail.
2. Put some water into a measuring cylinder and measure the volume. Carefully lower the golf ball into the water until it is fully submerged. Measure the volume again. The difference in the two readings is the volume of the golf ball.
3. 1/1000 = 0.001 seconds

***Handling data:* p 7**

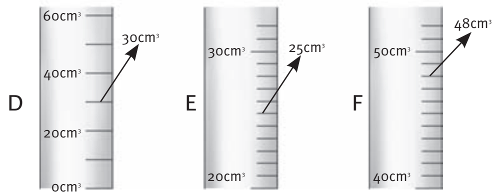
1. Scientific information is called data.
2. a) 18 °C
   b) on the third day. It was –1 °C

c) The night-time temperature was the lowest when there was no cloud

3. We can read off values which we have not measured.
4. a) 27 cm b) 20 cm c) about 300
5. a) 225 seconds
   b) 30 °C
   c) The rate of the reaction slows down with an increase in temperature.

Test yourself: **p 8–9**

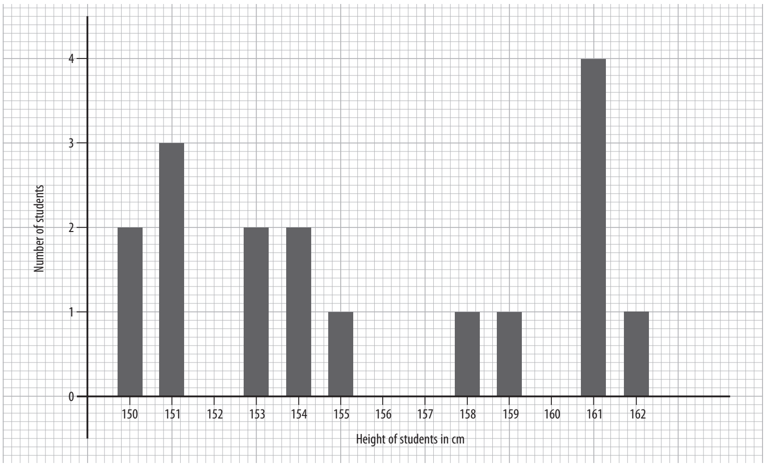
1. a) i) 20 ml ii) 75 ml iii) 37 ml
   b)



2. a) i) 15 min 1s ii) 35 min 6s
   b) i) 1 min 15s ii) 6 min 36s
3. i) 29 degrees ii) 15 degrees iii) 10 degrees
4.

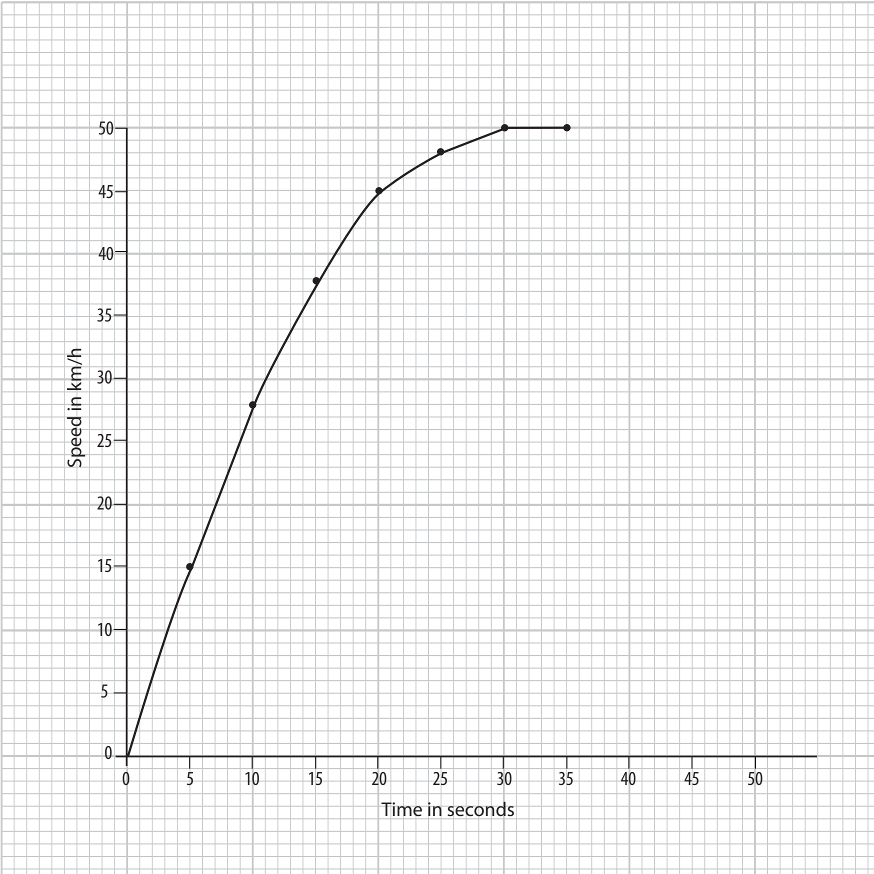
Measurement	Instrument used	Unit	Symbol
length	ruler	metre	m
mass	balance	gram	g
volume	measuring cylinder	cubic centimetre	cm^3
temperature	thermometer	degree Celcius	°C
time	stopwatch	second	s

5. a) 5 x 100 = 500 cm b) 10 x 1000 = 10 000 g
   c) 4 x 100 x 10 = 4000 mm d) 3 x 1000 x 1000 = 3 000 000 mg
   e) 2 x 1000 x 100 x 10 = 2 000 000 mm
6. a) 3 m b) 0.4 kg c) 1.8 km d) 1.30 min e) 750 m f) 2500 g g) 30 s
7. a)



   b) 155 cm c) 161 cm d) 18 students

8. a)



b) 22 km/h (approx.)

c) 11 seconds (approx.)

d) the graph levels out after 30 seconds because that is the maximum speed that the cyclist can reach.

Workbook 1, chapter 1

1. i) pipette ii) scales iii) round bottom flask iv) china dish
   v) conical flask vi) test tube vii) separating funnel viii) ruler
   ix) thermometer x) beaker

2.

Measurement	Units	Unit Symbol
length	metres	m
mass	kilograms	kg
volume	metres cubed	m^3
time	seconds	s
temperature	degree Celcius	°C

3. 40 ml 64 ml 122 ml 72 ml
4. 20 degrees 25 degrees 18 degrees 22 degrees
5. 5 min 7 s 35 min 26 s 8 s 2 min 56 s
6. 48 g 726 g 1991 g 5 g

Projects

1. Do you think scientists always need instruments to evaluate their observations? Explain.
2. Name some instruments that you have used to help you to see, hear, weigh, and measure.
3. You will find many articles about science in newspapers and magazines. Keep a scrapbook of articles about new discoveries and inventions.
4. Look at something very small with your naked eye. Then examine it with a magnifying glass or a microscope. What can you see with the instrument that you could not see without it?
5. Find out what the following scientists do: geologist, astronomer, chemist, physicist, biologist.

Multiple Choice Questions

1. When we are working in a laboratory,
   A the doors and windows should be closed.
   B the doors and windows should be open.
   C the doors should be locked and the windows should be open.
   D the doors should be open and the windows should be closed.
2. If we make judgements based only on our senses in scientific work the results are bound to be
   A unreliable B very reliable C consistent D perfect.
3. km is the symbol for
   A kilometre B kilogram C kilolitre D cubic kilometre
4. A thermometer is used to measure
   A weight B length C temperature D volume
5. We measure the volume of a liquid with a
   A ruler B stop watch C measuring cylinder D thermometer
6. The standard unit used for measuring mass is
   A litre B gram C metre D degree
7. Scientific information is called
   A table B chart C data D graph
8. When we do experiments, what we see, hear and feel are called
   A results B observations C conclusions D information
9. A line graph is useful because it helps you to
   A draw pictures B colour pictures
   C show results as a picture D put data in a table
10. 3000 cm is equal to:
    A 3 m B 30 m C 300 m D 3000 m

Answers

1. B	2. A	3. A	4. C	5. C
6. B	7. C	8. B	9. C	10. B

Chapter 2

Life and living things

Unit flow chart

Characteristics of living things

↓

Living things are made up of cells

↓

Living things grow into multicellular organisms

↓

Structure of green plants

↓

Sexual reproduction in flowering plants

Aims and learning objectives

- To show that all living things have similar characteristics and are made up of cells
- To show how organisms are constructed from cells, tissues, and organ systems
- To extend students' knowledge about plant structure and the method of sexual reproduction in plants.
- To explain seed dispersal and germination

Background information

The purpose of this unit is to introduce the students to the living things in their environment.

It will also help them develop an understanding of what all living things are made of. Most animals and plants are made up of parts. A horse has a heart, lungs, stomach, eyes, ears, etc. A plant has a stem, roots, leaves, flowers, and fruits with seeds. We call the main parts of an animal or plant its organs. Each organ does certain work for the organism.

For a long time people did not know what made up the organs of living things, but after the microscope was invented, scientists could examine small sections of the organs. About three hundred years ago, Robert Hooke, an English scientist, looked at a piece of cork through a microscope. He saw that it was made of thin, hollow spaces with walls around them. These little spaces looked like the cells in a prison or in a honey comb.

Hooke said that cork was made of cells. As time went on, other scientists saw cells in other living things.

When you think of a plant it is probably one that has seeds. All trees and shrubs, all crop plants and vegetables, all grasses and weeds are seed plants. We get almost all the plant food that we eat or feed our farm animals from these seed plants.

Unit introduction

Ask the students to name some of the things that all animals can do, and write their answers on the board. Using the list on the board, ask the students whether they think that plants can do some or all of the things that animals can do. Have them give examples of each activity of the plants they mention. Put a question mark after any activity they think plants do not perform. Explain that everything in our world is either living or non-living. Plants and animals are living things, but in time they stop living and die. Things such as air, water, and rocks are non-living now and were never alive... but what does 'alive' really mean?

Explain that once we discover how animals and plants are alike, we will learn something about what it means to be alive.

Teaching procedure

Start the lesson by asking the students to think of any animal they know, such as cats, dogs, frogs, birds, fish, spiders, crabs, etc. Ask them to identify one thing that all these animals can do? Probably the first thing that they would think of is that they can all move in some way. They can walk, crawl, fly or swim. Ask students if they know of animals that cannot move. Explain that some animals such as sponges and corals do not move from place to place. However, can move some parts of their bodies.

Enquire from students regarding movement in plants. Explain to the students that movement in plants is so slow that we usually do not notice it. For example, if we mark the spot where the tip of a vine is and then come back several hours later, we may find that the tip has moved a little bit. Speeded-up pictures can show plants sprouting from seed or moving their stems, leaves, and petals.

Explain to the class that living things must have food to stay alive. All animals use food to carry out the different functions. One cannot see a plant eat but plants that contain a green colouring matter called chlorophyll can make their own food. The process by which plants make their own food is called photosynthesis.

Can the students think of anything else that living things can do? Perhaps a student mentioned breathing as a life process. Explain that some animals breathe through lungs, others through gills. Still others take air directly into their bodies through their outer covering. Inform the students that plants also breathe. They do not have lungs or gills, nor do they make any breathing movements that we can see, but careful tests show that plants also take in oxygen.

Experiment: To find out if a plant gives out carbon dioxide

Materials: A potted plant, a small beaker containing lime water, a glass jar

Method: Water the plant and cover the soil with a plastic sheet. Place the beaker with lime water and the pot in the glass jar and cover it tightly. Let the jar stand overnight in a dark place.

What happens to the lime water in the jar? What does this show?

The lime water will turn milky proving that the plant gave out carbon dioxide.

Similarly, all living things grow until they are about the same size as their parents. Some animals grow faster than others. The process of growth in plants continues throughout their lives.

Explain to the students that living things also have the ability to produce young. Some kinds of animals give birth to live babies but most lay eggs. Plants can also produce young plants. A dandelion produces hundreds of seeds that float through the air and start new dandelion plants. Ferns, mosses and the larger algae and fungi produce millions of spores that can grow into new plants. The smaller algae and fungi make new plants by dividing into two.

Apart from the above, clarify that living things react to different messages from their surroundings. Messages such as light, smells, sounds, etc. are called **stimuli**. (singular stimulus). The way in which an animal acts when it receives a stimulus is called a **response**. Most animals respond to stimuli from their enemies by running away, hiding or fighting. When animals are hungry they respond to the stimulus of food by moving towards it and eating it. All animals respond to stimuli in some way or the other.

Ask students if they think that plants can also respond to stimuli. Just touching or shaking some plants will make their leaves fold together or droop. For example, the tip of a young sunflower plant turns towards the Sun. The stems and leaves of plants respond to the stimuli of the Sun's heat and light by growing upwards. The roots of plants respond to the stimulus of gravity by growing downwards.

Additional Activity 1

How does a plant respond to the stimulus of light?

Place a geranium, lily or other kind of plant near a sunny window. Observe the position of its leaves. Leave the plant in the window for several days. What do you observe? Now turn the plant around and leave it for several days. What happens?

What are living things made of?

Take the students to the laboratory and show them the microscope and hand lens. Show them slides of different kinds of plant and animal cells and microscopic organisms like the amoeba and paramecium. Help the students to practise and acquire skill in using a microscope.

Show the students pictures of different types of cells and explain the structure of a typical cell. Ask them whether our body is made up of only one type of cell. Discuss the shapes, sizes, and structures of cells adapted for the kind of function that they perform. Explain that there are many different sizes of cells. The smallest cells are those of bacteria and the longest cells in animals are the nerve cells. The yolk of an ostrich egg is just one cell. It weighs about half a kilogram.

Similarly, plants have various kinds of cells. Flat thin cells form a covering on the leaves, oblong cells in the leaves contain chlorophyll, long slender cells make up the tubes which carry water from the roots through the stems to the leaves. Cells with thick walls support the stem.

All cells in an organism work together. Each organ or part of an organ has its own kinds of cells. Each kind of cell is made in its own way and performs a particular function. It must depend on other kinds of cells to do the work it cannot do.

Additional Activity 2

Peel off the outer skin of an onion with a pair of forceps and place it in a drop of water on a glass slide. Cover it with a coverslip and observe it under the microscope. You will be able to see the cells clearly. Look for a small, round, yellowish lump inside each cell. This is the nucleus of the cell. Also look for the cytoplasm around the nuclei or in little streaks near the cell walls or across the cells.

Ask the students what happens to the food that we eat. Describe the digestive system with the help of a chart. Show the charts of the different systems of the body to the students. Briefly discuss the function of each system and how it works.

Structure of green plants

Bring some wild flowering plants to class. Divide the class into groups of four or five. Help them to study the different parts of the plant and discuss the position, structure, and function of each part and how each part is adapted for the function that it performs.

Additional Activity 3

Ask the students to bring some simple flowers such as a lily, rose, hibiscus, primrose, etc. to the class. Divide the class into groups of three. Ensure that each group has flowers, sheets of white paper, a scalpel and a magnifying glass.

Ask the students to count and remove the sepals and petals and arrange them on a sheet of paper. The inside of the flower consists of the carpel which has a sticky stigma, and the stamens which have pollen grains on their ends. Ask the students to take off a stamen and look at the pollen grains with the magnifying glass. Rub a stamen on the stigma. Observe what happens. With the help of the scalpel, help the students to make a longitudinal section of the carpel to expose the ovary with the ovules inside. Help the students study the different parts of the flower and the function of each part.

Explain that after pollination takes place, fertilization follows. Discuss the methods of pollination and the differences between cross- and self-pollination. Also discuss seed and fruit formation.

Explain the importance of seed dispersal and the methods that are employed by fruits to disperse seeds. Explain that when flowering is over and the seeds are mature, the whole fruit or individual seeds fall from the parent plant to the ground, where germination may take place. In some cases the seeds or fruit may be carried considerable distances from the parent plant. This helps to reduce competition for light and water between members of the same plant family. It may also result in new areas being colonized by the plant.

Discuss seed germination and the conditions necessary for germination to take place, such as water, oxygen and a suitable temperature. Explain that if any one of these is absent, a seed will not germinate properly.

Experiment: To find the conditions in which seedlings grow best.

Materials: Some healthy germinating seeds, four Petri dishes for each group, saw dust, some good soil.

Method:

Divide the class into groups of four.

Label the Petri dishes 1 to 4. Ask the students to plant four germinating seedlings in each of the four Petri dishes under the following conditions:

Conditions for the seedlings	did grow	did not grow
1. good soil+ water + sunlight	______	______
2. good soil + water – sunlight	______	______
3. good soil – water + sunlight	______	______
4. sawdust + water + sunlight	______	______

Conclusion: ____________________

Answers

***Life processes*: p 11**

1. An animal needs to move quickly in order to search for food and to escape from its enemies.
2. Animals eat in order to produce energy and to grow.
3. Living things use the energy produced by respiration to grow, to move and to enable the body to work properly.
4. Plants excrete carbon dioxide.
5. Asexual reproduction does not involve sex organs. Most plants and animals have sex organs. They use sexual reproduction to produce young.
6. A car is not a living thing because it is not made up of cells, it does not grow and it cannot reproduce. A car does not move on its own, it has to be driven by a human being.

***Cells*: p 12**

1. The nucleus contains the information which controls everything which happens in the cell.
2. a) The cytoplasm is all the living matter of the cell except the nucleus.
   b) It is a jelly-like substance which is fluid in nature.
3. The vacuole is a space that is filled with a fluid. In plant cells the fluid is cell sap. In animal cells it usually contains waste matter.
4. a) Chloroplasts contain a green chemical called chlorophyll.
   b) This is the chemical which allows green plants to use the Sun's light energy to manufacture their food.
5. a) Plant and animal cells have similar jobs to do. They take in food, release energy, get rid of waste, grow, and reproduce.
   b) Plant cells have a large central vacuole which contains cell sap. They have chloroplasts by which they can manufacture their own food. Plant cells also have a thick cell wall made of cellulose which gives them a specific shape.
   Animal cells have small vacuoles which contain excretory matter. They have a thin cell membrane through which exchange of materials takes place. Animal cells do not have chloroplasts.
6. A unicellular animal is so small that we cannot see it with our naked eye. We need to use a microscope which enlarges the image thousands of time in order to see it.

***Special cells for special jobs*: p 13**

1. Nerve cells, red blood cells, muscle cells.
2. a) Epithelial cells are thin and flat. They cover the surface of plants like skin.
   b) They protect the plant from infection and from losing too much water.
3. Root hair cells increase the surface area of the roots. They help to absorb water and minerals from the soil.
4. Pollen grains have a spiky surface to help them stick to the bodies of insects; others have tiny wings to enable them to be carried by the wind. This way they are carried from one plant to another and thereby help in plant pollination.
5. Cells are specialized to carry out all the complex functions in animals and plants.

***Cells, tissues and organs*: p 14**

1. a) A group of similar cells doing the same job is called a tissue.
   b) Muscle tissue, nerve tissue, blood tissue.
2. a) The stomach is an organ.
   b) Muscle tissue, nerve tissue, and blood tissue.
3. Organs work together to form an organ system, e.g. the digestive system.
4. Different tissues combine to make an organ. Different organs work together to form an organ system.

***Organ systems*: p 15**

1. a) The breathing system exchanges oxygen and carbon dioxide.
   b) The circulatory system transports substances to all parts of the body.
   c) The digestive system breaks down food into small molecules and absorbs them into the blood.
   d) The excretory system gets rid of poisonous substances from the blood and controls water levels in the body.
   e) The nervous system carries messages around the body.
2. a) Stomach, liver.
   b) Brain, spinal cord.
3. Lungs are organs because they are made up of different kinds of tissue which help to perform the function of gaseous exchange.

***The structure of green plants*: p 16**

1. Roots hold a plant in place in the ground. They also take in water from the soil.
2. Growth in plants takes place at the tips of the roots and the shoots.
3. The water absorbed by the roots from the soil is transported through tubes to other parts of the plant.
4. Flowers contain the reproductive organs of a plant. They usually appear at the top of the stem so that insects can reach them easily and help in pollination.
5. a) Leaves have a network of tiny tubes inside them which carry food and water to and from the leaf.
   b) Leaves have tiny holes on their underside to let gases in and out.
6. Trees get rid of waste by storing it in their leaves and dropping the leaves at certain times of the year.

***Sexual reproduction in plants (1)*: p 17**

1. Flowers are the reproductive systems of plants. They contain the reproductive organs which produce male and female sex cells or gametes.
2. The male sex cells are called pollen grains. The female sex cells are called ovules.
3. Sepals protect the flower when it is growing as a bud.
4. a) Nectar is a sugary solution produced in special glands called nectaries, which are situated at the base of the petals.
   b) When a bee reaches inside the flower to feed on nectar, the pollen collects on its back. When the bee visits another flower pollen is deposited on the stigma.
5. When the pollen is transported from the anther of one flower to the stigma of another flower, we say that cross-pollination has taken place. When the pollen from a flower is deposited on its own stigma, we call it self-pollination.

***Sexual reproduction in plants (2)*: p 18**

1. Insects such as bees visit flowers to collect nectar and pollen for food. While they are doing this the hairy body of the insect becomes covered in pollen grains. As the insect visits other flowers, pollen is transported from the anther of one flower to the stigma of another.
2. Pollen grains can be carried by wind.
3. Differences between insect-pollinated and wind-pollinated flowers:

insect-pollinated flowers	wind-pollinated flowers
• have bright colours	• have small green flowers
• have scent	• have no smell
• reproductive organs enclosed inside the petals	• reproductive organs hang outside the flower
• pollen grains are sticky	• pollen grains are smooth and light

4. a) Fertilization is the process when the nucleus of the male sex cell joins with the nucleus of the female sex cell so that a new plant can be formed.
   b) When a pollen grain lands on the stigma of a flower, it grows a pollen tube down towards the ovule. When the pollen tube reaches the ovule, the nuclei travel down the pollen tube. These nuclei join or fuse with the female nucleus and fertilize it.
5. The small and very smooth pollen grains were from the hazel catkins because hazel catkins are wind-pollinated flowers.

***Sexual reproduction in plants (3)*: p 19**

1. a) Usually the flower withers and dies after fertilization.
   b) The fertilized ovule grows inside the ovary until it develops into a seed.
   c) The ovary wall grows to form the fruit.
2. a) Seeds should be scattered so that new plants that grow from them will not be over crowded.
   b) Seeds can be scattered by wind, by animals, or by explosions.

***Test yourself:* p 20–21**

From top to bottom:

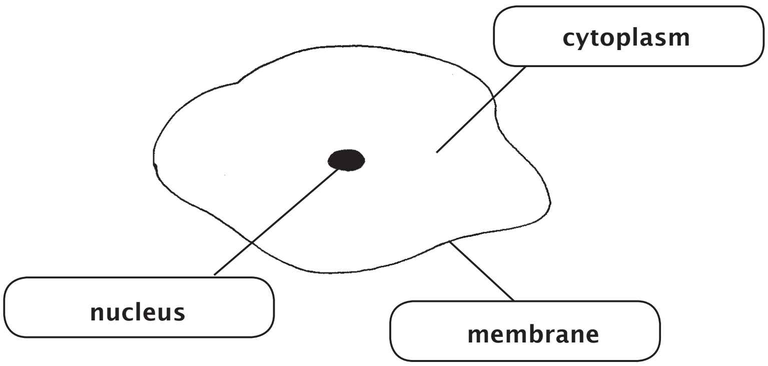
1. reproduction, movement, growth, respiration, response, excretion, feeding
2. a) It is an animal cell because it has a cell membrane and there is no chloroplast.
   b) The nucleus controls the whole working of the cell.
3. a) i) It carries messages from one part of the body to another.
      ii) It has long thin fibres which enable it to carry messages.
   b) kidneys, stomach, lungs, heart
   c) cell, tissue, organ, organ system, organism.
4. a) A – flower B – leaf C – stem D – root
   b) supports the plant: stem
      where reproduction takes place: flower
      anchors the plant in the soil: root
      where photosynthesis takes place: leaf
5. a) A – stigma B – anther C – nectar D – sepal
      E – ovary F – petal G – style H – filament
   b) i) anther ii) petals, nectaries iii) stigma
   c) bee or butterfly or beetle
6. a) i) Pollination is the process by which pollen grains are transferred from the anther of one flower to the stigma of another.
      ii) by insects and by wind.
   b) i) The scattering of seeds into new areas away from the parent plant is called dispersal.
      ii) A seed needs water, oxygen, and a suitable temperature to germinate.

7. a) As the seed takes in water the root begins to grow. Energy is provided by the food stored within the seed. The root continues to grow and the root hair begin to take in more water from the soil. Soon a young shoot grows upwards through the soil. It develops leaves so the seedling can make its own food by photosynthesis.
   b) The developing embryo gets its energy from the food stored in the seed.
8. Seeds do not germinate in the packet because they are dry.
9. The sycamore fruit has a pair of wings which act like the wings of a helicopter when they are dispersed by the wind.

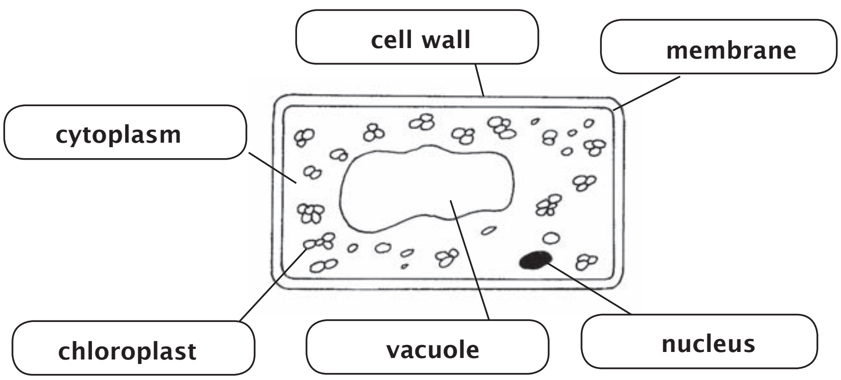
Workbook 1, Chapter 2

1. | | |
   |---|---|
   | respiration | getting energy out of food |
   | growing | getting bigger |
   | reproduction | making more of the same kind |
   | movement | going from one place to another |
   | excretion | getting rid of waste |
   | respond | react to something |
   | feed | taking in nutrients |

2. a)



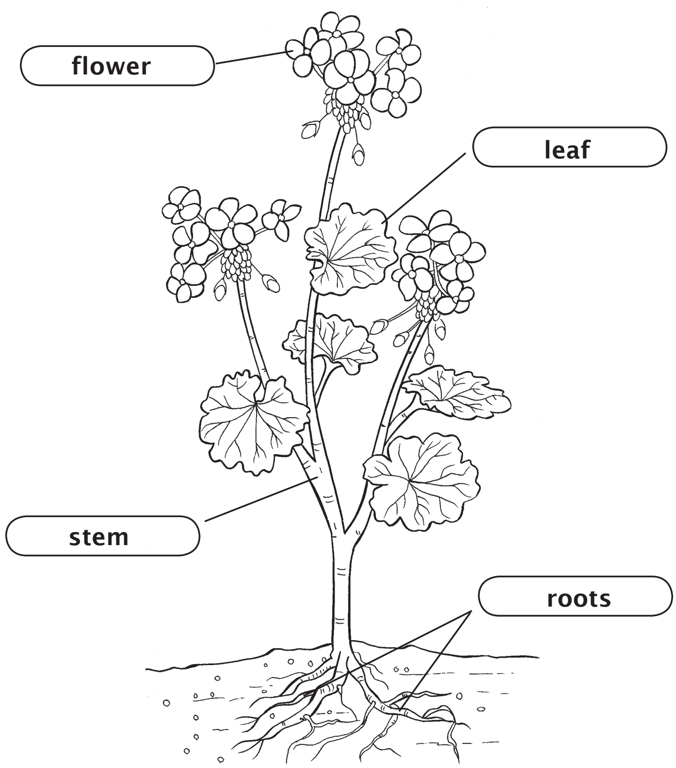
   b)



3. | | |
   |---|---|
   | red blood cell | smooth shape to squeeze easily past other cells |
   | cells of the gut | extensions that make the surface of the cell bigger |
   | nerve cell | long extension to carry messages for long distances |
   | muscle cell | long and thin with pointed ends to slide over each other |

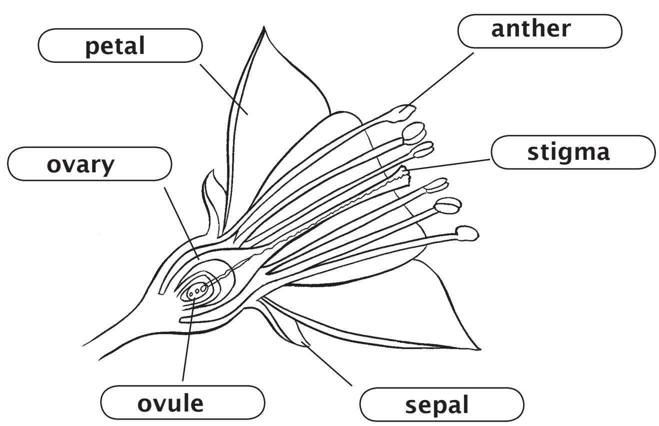
4. lungs: gaseous exchange
   kidneys: removal of waste matter from the body
   stomach and intestines: digestion and absorption of digested food
   heart: to pump blood to all parts of the body
   ribs: breathing movements
   liver: to produce bile and to store excess food

5. a)



b) flower: to allow pollination and make seeds and fruits
leaf: to make food and for gaseous exchange
roots: to absorb water and to anchor the plant to the soil
stem: to transport food and water throughout the plant and to bear the leaves and flowers.

6. a)



b) anther
c) ovary
d) When the pollen of a flower falls on the stigma of the same flower it is called self-pollination. When the pollen of a flower falls on the stigma of another flower it is called cross-pollination.
e) A pollen tube grows from the anther carrying with it the male nucleus. It enters the ovule and fuses with the nucleus of the ovule and fertilization is said to have taken place.

7. a) Dandelion seeds have a parachute mechanism which helps them to float in the air.
Sycamore fruit uses its helicopter-like wings as it flies in the air carrying the seeds to distant places.
b) Cherries are eaten by mammals and their seeds are left behind as animal waste.

c) Burdock seeds have hook-like spikes which cling to animal fur as they pass.

d) Seeds should be scattered far away from the parent plant so that each one gets enough food, water and light to grow properly.

Problems to solve

1. Name some of the organs of your body and write the function that each performs.
2. Design an experiment to show that seeds need water and warmth before they will germinate.

Answers to problems

1.

heart	to circulate blood in the body
lungs	to bring about gaseous exchange
stomach	to digest food
kidneys	to filter the blood
brain	to control the working of the whole body

2. Soak some bean seeds in water for a day. When they start to germinate, plant equal numbers of the germinating seeds in four pots containing good soil.

   Put the pots in the following conditions:

   A in a warm sunny place after watering it

   B in the refrigerator after watering it

   C in a warm sunny place without watering it

   D in the refrigerator without watering it

   Examine the seeds after two days. Pot A will have germinated and grown well because it had all the conditions that are necessary for germination.

Project

Ask the students to carry out the following project and prepare a report.

Dampen a piece of white bread with water and put it into a polythene bag. Seal the bag tightly. Put a label on the bag and place it in a warm place. After a few days, examine the bread carefully. You should be able to see the healthy growth of mould. (fungus)

Examine the mould with a hand lens. You should be able to see lots of vertical stalks growing from the surface of the bread.

Why do you think this mould is called a pin mould? Where do you think the mould came from? What kind of reproduction is this?

Multiple choice questions

1. All living things feed to produce:

   A oxygen B energy C carbon dioxide D babies

2. The removal of waste from the body is called

   A respiration B reproduction C growth D excretion.

3. Energy is released from food by the process of

   A growth B excretion C feeding D respiration

4. The main difference between plant and animal cells is

   A plant cells have a nucleus B plant cells have cytoplasm

   C plant cells have chloroplasts D plant cells have a cell membrane.

5. Nerve cells have thin long fibres which

   A cover the surface of the animal

   B absorb water for the animal

   C carry messages from one part of the body to another

   D carry oxygen around the body.

6. A group of similar cells doing the same job is called

   A tissue B organ C organ system D organism

7. Green plants make their own food by the process of
   A respiration B excretion C reproduction D photosynthesis
8. Pollination is a process in which pollen is transferred from the
   A stigma to the anther B anther to the stigma
   C petals to the stamens D anther to the petals
9. The ovary grows to form the
   A seed B cotyledon C fruit D ovule
10. When a seed begins to germinate, the first part that begins to grow is
   A root B shoot C flower D leaf

Answers

1. B	2. D	3. D	4. C	5. C
6. A	7. D	8. B	9. C	10. A

Chapter 3

Acids and alkalis

Unit flow chart

What are acids?

↓

Where can we find acids?

↓

What are the effects of acids?

↓

Indicators and acid strength

↓

Understanding neutralization

↓

Bases and alkalis

Aims and learning objectives

- To learn how acids and alkalis can be identified and distinguished from each other
- To understand that there is a range of acidity and alkalinity
- To understand the pH scale
- To understand what happens when an acid is added to an alkali
- To name some common indicators
- To explain the difference between the strength and concentration of an acid
- To explain the difference between an alkali and a base
- To identify some everyday uses of acids and alkalis
- To describe some useful neutralization reactions
- To recall the properties of acids, alkalis and salts

Background information

The purpose of this unit is to give the students an insight into the properties and uses of acids and bases.

Acids and alkalis are two common compounds. They are found in several things that we eat. They can react easily with many substances. Universal indicator and pH paper are used to detect some simple acidic, alkaline and neutral substances found in the laboratory and the home. Indicators are special chemicals which show whether a substance, in solution form, is acidic or alkaline. Indicators specify the difference between the strength of acids and alkalis by their colour. Some common indicators used in the school laboratory are litmus, methyl orange, pH paper, and universal indicator. The pH scale has a value ranging from 1 to 14, which is used to measure the acidity or alkalinity of a substance. It is a scale of colours ranging from blue to dark red with different shades in between which measure the pH of a solution. Substances with a pH value less than 7 are acidic, while substances with values larger than 7 are alkaline. A neutral substance has a pH value of 7.

When an acid and an alkali are mixed together, they neutralize each other. The process is called neutralization, resulting in the formation of salt and water. Solutions containing acid need an equal amount of alkali for neutralization.

Unit introduction

Begin the lesson by asking: *what does sour milk taste like?*

Milk that has turned sour contains an acid called lactic acid. Similarly, lemon juice and vinegar both contain acid and taste sharp or sour. The hydrochloric acid found in the stomach helps to break down food. Too much hydrochloric acid in the stomach can cause indigestion.

Acids taste sour. Ask students if this property of acids can be used in chemical tests. Why?

Ask students if they have ever tried tasting soap or baking soda. Ask them if we can taste other alkalis. Why? Some students may be familiar with the nature of acids and alkalis but some may be new to them.

This unit involves a lot of practical demonstration, so the students need to be taken to the laboratory for the activities and experiments. They must be warned about the corrosiveness of acids and alkalis, and also to be careful in handling laboratory equipment and chemicals.

Teaching procedure

Start the unit by discussing and comparing the properties and reactions of acids and alkalis at the same time. It will help to bring about a comparison between the properties of acids and alkalis.

Start the lesson by asking the students to name some common acids or alkalis that they have tasted. Explain that all acids and alkalis cannot be tasted as most acids and alkalis used in the laboratory are corrosive.

Ask the students: *what would you do if some acid was spilt on your clothes?*

Discuss the corrosive action of acids and how they can be neutralized or diluted to reduce their action.

Additional Activity 1

Make a practical demonstration of the corrosive action of acids in class. Put some strong sulphuric acid in a beaker and put a piece of cotton cloth in it. Ask the students to describe what happens. Explain the corrosive action of acids.

Perform the same reaction with some sodium hydroxide in a beaker. Ask what has happened. Explain the corrosive action of alkalis.

Properties of acids	**Properties of alkalis**
Acids are soluble in water	Alkalis are soluble in water
Acids turn blue litmus red	Alkalis turn red litmus blue
Acids produce hydrogen ions in solution	Alkalis produce OH ions in solution
Acids conduct electricity	Alkalis conduct electricity
Acids have a sour taste	Alkalis have a bitter taste
Acids have a pH less than 7	Alkalis have a pH greater than 7

Ask the students what they know about acid rain, before performing the following activity.

Additional Activity 2

Put some marble chips in a beaker and pour dilute hydrochloric acid over them. What happens? Bubbles of a gas are given off and the marble chips start dissolving in the acid. Explain that acid in rain causes stone work to corrode or wear away. Where does acid in rain come from? Discuss the pollution of air due to the emission of harmful gases from factories and vehicles. Explain that when these poisonous gases mix with the moisture in the air, they produce acid rain.

Indicators

Indicators are special chemicals that are used to show whether a substance in solution form is acidic or alkaline. Indicators indicate the difference between acids and alkalis by changing colour.

Additional Activity 3

Divide the class into groups of four or five. Give three test tubes to each group. Label the test tubes A, B, C. Pour a weak acid in A, water in B, and a weak alkali in C. Do not tell this to the students.

With a clean dropper, ask the students to pour a drop from each of the three solutions on to the different indicators provided, and write the colour changes that they observe.

Indicator used	test tube A	test tube B	test tube C
red litmus			
blue litmus			
methyl orange			

Which solution is: acidic ________, alkaline ________, neutral ________?

Now ask the students to add one drop of universal indicator to each test tube.

Write down the colour changes of the universal indicator:

acidic solution ________, neutral solution ________, alkaline solution ________

From the results, how can we find out how acidic or alkaline the solution is?

[Hint: Look at the pH colour chart.]

Strength of acids

Ask the students: *how do we know how strong an acid is?*

Explain that some acids are weak enough for us to eat, such as vinegar. However, other acids such as sulphuric acid are very strong. The strength of an acid is measured by its pH. The term pH comes from the German word 'potenz'. The lower the pH number, the stronger the acid. An acid with a pH of 1 is much stronger than an acid with a pH of 4. A substance with a pH of 7, such as pure water, is neutral. A substance with a pH greater than 7 is called an alkali. The higher the pH, the more alkaline the substance is. An alkali with a pH of 14 is much stronger than an alkali with a pH of 9.

The strength of an acid must not be confused with its concentration. Concentration depends on the amount of water present in its solution. Strength refers to the number of hydrogen ions present in it.

Write the two chemical formulae, HCl and H_2SO_4 on the board.

Ask the students: *which acid do you think is stronger, HCl or H_2SO_4?*

Explain that from the formula of the two acids, we can see that sulphuric acid has two hydrogen atoms while hydrochloric acid has only one hydrogen atom. Therefore, sulphuric acid is stronger as it has more replaceable hydrogen ions than hydrochloric acid.

Take the students to the laboratory to carry out the following activity.

Additional Activity 4

Divide the class into groups of four. Give the following chemicals (in test tubes) to the students. Ask them to test them with pH paper. Compare the colour with the colour chart and complete the following table:

Chemical	pH	strong/weak acid	strong/weak alkali
sodium hydroxide			
dilute hydrochloric acid			
ammonium hydroxide			
vinegar			
soap solution			
toothpaste			

coke			
tap water			
salt water			
baking soda			

Which substance is the strongest alkali?

Which substance is the strongest acid?

Which substance has a pH of 7? What kind of a substance is it?

Neutralization

Explain that the process of adding an acid to alkali to cancel each other out is called neutralization.

Ask the students: *what substances do you think will be formed when an acid and an alkali neutralize each other?*

Explain that when an acid is added to an alkali, water and a salt are formed.

Additional Activity 5

Ask the students to pour half a test tube of sodium hydroxide solution into a beaker. Add two drops of universal indicator solution to it. Match the colour of the alkali and read the pH value. Write it in the table below.

	Drops of acid added	pH value
1		
2		
3		

Add a drop of dilute hydrochloric acid into the sodium hydroxide solution. Stir the solution. Match the colour of the solution and read the pH value. Write it in the table. Continue to add the acid drop by drop and note the pH value.

Is there a reading where the acid and alkali cancel each other out?

What has happened?

How many drops of acid were used to neutralize the alkali?

Draw a graph to show how the pH value of the solution changed. (Value of the acid in drops on the x-axis and pH values 1 to 14 on the y-axis).

With the help of a dropper, take a few drops of the neutralized solution in a watch glass. Evaporate the solution over a water bath.

What is left on the watch glass? What do you think it is?

Applications of neutralization

Sometimes acids and alkalis may cause problems for us. These problems can often be solved by neutralization.

Problem	cause	remedy
indigestion	too much acid in stomach	Drink a weak alkali like milk of magnesia or take an antacid tablet.
bee sting	acidic in nature	Rub on baking soda. It is alkaline
wasp sting	alkaline in nature	Rub on vinegar. It is acidic.
pain in tooth	acid wears away enamel	Use toothpaste. It is alkaline
acid burn on skin	skin burns	Rub on soap and water. It is alkaline
plants do not grow well	acidic soil	Add lime. It is alkaline

Salt

Ask the students: *what is a salt? What does it look like?*

Explain that some salts look like table salt. Remind them of the activity performed earlier where a salt was formed from a neutralization reaction.

Explain that a salt is a chemical compound which is formed because of the action of an acid and an alkali. For example, sodium hydroxide and hydrochloric acid react to form sodium chloride and water. Write the equation for the reaction on the board.

Explain that water is also formed in this reaction. This is also called a neutralization reaction. Explain the formation of the type of salt on the board by writing equations. Explain that the type of salt that is formed by the reaction between an acid and an alkali depends upon the number of replaceable hydrogen atoms in the acid. An acid such as hydrochloric acid has one hydrogen atom in its molecule. If the hydrogen atom is completely replaced by sodium, a neutral salt, sodium chloride, is formed. Comparatively, an acid such as sulphuric acid has two hydrogen atoms. If both the hydrogen atoms are replaced by a metal then a neutral salt will be formed. However, if only one hydrogen atom of sulphuric acid is replaced, an acidic salt will be formed.

Answers

***Acids and alkalis*: p 22**

1. a) Oranges, lemons and limes taste sharp because they contain an acid.
   b) They are called citrus fruits because they contain citric acid.
2. a) Ethanoic acid, citric acid, lactic acid, tartaric acid, tannic acid.
   b) Vinegar, lemon juice, milk, grapes, tea.
3. Laboratory acids chiefly include sulphuric acid, hydrochloric acid and nitric acid. These acids are very corrosive and can cause a lot of damage to clothing or skin, therefore they should be handled with care.
4. When performing experiments in the laboratory using acids, our eyes should be protected by safety goggles. If acids are spilled on clothing or skin accidentally, they must be washed off immediately with plenty of water.

***Acids around us*: p 23**

1. Acids in food give them a slightly sour or sharp taste.
2. Fizzy drinks are made by adding carbon dioxide gas to the drink under pressure.
3. a) Sulphuric acid is used in car batteries and as a raw material for making many other chemicals such as plastics, paints and soap.
   b) Nitric acid is used to make fertilizers and explosives.
4. When coal and oil burn, sulphur dioxide is produced and released into the atmosphere. It dissolves in rain water to form sulphuric acid. This is a strong acid and it makes the rain very acidic. When acid rain falls, it harms plants and water life. It also eats into stonework, especially limestone.

***Indicators and acid strength*: p 24**

1. The strength of an acid is measured by its pH. The lower the pH number, the stronger the acid. The higher the pH number, the weaker the acid.
2. The stronger the acid the more hydrogen ions there are.
3. a) 7 b) 6 to 1 c) 8 to 14.
4. Concentration of an acid depends on the amount of water present in it. If there is more water, the concentration will be low and vice versa. Comparatively, the strength of an acid refers to the number of hydrogen ions in it. Higher number of hydrogen ions yields stronger acid.
5.

Indicator	Colour in acid	Colour in alkali
litmus	red	blue
phenolphthalein	colourless	pink
methyl orange	orange	yellow

6. a) A universal indicator is made up of a number of dyes which change colour when put into an acid or an alkali. At the start, before an acid is added to an alkali, the indicator is purple. As drops of acid are added, the alkali is slowly cancelled out. This causes the indicator to change colour gradually. Eventually it becomes green, which indicates that the solution has become neutral.
   b) The universal indicator changes colour gradually so we can get accurate results.

***Neutralization*: p 25–26**

1. When an acid and an alkali are mixed together, they cancel each other out or neutralize each other. During the neutralization reaction the hydrogen ion in an acid is replaced by a metal, and the hydroxide ion of the alkali joins with the hydrogen ion of the acid to form water. The reaction also produces a salt depending on the acid and the alkali that react together, for example, when dilute hydrochloric acid and sodium hydroxide are mixed, sodium chloride (common salt) and water are produced.
2. a) The indicator changes colour as the pH of the solution gradually changes to neutral.
   b) i) pH 14 ii) pH 10 iii) pH 7 iv) pH 3
3. acid + alkali ⟶ salt and water.
4. The alkali is more concentrated than the acid.
5. a) hydrochloric acid b) nitric acid c) ethanoic acid d) citric acid

***Useful neutralization reactions*: p 27**

1. a) Our teeth get coated with sugar as we eat food during the day. Bacteria feed on the sugar and produce acid as waste. This acid causes tooth decay.
   b) Most toothpastes that we use are slightly alkaline. Not only do they remove the bacteria but they also neutralize the acid.
2. a) Hydrochloric acid is produced in our stomachs to help in the digestion of food. Sometimes, during a big meal, too much acid is produced and this causes indigestion.
   b) Indigestion tablets or antacids contain metal carbonates or hydroxides which neutralize the excess acid.
3. Bee stings contain acid, so sodium hydrogen carbonate can be used to neutralize the acid, thereby relieving the painful effects of a bee sting.
4. Wasp stings are alkaline so vinegar, a weak acid, will take away the painful effect of a wasp sting.

***Bases and alkali*: p 28**

1. sodium hydroxide, potassium hydroxide, ammonium hydroxide
2. magnesium oxide, iron oxide, sodium oxide
3. Uses of alkalis: soap, oven cleaner, detergent powder, bleach
4. a) 8 b) 14
5. a) blue b) purple

***More about neutralization*: p 29**

1. sodium chloride
2. a) Pour some alkali in a beaker and add a few drops of an indicator to it. Note the colour change. Now add an acid drop by drop into the alkali. Note the point where the colour of the indicator just changes. A salt and water have been formed by the reaction of the alkali and the acid. Pour the solution into an evaporating dish and heat it till the water evaporates. The salt will remain in the dish.
   b) The safety precautions while doing this experiment would be: add just a few drops of the indicator; pour the acid drop by drop; note the colour change of the solution carefully; heat the solution gently without spilling.
3. a) Some salts contain a small amount of water, therefore, they form crystals.
   b) The water contained in salt crystals is called water of crystallization.
   c) copper(II)sulphate-5-water, $CuSO_4.5H_2O$
4. a) In acid salts, not all the hydrogen ions present in the acid are replaced during neutralization. Comparatively, in other salts all the hydrogen ions are replaced. For example, sulphuric acid has two hydrogen atoms that can be replaced during neutralization. If both hydrogen atoms are replaced, a normal salt, such as sodium sulphate will be formed. But if only one hydrogen atom is replaced, an acidic salt—sodium hydrogen sulphate—will be formed.
   b) sodium hydrogen sulphate

Test yourself: p 30–31

1. a) Fizzy drinks are made by adding carbon dioxide to the drink, which dissolves in water to form a weak acid called carbonic acid.
   b) Vinegar preserves fruits and vegetables.

2. a) i) lemonade ii) still mineral water
   b) Less acidic than cola because it has a higher pH value.
   c) It contains dissolved carbon dioxide in it so it is slightly acidic.
   d) i) They could be right as fizzy drinks are acidic in nature so they could cause the calcium of the teeth to dissolve.
      ii) They could be wrong as still drinks contain sugar which could cause tooth decay.
3. a) i) red grape juice ii) litmus iii) beetroot juice iv) red cabbage
   b) i) red
      ii) The medium will be slightly alkaline as sodium hydroxide is stronger than vinegar.
4. a) Universal indicator is a mixture of several indicators: it gives a different colour at each pH level.
   b) It is made up of a number of dyes therefore it is more expensive than litmus.
   c) The pH scale is used to measure the concentration of an acid or alkali.
   d) i) Dissolve the aspirin in 5ml of water and test it with litmus. The litmus paper will turn red.
      ii) This shows that aspirin has a pH value of 2.
5.

name of substance	pH	colour of universal indicator
hydrochloric acid	*1*	*red*
lemonade	*3*	*orange*
pure water	*7*	*green*
sodium hydroxide	*14*	*purple*

6. The concentration of an acid depends on the amount of water present in it, whereas the strength of an acid refers to the number of hydrogen ions present in it.

   Experiment

   Take two filter papers, and mark them A and B. Add a drop of dilute HCl to A, and a drop of vinegar to B. Observe the changes. You will see that paper A will have a hole in it whereas B will not. This proves that HCl is stronger than vinegar.
7. a) When an acid and an alkali are mixed together they cancel each other out or neutralize each other.
   b) i) A wasp sting is alkaline so we can use vinegar (an acid) to neutralize its effect.
      ii) A bee sting is acidic so we can use baking soda (an alkali) to neutralize it.
   c) A dock leaf must be having an alkaline chemical in it.
8. a) All acids contain hydrogen ions.
   b) All alkalis have hydroxide ions.
   c) It contains hydrogen as well as hydroxide ions.
   d) Salt and water
9. a) chloride b) nitrate c) chloride d) sulphate
10. A base that is soluble in water is called an alkali.

Workbook 1, Chapter 3

1. lemonade — acid
   water — neutral
   washing powder — alkali
   lime — alkali
   bleach — alkali
   apple — acid
2. Rain dissolves ***carbon dioxide*** from the air, making carbonic acid. Other gases produced by industry cause rain to be more acidic. These gases are ***sulphur dioxide*** and nitrogen dioxide. When they dissolve in water they form sulphurous acid and ***nitrous acid***.

Burning fossil fuels such as ***coal*** and oil give off these gases causing acid rain. Acid rain damages ***buildings*** and ***plants***. It also pollutes water, killing ***fish***.

3. a) litmus

   b) i) red   ii) blue

   c) It gives the exact pH of the acid or alkali.

   d) i) Refer to the coloured diagram on p 24 of the student's book.

   ii)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	pH scale

strong acid	weak acid	neutral	weak alkali	strong alkali

4.

Household item	pH	Colour of universal indicator	Acid, alkali or neutral
oven cleaner	*13*	*purple*	*strong alkali*
tap water	*7*	*green*	*neutral*
vinegar	*1*	*red*	*strong acid*
lemon juice	*3*	*orange*	*weak acid*
baking powder	*9*	*blue*	*weak alkali*

5. hydrochloric acid ⟶ chloride

   nitric acid ⟶ nitrate

   sulphuric acid ⟶ sulphate

   phosphoric acid ⟶ phosphate

   ethanoic (acetic) acid ⟶ ethanoate (acetate)

6. a) alkali

   b) To cancel the affect of an acid or alkali when they are mixed together.

   c) salt and water

   d) sodium hydroxide + hydrochloric acid ⟶ sodium chloride + water

7.

Indigestion tablet	number of drops of acid needed to neutralize tablet			
	1st Exp	2nd Exp	3rd Exp	Average
Ono	12	12	14	*12.67*
Burpo	18	19	22	*19.67*
Relievo	22	21	24	*22.33*

   a) so that the tablets would dissolve quickly

   b) to get accurate results

   c) when the indicator used changed colour

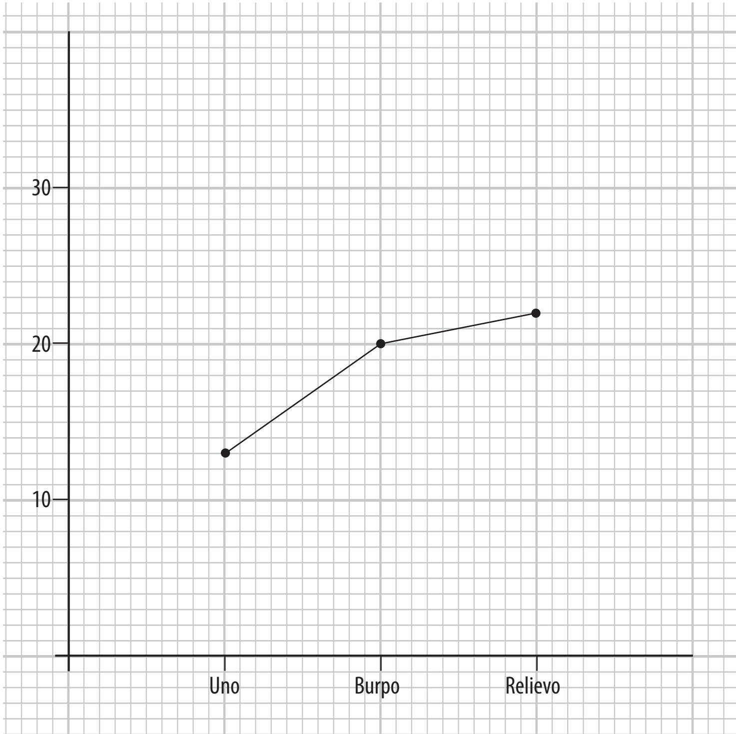
   d) To get better and accurate results. Tell the students that scientists repeat experiments and base their results by taking an average to ensure accuracy.

   e) Ono 12 +12+ 14= 38 / 3 = 12 .66

   Burpo 18 + 19 + 22 = 37 / 3 = 19.66

   Relievo 22+ 21+ 24 = 67 / 3 = 22.33

f)



g) Ono, because it took the least number of acid drops for neutralization. This means that it will take the shortest time to relieve indigestion.

Project

Make an acid indicator

Materials: a red cabbage, distilled water, knife and chopping board, saucepan, sieve or strainer, large jar, small jars, substances to test

Method: To make your indicator, take a fresh red cabbage and chop it finely on the chopping board. Boil about half a litre of distilled water in a saucepan. Add the chopped cabbage carefully to the boiling distilled water and take the saucepan off the heat. Leave to cool. Strain the liquid into a jar. The liquid should be a dark reddish purple colour. The colour will change when you test acids or alkalis with it.

To test if something is acid or alkali, pour a small quantity of your indicator into a small jar. Now add a little of the substance to be tested. A change in colour indicates the result as below.

Acids turn the indicator red. Distilled water has no effect on the indicator. Alkalis turn the indicator green.

Try lemon juice, vinegar, yoghurt, tap water, baking soda, bathroom cleaner, washing soda, etc. Record your results in a table.

Multiple Choice Questions

1. Acids taste

   A sour B bitter C sweet D salty

2. We must handle acids and alkalis with care as they are:

   A delicate B hot C corrosive D fizzy

3. The poisonous gas that is released when coal and oil burn is:

   A oxygen B hydrogen C sulphur dioxide D nitrogen

4. The pH scale has a range from:

   A 1 to 10 B 1 to 14 C 1 to 7 D 1 to 100

5. The process of adding acids to alkalis to cancel each other out is called:

   A neutralization B condensation C filtration D distillation

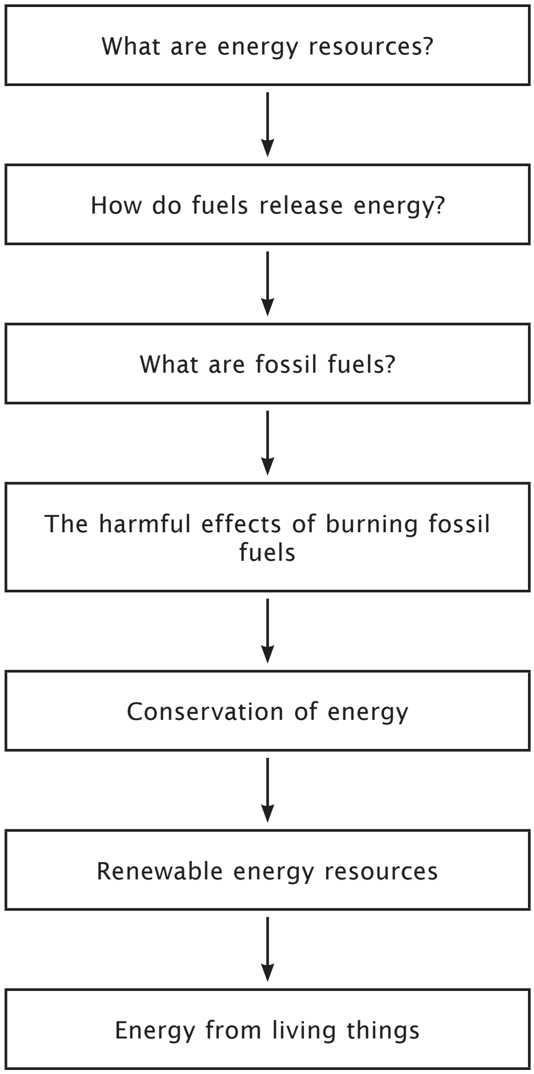
6. Which of the following is not acidic?
   A bleach   B lemon juice   C milk   D fizzy drink
7. What would be the colour of pH paper when it is dipped in hydrochloric acid?
   A yellow   B red   C green   D blue
8. The pH scale is used to measure the
   A pressure of a gas   B volume of an acid
   C temperature of a substance   D degree of acidity of a substance
9. An alkali is spilled on your clothes. Which one of the following would you use to neutralize it?
   A baking soda   B soap solution   C lemon juice   D milk of magnesia
10. The chemical name for common salt is:
   A sodium chloride   B sodium hydroxide   C calcium chloride   D calcium hydroxide

Answers

1. A	2. C	3. C	4. B	5. A
6. A	7. B	8. D	9. C	10. A

Chapter 4 Energy resources

Unit flow chart



Background information

The purpose of this unit is to give the students a view of the importance of the sources of energy that we are using today and their role in causing pollution on Earth. Furthermore, students should have knowledge of the way in which fossil fuels have formed and the effects of burning them. The teacher may help in understanding the harmful effects of using fossil fuels and of finding new energy resources. Students may be familiar with fuel currently in use; however, information about other sources of energy may be a new experience for them.

Since prehistoric times human beings have burnt things and used them as a source of heat to cook their food, to bake and harden clay pots, to make jewellery and weapons from metals, etc.

Modern civilizations depend on fuels to provide energy for transport, industry, and for use in homes. In some parts of the world wood is still a very important fuel but better fuels have been discovered and developed.

Unit introduction

Begin the lesson by showing the students a lump of coal.

Ask the students: *what is this? Where do you think it came from?*

Explain that coal is a fossil fuel, which was formed about 300 million years ago from the remains of living things. Fossils of plants can sometimes be found in lumps of coal. Coal stores the energy from the Sun which made the plants grow millions of years ago.

We can think of coal as an important form of the element carbon, formed at different pressures and temperatures under the Earth's surface. Ask the students if they can name another fuel which is found on the Earth? (Hint: It provides us with energy and several chemicals are also extracted from it. We use it in our homes and in our cars and motorcycles.)

Explain that natural gas and oil are also fossil fuels. Hundreds of millions of years ago, while ancient forests were starting to form coal on land, other fossil fuels such as oil and natural gas were being made in the sea. Large pockets of crude oil are found where layers of porous rock meet impermeable rock. Oil geologists study geological maps to find areas where the right type of rocks are found. To check the shape of the rock layers, they can send shock waves through the ground. These are the methods which are used to find areas where oil or gas is likely to be found.

Teaching procedure

Show the pictures of the formation of coal on page 33 of the student's book. Discuss how coal was formed.

Ask the students: *how long do you think the cycle took to form coal?*

Ask the students to study the diagram of sedimentary rocks where oil and gas are found on page 34 of the Student's book. Discuss the formation of sedimentary rocks and the formation of oil and gas from the bodies of microscopic plants and animals that once lived in the sea.

Additional activity 1

Heat a lump of coal strongly in a deflagrating spoon over a Bunsen flame. Put the coal in a gas jar containing some calcium hydroxide solution (lime water). Does it continue to burn? What is the colour of the flame? Is the gas jar warm? What form of energy is released? Is there any smoke? Is ash left on the deflagrating spoon?

Remove the deflagrating spoon and quickly cover the gas jar with a cover glass. What happens to the lime water? What gas do you think has been formed?

Ask the students: *what fuel is provided at our homes to light stoves? What about the fuel used in cars? What do you understand by CNG? Where does natural gas come from to our homes? Why do you think it is useful as a fuel?* Explain that it burns cleanly and does not leave any ash.

Inform the students that natural gas is a compound called methane. It is a hydrocarbon—a compound made of carbon and hydrogen.

Methane + oxygen $\longrightarrow$ carbon dioxide + water + heat

Other hydrocarbons like ethane, propane, and butane can be used as fuels. Many of them are extracted from crude oil.

Take the class to the laboratory and show them a demonstration of how fuels burn.

Pollution

Show the class pictures/photographs of polluted areas of the world. Ask the students: *can anyone define pollution?*

Explain that pollution occurs when something unwanted appears in the environment. Discuss the different kinds of pollution with everyday examples. Ask them what types of pollution they know of. The students may be able to mention air, water, and land pollution. You can discuss noise and toxic chemicals here. Where do toxic chemicals come from?

Explain that air becomes polluted when too much fuel is burned improperly in factories, furnaces and cars. The wind can blow away some of the pollution in the air. However, in large cities sometimes there is too much pollution in the air for the wind to carry away. As a result, the polluted air stays still and trapped within the city.

Additional activity 2

Ask the students to make a list of the ways to reduce different kinds of pollution. They can do research on the Internet. They can either submit it as a project or as a chart for display in the school corridor.

Fossil fuels like coal and oil contain the element sulphur as an impurity. When these fuels are burned, the sulphur reacts with oxygen in the air to make sulphur dioxide. This gas can cause serious pollution in the atmosphere. Sulphur dioxide dissolves in water to give strong sulphurous acid.

Experiment: To prove that sulphur dioxide dissolves in water to form an acid

Materials: deflagrating spoon, Bunsen burner, glass jar, blue litmus paper, water, some amount of sulphur, universal indicator

Method: Burn some sulphur in a deflagrating spoon over a Bunsen flame. When it is heated it starts burning with a blue flame. Lower the burning sulphur in a glass jar containing a little water and cover it with a glass cover. Shake the jar to mix the fumes with the water and test the solution thus formed with a piece of blue litmus.

What colour change do you see?

Add a drop of universal indicator to the solution. What do you see? Explain your result.

Explain the harmful effects of sulphur dioxide pollution to the students. Industries and power stations that burn coal, coke or oil let sulphur dioxide escape from their chimneys into the atmosphere. This mixes with the air and moves around as the wind blows. The sulphur dixide dissolves in water in the air and falls as acid rain. Petrol engines give out nitrogen dioxide in their exhaust fumes. This also dissolves in water to form acid rain.

Acid rain also causes problems in lakes making the water slightly acidic. Some of the small organisms cannot live in acidic conditions so they die. Larger organisms such as fish then have less food and so some of them die. Their decaying bodies increase pollution until the lake has very little life in it.

Discuss global warming and the greenhouse effect. Make a list of the harmful effects of global warming on our planet.

Ask the students to study the table of how long fossil fuels will last, on page 37 of the student's book. Discuss the rate at which we are using up fossil fuels. Why must we be careful in using fossil fuels? What are the best means of conserving energy in our homes and workplaces?

Ask the students: *what do you think will happen if we run out of our energy reserves?*

Ask them to collect information from the Internet, magazines and newspapers about renewable energy resources and how they can be used.

Students will be surprised to know that plants are also a renewable energy source.

Additional activity 3

The teacher can demonstrate to the students that decaying plants produce energy. This can easily be shown by filling a vacuum flask with fresh grass clippings. A thermometer is then fixed into the neck of the flask so that its end rests in the centre of the clippings. Seal the mouth of the flask with a cotton wool plug. Note the temperature. After a few days the temperature is much higher.

Why do you think the temperature rises?

Explain that energy has been released by the micro-organisms which have started to digest the grass.

Discuss the production of alcohol from sugars by the activity of yeast with the help of the diagram on page 42 of the student's book. Can alcohol be used as an energy source? Discuss the use of the alcohol thus produced.

Energy for living things

All living things need energy to stay alive. They get this energy from food where it is stored as chemical energy. Discuss photosynthesis and how plants use the Sun's energy to make carbohydrates which store chemical energy. Energy enters the bodies of living things when they eat plants or plant-eating animals.

How is this energy released? Ask the students to breathe out on their hands. What do they feel? Is the breath warm or cold? Why do they think it is so? Explain that stored chemical energy in food is released by a process called respiration. Respiration takes place inside the cells of plants and animals. Here energy is released from the food in a chemical reaction.

glucose + oxygen ⟶ carbon dioxide + water + energy

This form of respiration is very similar to burning a fuel. We can use this fact to measure energy stored in different kinds of food

Additional activity 4

Make groups of six students and ask them to perform the experiment given on page 43 of the student's book. Help them to find out the amount of energy in different foods.

Answers

***Energy resources*: p 32**

1. Most of the world's energy comes from burning fuels.
2. a) The chemical reaction which takes place when a fuel reacts with oxygen to give out thermal energy (heat) is called combustion.
   b) The small amount of energy needed to light a fuel is called ignition.
3. coal, natural gas, kerosene oil, wood, charcoal
4. Oil products are used in vehicles, for heating homes and in power stations.
5. A methane molecule contains one carbon atom and four hydrogen atoms, which are bonded together chemically. When methane is ignited, the energy is used to break the bonds between the carbon and hydrogen atoms. Once free, the atoms can react with oxygen in the air to form new molecules. The products from burning methane are water and carbon dioxide. Making bonds in the new molecules releases lots of energy which can then be utilized.

***Fossil fuels*: p 33–34**

1. A fossil fuel is formed from the remains of living things. Coal, oil, and natural gas are fossil fuels.
2. There were no human beings living on the Earth at that time.
3. a) About 300 million years ago, as the plants of the forests died, they fell and started rotting. The decaying forest formed a thick layer on the wet and swampy floor of the forest. As time passed, the action of bacteria changed the decaying plants to peat. In a way, peat is the first stage of coal formation.
   b) Gradually the land sank and water covered it. The decaying plants were covered by layers of mud and gravel. As more and more rocks were laid down by the seas above, the pressure on the peat layers increased and so did the temperature. Eventually, over millions of years, the decaying plants formed coal.
4. a) Crude oil is thick and black.
   b) Crude oil is a fossil fuel because it was made from the dead bodies of microscopic plants and animals that once lived in the sea.
5. Porous means something having sponge-like holes through which liquid or gas can seep.
6. Gas deposits collect above the oil because they are less dense.

***Burning fossil fuels*: p 35–36**

1. When fossil fuels are burnt they produce harmful substances that cause air pollution and, in turn harm the environment.
2. carbon dioxide, sulphur dioxide, nitrogen dioxide
3. All rain water usually contains a small amount of carbonic acid as it dissolves carbon dioxide from the air. Apart from this, other gases such as sulphur dioxide and nitrogen dioxide produced by industries and power stations cause rain to become more acidic. When these two gases dissolve in water they form sulphurous and nitrous acids respectively. When this rain falls over forest areas, it kills the trees because the acids release poisonous aluminium from the soil into the water, which are absorbed through the roots of trees.
4. The layer of air which surrounds the Earth acts as an insulating layer. Carbon dioxide gas in the atmosphere absorbs the heat from the Sun and keeps it in thereby maintaining a specific temperature for life on Earth.

5. a) Similar to a greenhouse, carbon dioxide is very good at keeping heat within the Earth's atmosphere. This is why it is called a greenhouse gas. It has been very useful in making the Earth warm enough for human life to survive.
   b) methane
6. a) An increase in the amount of carbon dioxide in the air is increasing the greenhouse effect, which is causing the temperature of the Earth to rise. This is global warming.
   b) Global warming will cause the ice caps at the Poles to melt which in turn will cause the sea level to rise, thus causing a change in weather patterns: more flooding will occur in the low-lying parts of the world.

***How long will fossil fuels last?*: p 37**

1. natural gas
2. There are three things that can be done:
   - Make the best possible use of the energy we get from fossil fuels now.
   - Find alternative fuels to coal, oil, and gas.
   - Find new sources of energy where fuels do not have to be burned.
3. a) Conservation means making the best use of energy supplies and reducing waste as much as possible.
   b) In cooler parts of the world it is important not to waste fuel in the home, in vehicles or in industry because when energy used for heating escapes, it is lost into the atmosphere and can never be recaptured or used again.
4. The floor of the loft and the cavity in the walls can be filled with material such as glass fibre or mineral wool. The fibres of the insulating material trap lots of air between them. Air is a poor conductor of heat and so less energy escapes.

***More ways of cutting fuel bills*: p 38**

1. The three ways are:
   - We should make best use of the energy we get from fossil fuels now.
   - We should find alternative fuels to coal, oil, and gas.
   - We should find new sources of energy which do not involve burning fuels.
2. Conservation means to make the best use of the available energy supplies without wasting much.
3. a) through the roof, through the windows, through the walls, through draughts
   b) insulating walls, double glazing windows, using draught excluders, using hot water cylinder jackets.
4. The fibres of the insulating material trap lots of air between them. Since air is a poor conductor of heat, the amount of energy escaping can be reduced.
5. Compared to double glazing, draught excluders are cheaper and easier to fit. They also make the house more comfortable and their cost can be recovered very quickly.

***Renewable energy resources*: p 39**

1. a) A renewable energy source is a natural energy source which can supply energy for millions of years without becoming exhausted.
   b) The Sun, wind, and tides.
2. The energy produced by wind is difficult to store, and electricity is only produced when the turbines are rotating.
3. a) A wind farm has a large number of wind turbines in one place.
   b) A good place to establish a wind farm would be a windy location on land or out at sea.
4. a) Hydroelectric power is electricity produced from flowing water.
   b) A hydroelectric power station should be built at a high place through which a river flows.
5. Building a hydroelectric power station results is a great change in the surrounding environment. This change may cause flooding of farmlands as well as relocation of people to new areas.

***More renewable energy resources*: p 40–41**

1. a) Solar panels are sheets of metal which absorb the Sun's energy.
   b) They should be located on the roofs of houses in order to make maximum use of the Sun's energy.

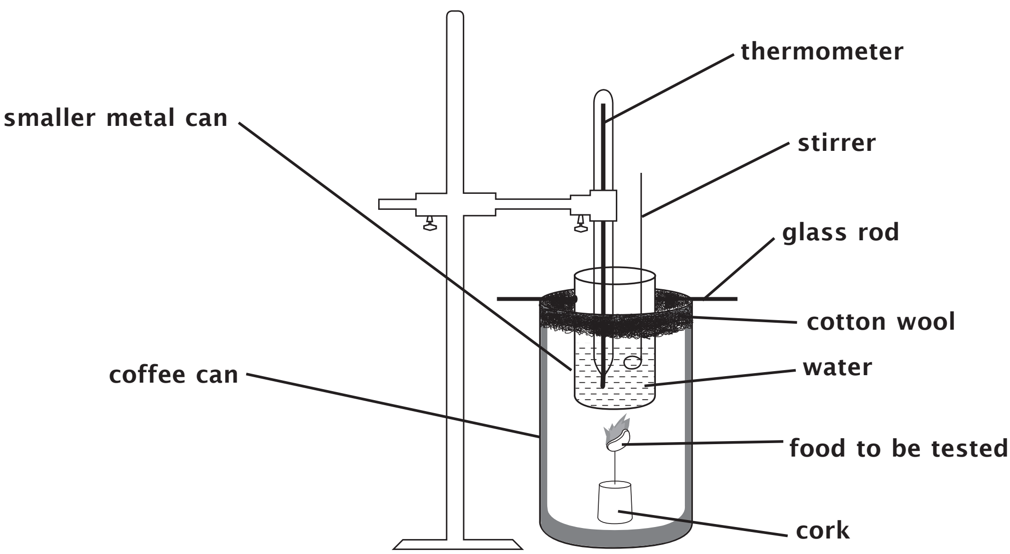
2. a) A solar cell produces a small amount of electricity when light shines on it.
   b) They produce electricity for satellites.
   c) A large number of solar cells are needed to produce useful energy.
3. a) A tidal barrage is a long barrier built across the mouth of an estuary to control the water flow. A tidal power station is built on the tidal barrage. Water flows from the river through the turbines of the barrage. Electricity is produced and the water is trapped. Water is released to flow back through the turbines, producing more electricity.
   b) Since tidal barrages change the flow of the river, sea birds and other animals might not be able to live in the estuary.
4. Floating generators could be used to generate electricity as they would move up and down with the waves. The movement would drive the generators and produce electricity.
5. The sea is constantly moving and there is a lot of energy in the waves which can be used in several ways. Comparatively, there are days when the wind does not blow at all, which means the turbines will not be able to generate electricity on those days.

***Energy from living things*: p 42**

1. Green plants derive their energy from the Sun.
2. a) carbon dioxide
   b) Because they will be able to supply energy for millions of years.
3. a) The process by which sugar can be changed into alcohol by using yeast is called fermentation.
   b) The alcohol produced by the fermentation of sugar in Brazil is mixed with petrol and used in cars and lorries as fuel.
4. a) Rotting biomass produces methane (natural gas) which is collected and used as a fuel. This gas is called biogas.
   b) Since most of the population in developing countries lives in villages and keeps cattle, biogas can easily be generated by using plant and animal waste and can be used as a fuel for heating and cooking. It is a cheap renewable energy source.

***Energy from living things*: p 43**

1. a) food
   b) (i) Green plants make their own food by using the energy from the Sun. The process is called photosynthesis.
      (ii) Animals get their food energy by eating plants or other living things.
   c) This energy is used by their body for carrying out different activities.
2. a) Some of the heat is absorbed by the container, the test tube, and some is lost to the surroundings.
   b) The energy value of a particular food can be determined by burning a known mass of food sample in a food calorimeter. The diagram below shows a simple home-made calorimeter.



The food is oxidized into carbon dioxide and water. The energy set free raises the temperature of a known mass of water in the calorimeter. The energy value of the food can then be calculated by the formula:

$$\text{energy (in joules)} = \frac{\text{mass of water (in grams)} \times 4.2 \times \text{rise in temp (in °C)}}{\text{mass of food (in grams)}}$$

***Test yourself:* p 44–45**

1. a) Combustion means burning.
   b) i) A substance that burns to produce energy.
   ii) Cardboard, paper, petrol, and tree branch can be used as fuel.
   c) When a fuel is ***ignited*** the energy is used to ***break*** the bonds holding the ***atoms*** in the fuel together. Once free, the atoms can ***react*** with oxygen to form new ***molecules***. Energy is ***released*** when new bonds are made.
2. a) Coal was formed from the remains of plants which grew in huge forests about 300 million years ago. Bacteria changed the decaying plants into peat. Gradually the land sank and water covered it. As time passed layers of mud and gravel were deposited over the decaying plants. As more and more rocks were laid down by the sea above, the pressure on the peat layers as well as the temperature increased. Eventually, over millions of years the decaying plants formed coal.
   b) Coal is called a fossil fuel because it is made from the remains of plants that lived millions of years ago.
   c) Scientists are trying to find alternative energy sources now because we will run out of fossil fuels soon.
   d) geography, geothermal, geology, geometry
   e) thermometer, thermoplastic, thermal, thermostat
3. a) sulphur dioxide, nitrogen dioxide
   b) These gases dissolve in rainwater and form acids which fall as acid rain. Acid rain harms plants, trees and stone work.
   c) An increased production of greenhouse gases will lead to global warming, which will eventually cause:
   - ice caps to melt
   - sea levels to rise
   - weather patterns to change
   - more flooding in the low-lying parts of the world
   - larger deserts
   - more droughts
   - poor growth of crops
   - spread of disease-carrying insects that live in warm areas
4. a) three years
   b) i) A cavity wall has a space between its inner and outer surfaces which can be filled with an insulating material such as glass fibre, mineral wool or foam to prevent heat loss.
   ii) Foam is made up of air bubbles. Air is a poor conductor of heat so not much heat escapes.
   iii) six years
   c) i) In double glazing, a second window is added to the one which is already there. The layer of air trapped between the glass acts as an insulating layer and so reduces the amount of heat lost.
   ii) 60 years
   iii) Double glazing is soundproof.
5. a) i) the Sun ii) photosynthesis
   b) The stepwise process involved in the production of ethanol from sugar cane.
   c) A Energy from sunlight taken from sugar cane
   B Pieces of sugar cane crushed
   C Plant juice filtered and heated

D Plant juice fermented with yeast for several days

E Extract distilled to give 95% ethanol

d) Energy is lost at each stage.

Work book 1 Chapter 4

1. a) oil, gas

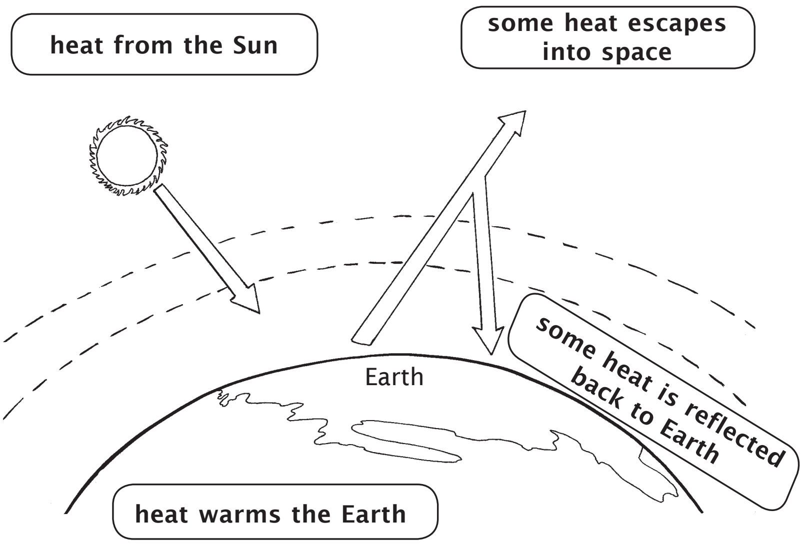
b) i) Fuels such as coal, oil, and gas which were formed millions of years ago from the remains of living things.

ii) oxygen

iii) carbon + oxygen ⟶ carbon dioxide

c) When the fuel is ignited, the energy is used to break the bonds between the atoms in molecules. Once free, the atoms can react with oxygen in the air to form new molecules. A lot of energy is released when bonds are made in the new molecules.

2. a)



b) Global warming

c) Carbon dioxide is very good at keeping heat in—this is why it is sometimes called a greenhouse gas.

d) Heating up of the Earth will melt the ice caps, leading to a rise in the sea levels which in turn will cause weather patterns to change. More rain will cause flooding in the low-lying parts of the Earth.

e) Disease-carrying insects such as mosquitoes will spread diseases in the new areas.

3. a) The black solar panels located on the roof of a house absorb energy from the Sun and thereby provide heat.

The layer of air trapped between the glass acts as a good insulator and therefore reduces the amount of heat lost.

Shutters made of insulating material prevent heat loss from windowpanes at night.

A conservatory facing south and having windows in the east and west directions allows the maximum amount of sunlight to heat it up and to keep the heat in.

The fibres of the insulating material in the cavity walls trap lots of air between them. Air is a poor conductor so not much heat escapes.

The glass fibre in the floor of the loft contains air which does not let heat pass through.

b) (i) loft insulation

(ii) conservatory

(iii) In northern UK the daylight hours are fewer and the temperature is very low. As a result, it will take a long time to recover the cost.

(iv) Double glazing also provides very efficient soundproofing.

4. coal — non-renewable
   woodland — renewable
   wind — renewable
   food — renewable
   uranium — non-renewable
   gas — non-renewable
   hydroelectric — renewable
   oil — non-renewable
   solar — renewable

coal	non-renewable
woodland	renewable
wind	renewable
food	renewable
uranium	non-renewable
gas	non-renewable
hydroelectric	renewable
oil	non-renewable
solar	renewable

5. When animal and plant waste ***decays***, a gas called ***methane*** is given off. This gas is to be collected and used as ***fuel***. Some villages in developing countries have ***biogas*** generators. Animal waste is put into a tank with a lid. As ***microbes*** digest the waste, gas is given off. This can be used for ***cooking*** and heating homes in cold weather.
6. a) to obtain accurate results b) walnut
   c) from sunlight d) heat energy
   e) i) sitting ii) running
   f) i) The container of the burnt food should have a narrow mouth.
      ii) So that heat lost to the surroundings could be reduced.

Problems to solve

1. What fuel is used to heat your home? What are the reasons for using this fuel?
2. If all fuels gave the same amount of heat for the same cost, which fuel would you prefer to use? Give reasons for your answer.
3. You have learnt what fire needs in order to burn. How can this help you to prevent and extinguish fires?
4. Name at least four things that could be used in place of coal, oil and natural gas to produce heat.
5. Turning off electric lights that are not needed can help conserve fuel. How is this possible?

Project

- Make a model of the formation of coal from plasticine. Display it on a wooden board.
- Cut out layers of coloured glazed paper to make a display of the formation of oil and gas. Mount it on a styrofoam sheet and hang it in the class room.
- Design a house which will conserve maximum energy in cold countries. Remember to include double glazing, draft excluders, insulation, etc.
- Make a collection of products that are made from coal and petroleum. Display these products so that they can be studied by your class.
- Prepare a set of rules for helping prevent and extinguish fires. Write them on a large sheet of card that can hang in your classroom.

Multiple Choice Questions

1. All our energy comes from
   A plants B animals C the Sun D gases
2. What kind of energy do we get from the Sun?
   A heat and electrical B heat and light
   C electrical and mechanical D chemical and electrical
3. Coal was formed from the remains of
   A bacteria B animals C plants D sea animals
4. Crude oil was formed from dead plants and animals that once lived
   A on land B in the sea C in the air D in rocks
5. Acid rain is produced when gases such as ________ dissolve in rain water
   A sulphur dioxide B nitrogen C hydrogen D oxygen

6. __________ is called a greenhouse gas.

A Sulphur dioxide B Carbon dioxide C Nitrogen dioxide D Chlorine

7. Which of the following is not a renewable energy resource?

A wind B hydroelectricity C solar energy D natural gas

8. Most of the world's energy comes from burning

A paper B rubber C fuels D plastics

9. Which one of the following is not a way of generating power from water?

A tidal barrage B wave power C dams D solar cells

10. As food burns it releases energy in the form of

A heat B electricity C light D force

Answers

1. C	2. B	3. D	4. B	5. A
6. B	7. D	8. C	9. D	10. A

Chapter 5

Simple chemical reactions

Unit flow chart

What a chemical reaction is

↓

Reaction of acids with metals

↓

Reaction of acids with carbonates

↓

Burning and combustion

Aims and learning objectives

- To show that chemical reactions lead to the production of new materials
- To learn to test for the products of some chemical reactions
- To investigate what is needed for things to burn

Background information

Changes in materials are going on around us all the time. Most of the changes in materials are of two main kinds. In one kind the volume or the state of the material is changed. We call this a physical change. In the other kind, one material is changed into another material. We call this a chemical change.

Unit introduction

Ask the students if they have ever changed a material so that it had different characteristics. What did they do to it and how was it different? Then have them look at the pictures on page 46 of the student's book and discuss how materials can be changed. Then have them read about the chemical reactions on the page.

Explain that when a physical change takes place, a material is changed in size or form without actually becoming another material. If we stretch or squeeze a piece of soft rubber, we change its size, but it is still rubber. It springs back when we let it go. When sugar dissolves in water it changes form, from a solid to a liquid, but it is still sugar. Other physical changes occur when ice melts, when water freezes, when wet things become dry.

Explain that when a chemical change takes place, a material is changed into one or more different materials. For example, if we hold a piece of paper next to a lighted match, the paper catches fire and burns. A flame is seen, some smoke, and then nothing but ashes. The paper has disappeared. Such a reaction cannot be reversed. We cannot get back the paper we have burnt. Similarly, when we heat mercuric oxide, mercury and oxygen are produced. A red powder is changed into a silver-coloured liquid and a colourless, odourless gas is given off. Both of these are examples of chemical changes. Other chemical changes occur when wood rots, iron rusts, milk sours and cloth fades.

Ensure that the students understand the difference between a physical and chemical change.

Teaching procedure

Ask the students: *how can we bring about chemical changes?*

Explain that matter cannot change itself. Energy is needed to change it, either physically or chemically.

Experiment: What happens when iron and sulphur are heated together?

Materials: iron filings, some sulphur, china dish, bar magnet, test tube, Bunsen burner

Method: Mix equal quantities of iron filings and sulphur powder in a china dish. Stir the mixture with a magnet. What happens?

Put equal quantities of iron filings and sulphur powder in a test tube and heat till a red glow spreads through it. When the test tube cools down, break it and take out the material.

How can you test the material to find out whether it is still a mixture of iron and sulphur?

Explain to the children that when sulphur and iron filings were simply mixed, they did not change chemically. Therefore, when a magnet was brought near, the iron filings were attracted to it. When both components were heated together, both lost their originality and formed a new compound, iron sulphide.

When some metals react with dilute acids, they set free hydrogen ions from the acids. The substance left behind is a metal compound called a salt. Metals react with acids to form metal sulphates. Write the chemical equations on the board and explain the reactions.

Take the students to the laboratory to demonstrate the experiment on page 47 of the student's book. Divide them into groups of four. Pour 2 cm^3 of dilute hydrochloric acid into a test tube. Put a small piece of zinc into the acid.

Is any gas given off? Feel the bottom of the tube. Is it warm or cold? Test the gas with a burning splint. What happens?

Repeat the above tests with magnesium, copper, and iron, and record your results:

Metal	**any reaction?**	**Is hydrogen given off?**	**rate of reaction**
zinc			
magnesium			
copper			
iron			

Using the results, ask the students to arrange the metals in order of their reactivity.

When dilute acids react with metal carbonates, carbon dioxide gas is given off. Fizzing and effervescence are usually seen and heard. Write the chemical equation on the board and explain it .

Additional activity 1

Take some calcium carbonate in a test tube and add dilute hydrochloric acid. What do you observe? Test the gas coming out of the tube with a burning splint. What happens? What can you say about the gas that is being evolved? Test the substance in the test tube with litmus paper. What do you observe? Is the substance in the test tube acidic, alkaline or neutral?

Discuss the chemical reaction of carbonates with dilute acids. Carbon dioxide is produced. It does not burn and the salt that is produced by this reaction in the test tube is neutral (having no effect on litmus).

If we want to see which gas is produced by this reaction we can bubble the gas produced through lime water. It will turn the lime water milky proving that the gas is carbon dioxide.

Burning

Ask the students: *what happens when you light a match? What kind of a change is it?*

Explain to the students that whenever you light a fire, you bring about a chemical change called burning. When a material burns it combines with oxygen. In every fire, materials combine with oxygen so rapidly that heat and light are given off. We call this chemical change burning or combustion.

What happens when materials burn? A good way to find out is to observe a burning candle. Ask the students to study the diagram on page 50 of the student's book and describe what is happening.

Light a candle and have the students observe the flame. Ask them what they can see and what is happening to the wax.

A candle is made of wax which is a compound of two elements—carbon and hydrogen. As the candle burns, both physical and chemical changes take place. First, heat from a burning match melts the wax in the wick, and then changes some of the melted wax to a gas. The hot gas burns and gives off heat which melts the wax at the top of the candle. As wax burns, it uses oxygen from the air to produce carbon dioxide and water.

Additional activity 2

Lower a lighted candle into a glass jar and quickly cover the jar with a lid. After a few seconds, take the candle out and quickly put the cover back on the jar. Pour a little lime water into the jar and shake it. What do you notice? Does the burning candle give off carbon dioxide?

Additional activity 3

Hold a cool drinking glass upside down over a lighted candle, but do not let it touch the flame. What appears on the inside of the glass? What do you think this is? Where did it come from?

What kinds of food provide you with energy?

When any fuel is oxidized, it produces energy.

Ask the students: *does your body need fuel? Why? Where does the fuel for your body come from?*

Explain that the energy that our body needs to move and keep warm comes from the food that we eat. This food is the fuel for our body. Much of the food that we eat can be oxidized in our body.

Ask the students what they think is a good fuel? Explain that a good or efficient fuel must produce a large amount of energy. Yet it should not cost too much to produce that amount of energy. It is much the same with the foods that we eat. Why do we eat nuts and fatty foods in winter? Explain that some foods are better fuels than others. The best fuels for our body are the kinds of foods that contain carbohydrates and fats. When these are oxidized in our body, they produce large amounts of energy. For this reason fats and carbohydrates are also called energy foods.

Putting out a fire

Carbon dioxide can be used to put out all kinds of fires. It is especially good for stopping petrol, oil, and electrical fires. One kind of fire extinguisher contains liquid carbon dioxide. When a valve in the extinguisher is opened, the liquid carbon dioxide shoots out. Part of it evaporates, cooling the rest until it freezes into a fine powder.

Experiment: To find out how carbon dioxide puts out a fire

Materials: 3 tbsp of baking soda, a cup of water, glass jar, ¼ cup vinegar, candle

Method: Dissolve the baking soda in a cup of water and pour the solution into a glass jar. Now add the vinegar. What happens? Lower a lighted candle into the jar. What happens? Why?

Answers

***Simple chemical reactions*: p 46**

1. a) an explosion b) rusting of iron c) burning of fuel d) electrolysis
2. • a new substance is formed.
   • energy is usually taken in or given out.
   • usually the reaction cannot be reversed.

3. a) Iron and sulphur are the reactants.
   b) Iron sulphide is the product.
4. a) magnesium + oxygen $\longrightarrow$ magnesium oxide.
   b) (reactants) (product)

***Reactions with acids (1): metals*: p 47**

1. a) A metal corrodes whenever a chemical attacks its surface.
   b) water, air and acids.
2. Bubbles of hydrogen gas are produced.
3. Hydrogen gas and a salt are produced.
4. a) zinc + hydrochloric acid $\longrightarrow$ zinc chloride and hydrogen gas
   b) $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$
5. a) Hold a lighted splint near the mouth of the test tube. If there is an explosion with a squeaky pop, hydrogen is present.
   b) This test enables us to tell the difference between hydrogen and other colourless gases such as oxygen, nitrogen and carbon dioxide.

***Reactions with acids (2): carbonates*: p 48**

1. a) Carbonates are chemicals which contain carbon and oxygen joined together.
   b) calcium, carbon and oxygen
2. Carbon dioxide gas is produced.
3. Calcium chloride, water and carbon dioxide are produced.
4. a) calcium carbonate + hydrochloric acid $\longrightarrow$ calcium chloride + water + carbon dioxide
   b) $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$
5. a) Some other gas may also produce the same result.
   b) If carbon dioxide is bubbled through lime water, it will cause the lime water to turn milky.
6. a) Baking powder is sodium hydrogen carbonate.
   b) When baking powder is heated, carbon dioxide gas is given off, which makes the cake rise.

***Burning (1)*: p 49**

1. Burning of fuel in air is a chemical reaction which causes the fuel to combine with oxygen thus forming an oxide.
   Carbon dioxide is produced when carbon is burnt in air.
2. Substances which burn are said to be flammable. Coal, petrol, wood are a few examples.
3. Fuels which contain the elements, hydrogen and carbon, are called hydrocarbons. When a hydrocarbon burns in air, its elements, carbon and hydrogen, combine with oxygen to form carbon dioxide and water.
4. The human body needs fuel to produce energy.
   This fuel comes mainly in the form of carbohydrates from the food we eat.
5. a) In both reactions, heat is produced.
   b) Combustion is accompanied by a flame, whereas there is no flame in respiration.

***Burning (2)*: p 50–51**

1. a) It would take 4s.
   b) It would take 10s.
2. It collects in the test tube.
3. Priestley thought that he had found a new kind of air in which things burnt more brightly.
4. i) Both used up one-fifth of the air.
   ii) In the candle experiment the candle burned, while in Lavoisier's experiment the mercury was only heated.
5. Water reduces the temperature of the bonfire.

***Test yourself:* p 52–53**

1. a) Collect the gas produced in a test tube and test it with a burning splint. If a squeaky pop is heard, the gas produced is hydrogen.

b) sodium + water ⟶ sodium hydroxide + hydrogen gas

c) i) (reactants) ii) (products)

2. a) i) When a strip of magnesium is put in a test tube containing dilute hydrochloric acid, bubbles of hydrogen gas are seen.

   ii) When sulphuric acid is added to calcium carbonate, an effervescent reaction takes place. It results in calcium sulphate and water and carbon dioxide gas are produced.

   b) i) zinc + sulphuric acid ⟶ zinc sulphate + hydrogen gas

   ii) sodium carbonate + hydrochloric acid ⟶ sodium chloride + hydrogen gas

3. a) To test the presence of carbon dioxide. Lime water turns milky.

   b) Carbon dioxide is produced as a result of respiration in our body, so there is more carbon dioxide in exhaled air as compared to inhaled air.

   c) To get accurate results.

4. a) The pump pulls the gas being produced through the apparatus, thereby ensuring that the gas passes through the soda lime.

   b) This means that the candle contains hydrogen and carbon.

   c) i) Water is produced from the oxidation of hydrogen present in the hydrocarbon.

   ii) It evaporates.

   d) As the hydrocarbon is burning and forming carbon dioxide and water, the candle loses weight.

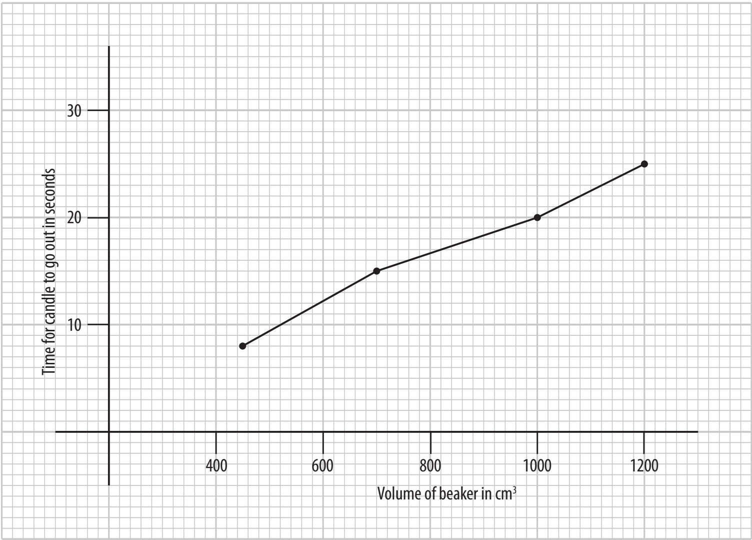
   e) The weight of the soda lime will increase due to the formation of sodium carbonate which is a salt.

5. a) To get an average reading of the results.

   b) 8.3 s, 14.8 s, 19.5 s, 25 s

   c) To get accurate results; a different type of candle may burn at a different rate, etc.

   d)



Work book 1 Chapter 5

1. a) A new substance has been formed which is different from the reactants.

   b) iron + sulphur ⟶ iron sulphide

   c) product

   d) i) no

   ii) In the reaction, a completely new substance has been formed which no longer possesses the individual qualities of the original reactants anymore.

2. a) To measure the amount of gas that has been collected.

   b) i) 1 cubic centimetre ii) 4.8 cubic centimetre

c) i) 20s ii) 45s

d) i) No more gas is being produced.
   ii) The zinc granules have been used up completely.

e) hydrogen

f) Test the gas with a burning splint. If the gas burns with a blue flame accompanied by a popping sound, the gas is hydrogen.

3. Carbonates are chemicals which contain carbon and ***oxygen*** joined together. They react easily with ***acid***. When dilute hydrochloric acid is added to a metal carbonate such as ***calcium*** carbonate, ***carbon dioxide*** gas is produced. During the reaction, fizzing or ***effervescence*** is usually seen and ***heard***. If the gas is bubbled through ***lime water***, it will turn it milky.

4. a) oxygen
   b) Carbon dioxide gas is produced.
   c) i) blue
      ii) Because during the reaction water is produced which will be absorbed by the copper(II)sulphate, thereby turning it blue.
      iii) It would increase.
      iv) Because it will absorb the water that has been produced during the reaction.
   d) When something burns, it combines with oxygen to form an oxide. This reaction cannot be reversed as a completely new product has been formed whose properties are entirely different from its reactants. The reaction cannot be reversed to yield the original reactants.
   e) Heat energy has changed into chemical energy.

5. a) French
   b) tax collector
   c) He showed that substances gained weight when they burned rather than lost weight as was the previous concept.
   d) To test the idea that burning needs oxygen, he tried heating sulphur in a jar containing no air. It did not burn. When he heated it in a jar full of oxygen it burned very quickly.

6. a) To put out fires.
   b) fuel, air, heat.
   c) It releases nitrogen gas in the form of foam which cuts off the supply of air and thus puts out the fire.

Problems to solve

1. When magnesium burns, the white powder that is left is heavier than the magnesium actually used. Why?
2. How could you show that rusting of iron takes oxygen from the air?
3. When set over a gas flame, the outside of a kettle full of cold water often becomes coated with a thin layer of water at the bottom. Where does this water come from?
4. Which of these are chemical changes?
   a. melting of butter
   b. lighting a match stick
   c. freezing of water
   d. rock crushed into small pieces
   e. green leaves turn yellow when kept in the dark
   f. spirit evaporates if left in an open bottle
   g. fire crackers explode when lighted
   h. silver spoons tarnish
5. Iron rust contains oxygen and iron. Why can you not use a magnet to separate them?
6. Is distillation of water a chemical change? Explain.

Answers to problems

1. A salt called magnesium oxide is formed which is a combination of magnesium and oxygen.
2. Weigh an iron nail. Place it in a dark damp place for a few days. You will see a red coating of rust formed on it. Weigh the rusty nail. You will see that the weight has increased because iron oxide has been formed.
3. The water has come from the gas methane which is a hydrocarbon. It produces carbon dioxide and water when it burns.
4. b, g, h
5. A chemical reaction has taken place and a new substance has been formed.
6. No, because water has only changed its physical state. No chemical reaction has taken place.

Project

- Ask the students to find out information about the experiences of early scientists and how they discovered gases in the air. Ask them to use the Internet and/or reference books in the library. Submit it as a project.
- Use some red and blue litmus paper to test chemicals in your home. The materials that you can test may include soap, toothpaste, tooth powder, water softeners, cleansers, polishes, sour milk, fruits and other foods. Record your results in a table.

Multiple Choice Questions

1. Which one of the following is not a chemical reaction?
   A rusting of iron B cooking of food C glowing of an electric bulb D growth in plants
2. Metals react with acids to form
   A salts and hydrogen B water and hydrogen C salts and water D oxygen and salts
3. Which one of the following metals does not react with acids?
   A gold B silver C copper D zinc
4. Which gas is given off when an acid reacts with a carbonate?
   A oxygen B carbon dioxide C hydrogen D nitrogen
5. The gas that makes cakes rise is
   A carbon dioxide B oxygen C hydrogen D nitrogen
6. The food which provides energy to our bodies is
   A carbohydrates B proteins C minerals D vitamins
7. How much of the air is used when something burns?
   A 1/2 B 1/3 C 1/4 D 1/5
8. Which one of the following is not needed for a fire to burn?
   A fuel B carbon dioxide C oxygen D heat
9. Which one of the following does not occur when a chemical reaction takes place?
   A a new substance is formed
   B energy is usually given out or taken in
   C usually the reaction cannot be reversed
   D the products are the same as the reactants
10. Which of the following do not cause metals to corrode?
   A water B oil C air D acids

Answers

1. C 2. A 3. A 4. B 5. A
1. A 7. D 8. B 9. D 10. B

Chapter 6

Electrical circuits

Unit flow chart

Electricity is closely related to our daily lives

↓

Some materials allow electrons to pass through easily, some do not.

↓

Types of electrical circuits

↓

Electricity in the home

↓

Resistance wires and fuses.

Aims and learning objectives

- To extend knowledge about electric circuits
- To use the concepts of electric currents and energy transfer to explain the working of electrical devices
- To use an ammeter to measure the current flowing in an electric circuit
- To differentiate between different types of circuits
- To understand electrical resistance and to describe how a resistance wire can be used as a fuse.
- To consider the hazards of electricity

Background information

All materials are made up of tiny particles called atoms. All atoms have electric charges inside them. In the centre of each atom there is a nucleus which is made of two types of tiny particles called protons and neutrons. Even tinier particles orbit around the nucleus. These are called electrons. Protons and electrons both carry electrical charges but they are of opposite types. Protons have a positive charge; electrons have a negative charge. Neutrons have no charge on them. Normally atoms have equal numbers of protons and electrons, so the positive and negative charges cancel each other out. But electrons can be made to move under the influence of an electric source such as a battery or a cell.

Unit introduction

Most students are familiar with and able to use a wide variety of electrical machines. Begin this section by asking the students to list some of the many uses of electricity, using the pictures on page 54 of the student's book.

Ask the students: *what is electricity?*

You will probably not receive a satisfactory answer, but it is useful to find out what ideas and misconceptions students already have about electricity. You can suggest that since electricity is so important in our lives and since students seem to be so uncertain about exactly what it is and what it does, it is time to study it in more detail.

Explain that when we switch on a radio or television, the electricity passing through the cable is actually a flow of electrons. This flow of electrons is called a current. Electrons flow easily through the copper wire in the cable. Copper is said to be a good conductor of electricity as it allows the electrons to pass through. Electrons cannot pass through the plastic coating round the wire. Plastic is, therefore, said to be an insulator.

Ask the students to look at cells, batteries and some simple circuits. Explain that cells and batteries are a useful source of electric charge. They change chemical energy into electrical energy.

Teaching procedure

Make an electric circuit and show it to the students in class.

Additional activity 1

Connect a dry cell to a light bulb by two copper wires and a switch. The bulb lights up. You have just made a complete loop known as an electric circuit. Open and close the switch several times.

Ask the students: *why does the bulb go off when the switch is open?*

Explain that electric current flows through a closed circuit only.

Ask the students: *why do we use a cell in the circuit?*

Explain that the electric cell drives the current in the circuit.

Ask the students: *what is a battery? How do you think it is made?*

Explain that a battery is made up of several cells joined together.

Additional activity 2

Find out which materials conduct electricity.

Set up an electric circuit using a cell, a bulb, a switch, and crocodile clips as shown in the diagram on page 55 of the student's book.

Place a copper wire between the crocodile clips. Does the bulb light up?

Replace the wire with different objects and see whether the bulb lights up or not. Write your results in the table:

Object	The bulb lights up (Yes/No)	Insulator/Conductor
copper wire		
glass rod		
paper clip		
iron nail		
chalk		
drinking straw		

What do you conclude from the results?

Using symbols to draw circuit diagrams

Ask the students: *why do we use symbols to draw circuit diagrams?*

Explain that everyone is not an artist with the capability of drawing good diagrams. Also it is a quicker and easier way of representing electric components in a circuit. Allow the students to become familiar with electrical symbols and circuit diagrams.

Switches

Ask students why we use switches in a circuit.

Stress the importance of being able to switch the current on and off when required. Discuss the different types of switches used in circuits.

Measuring current

The flow of charge is called a current and the instrument used to measure the current is called an ammeter. It measures the current in amperes. A current of one ampere means that about 6 million, million, million electrons are flowing round the circuit every second.

Show the students an ammeter. Make an electric circuit and connect it to an ammeter. Stress the importance of connecting it in the correct way otherwise it will not work. The positive terminal of the ammeter should be connected to the positive terminal of the cell. Explain that the reading on the ammeter shows the amount of current flowing through the circuit.

Connecting appliances in circuits

In series

Ask the students: *can you guess how heat is produced in electric kettles, irons, hair dryers and toasters?*

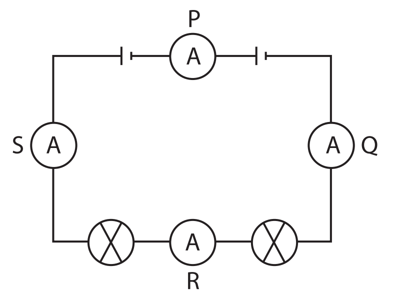
Connected to a battery, a single bulb glows brightly. If you add a second bulb in the same circuit, both bulbs glow dimly. Can the students guess why? Explain that this is because both bulbs have to share the current. Ask the students that what would happen if one bulb was removed and why. After taking a few answers explain that the other bulb goes out because the circuit is broken.

Additional activity 3

Set up a circuit as shown in the diagram with ammeters connected at different points in the series circuit.

How many paths are there for the current to flow along? Is it a closed circuit?

Note the readings on the ammeters P, Q, R, and S. Is the current at all positions in the series circuit the same or different?



In parallel

Explain to the class that when we plug in an electric heater, we are connecting it to a circuit. The circuit does not have a battery, but it is receiving the current from the mains supply.

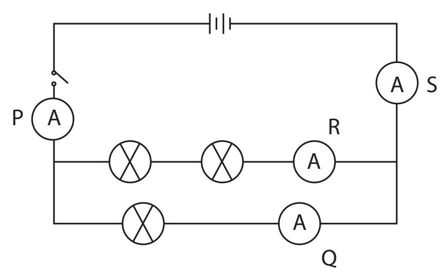
If two bulbs are connected in a parallel circuit, each bulb has a direct connection to the battery. Each gets the full battery current, so each glows brightly. Ask the students what might happen if one bulb is removed. Inform them that even if one bulb is removed in a parallel circuit, there is still an unbroken circuit through the other bulb, so it continues to glow brightly.

Additional activity 4

Set up a circuit as shown in the diagram with ammeters connected at different points in the parallel circuit.

How many paths are there for the current to flow along? Is it a closed circuit?

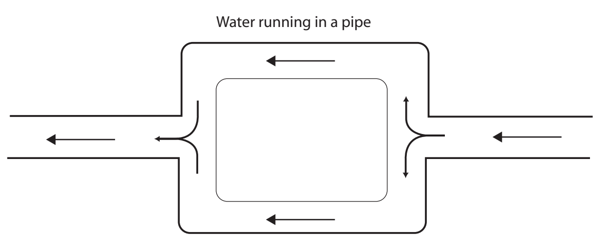
Note the readings in the ammeters P, Q, R, and S. Is the current at all the positions in the parallel circuit the same or different?



Let students find the differences between the series and the parallel circuit.

Discuss how circuits are used in our homes to supply devices with electricity. The electrical appliances in our homes are connected in parallel. Turning on one or more appliances will not affect those that are working. Also, the failure of any appliance will not affect the other appliances. The current flowing in a parallel circuit is similar to water running in a pipe.

Therefore, the total current in different branches must be equal to the current going into and out of the branches.



Resistance

Ask the students: *why does the element of a bulb light up? Why does the element of an electric heater glow?*

Explain that current can easily pass through a piece of copper wire, but it does not pass so easily through a thin piece of tungsten wire used in a bulb or a nichrome wire used in an electric heater element. We say this wire has much more resistance than a copper wire. This means that fewer electrons are moving through the wire.

Ask the students: *why do you think fewer electrons are moving through the wire?*

Explain that the material of the wire is holding electrons back, and that electrons have to be forced to pass through the element using energy. In other words it is resisting the flow of electrons. As a result heat is produced.

Set up the apparatus as shown on page 61 of the student's book. Include a bulb connected in line with the ammeter.

Look at the ammeter and the bulb. Does the bulb light up? What is the ammeter reading?

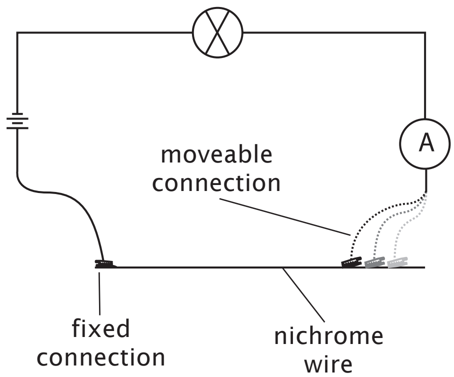
Replace the steel wool with a copper wire. Does the bulb light up? Is it as bright as before? What is the ammeter reading? Repeat the task with a nichrome wire. Which wire allows more current to pass through?

Additional activity 5

Set up the apparatus as shown in the diagram alongside. Make the length of the nichrome wire 10 cm. Note the reading of the ammeter. Increase the length of the nichrome wire and then note the reading of the ammeter. What happens to the flow of current? Has it increased or decreased with the increment in the length of the wire?

Repeat the same activity with a thinner nichrome wire of 10 cm. Note the reading of the ammeter. Does the thick wire allow more or less current to pass through?

From this activity, students should be able to conclude that all conductors have resistance. However, long, thin wires have more resistance than short, thick wires. A nichrome wire has more resistance than a copper wire.



Fuses

Ask the students: *what do we say about a bulb that has blown?*

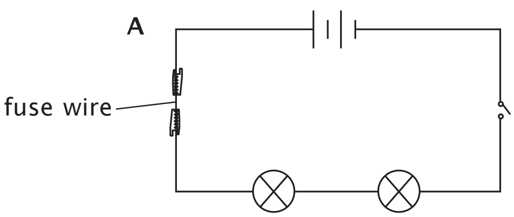
We say it has fused. In other words, we say that there was too much current flowing through the bulb. This melts the tungsten filament of the bulb, hence the bulb has blown, or fused.

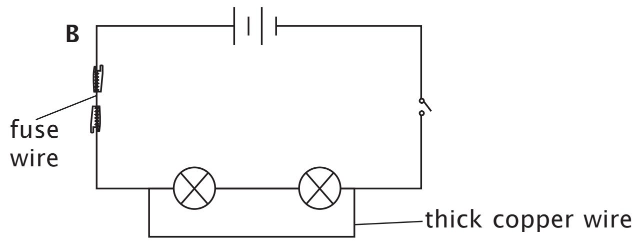
Explain to the students that if there is too much current in a circuit, the electrical appliance attached to it will burn out. Does this happen every time we switch on an electrical appliance? It does not happen, as a short piece of thin wire is connected along the mains circuit. This wire overheats and melts if too much current flows through it. Why do you think there are fuses in the mains circuit? Fuses are important because if a fault develops, the fuse 'blows' and breaks the circuit before any further damage is caused.

Allow the students to study fuses and other safety devices in electrical circuits.

Additional activity 6

Set up the apparatus as shown in diagram A.





Close the switch. What happens to the light bulbs and the fuse wire? Rearrange the circuit as shown in diagram B. Close the switch. What happens to the light bulb and the fuse wire?

Explain that the copper wire is parallel to the light bulb. We say that it produces a short circuit. It takes a large amount of current from other parts of the circuit. This may cause overheating. A short circuit may even cause a fire. A fuse can be used as a safety device because it melts before the current becomes too large.

Looking at electric plugs

Open a wired plug carefully. Try to locate the fuse. How many wires are there?

Electric cables have the following colour coding:

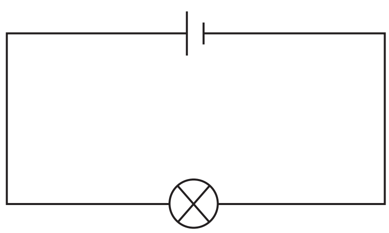
Wire	colour
live	red
neutral	black
earth	green

Explain that three pin plugs are a simple, safe way of connecting electrical appliances to a mains circuit. They are normally fitted with 3A to 13A fuses. The value tells you the current needed to blow the fuse. If a television set takes a current of 0.5A, its plug should be fitted with a 3A fuse. The fuse value should always be more than the actual current, but as close to it as possible. The TV will still work with a 13A fuse fitted, but it might not be safe. If something goes wrong, the circuits could overheat and catch fire without the fuse blowing first.

Answers

***Conductors and insulators*: p 55**

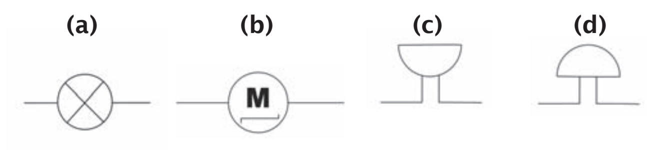
1 a) An electrical conductor allows electricity to pass through it.
   b) An electrical insulator does not allow electricity to pass through it.
2. conductors: metals, graphite, carbon
   insulators: glass, rubber, wood
3. They are made of plastic because plastic is an insulator and does not allow electricity to pass through it.
4. a)



   b) a switch

***More electrical components*: p 56**

1. Take symbols of bulb, motor, buzzer and bell from textbook page 56.



2. a) Electrical energy is changed to sound energy
   b) Electrical energy is changed to heat and light energy.
   c) Electrical energy is changed to mechanical energy.
   d) Chemical energy is changed into mechanical energy.
3. Electrical components must be kept clean so that they do not corrode, they are reliable and last longer.
4. The gap between the contacts acts as an insulator.
5. A Reed switch is operated by a magnet. When a magnet is held close to the switch, the contacts close and the switch is on. The switch is off when the magnet is removed.

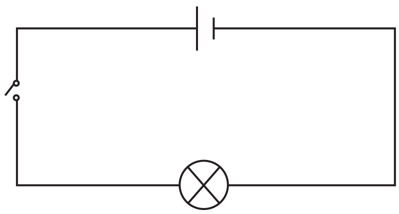
***Measuring current*: p 57**

1. Electric current is measured in amperes.
2. An ammeter is used to measure current flow accurately.
3. The symbol 'A' means amperes.
4. The positive connector of the ammeter should be attached to the positive terminal of the battery and the ammeter should be placed before the bulb.

5. The same amount of current i.e. 4A flows out of the bulb.

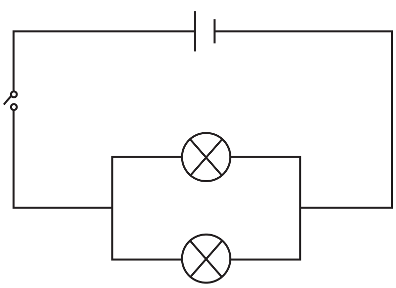
***Series circuits*: p 58**

1. All the components are joined together in a line.
2. If one of the bulb blows, the circuit is broken. The other bulbs will not glow.
3. Adding more cells in a series circuit will push more current in the circuit and the bulbs will glow more brightly.
4. Adding more bulbs in a series circuit will make it more difficult for the current to flow. All bulbs in the circuit will glow dimly.
5.



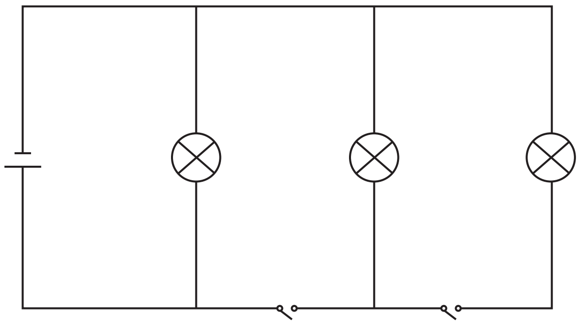
***Parallel circuits*: p 59**

1. In a series circuit, all the components are joined together in a line. In parallel circuits, the components are arranged in such a manner that provides more than one pathway for electricity to flow.
2. If one bulb blows, the other bulbs keep glowing. This happens because the circuit still remains complete through the undamaged bulb or bulbs.
3. a)



   b) Both bulbs glow with equal brightness as the same amount of current flows through them.

4.



***Parallel circuits in the home*: p 60**

1. Electrical devices can be connected to the parallel circuit in homes at any point.
2. a) A ring main is an extended form of a parallel circuit. The circuit is arranged in the form of a ring.
   b) Devices can be placed anywhere between the two wires of the ring.
3. lamp, radio, washing machine, toaster
4. a) Though a ring main is an extension of a parallel circuit allowing devices to be plugged in at any point of the ring, the ring also has an extra wire called the earth wire.
   b) The earth wire is present for the sake of safety.
5. Answers depend on students.

***Resistance*: p 61**

1. too much current flowing through the bulb
2. The thin filament of the bulb gets hot, burns and melts when a large current flows through it.
3. a) copper, nichrome

   b) Copper has the lowest resistance.
4. The resistance of a wire decreases as its thickness increases.

***Test yourself*: p 62–63**

1. a) A conductor is a material that allows electricity to pass through it.

   b) iron wire, aluminium foil

   c) The connections might be loose or the battery might be low. He could tighten the connections or change the battery.
2. a) 0.25 A in each bulb.

   b) 0.25 A in each bulb

   c) 0.25 A in each bulb.
3. a) i) 0.3 A ii) 0.3 A iii) 0.3 A iv) 0.6 A

   b) 0.3 A

   c) i) 0.6 ii) 0.2 A iii) 0.2 A
4. a) electric fire: electricity to heat
   table lamp: electricity to light
   hairdryer: electricity to heat and mechanical energy
   television: electricity to light and sound energy
   toaster: electricity to heat

   b) i) electric fire ii) table lamp

   c) A toaster needs thicker wires for greater resistance to cause the element to heat up.

   d) i) 13 A ii) 5 A iii) 3 A

   e) A fuse is made of a wire which has a high resistance. When too much current flows through it, the wire melts and breaks the circuit. When this happens the supply of electricity is cut off and the rest of the circuit, including any device attached to it, remains safe.
5. a) bedroom 1

   b) bathroom

   c) Sometimes both switches may be on or off at the same time.

   d) i) It is called a ring main.

      ii) The circuit is made in the form of a ring, and devices can be placed anywhere in the ring between the two wires.
6. a) i) towards A ii) towards B

   b) A thicker wire has lower resistance and so the bulb will glow more brightly.

   c) i) It is called a variable resistor because the value of the resistance can be changed by moving the clips.

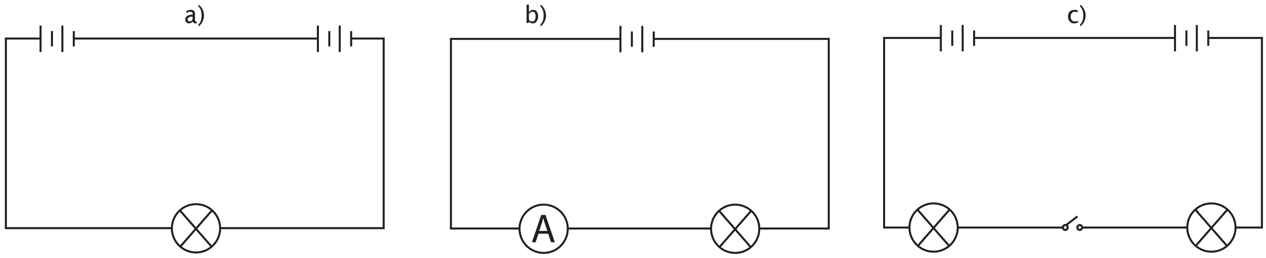
      ii) It helps to control the amount of current flowing through a circuit. It also controls the voltage at different points in a circuit.

Workbook 1 Chapter 6

1.

switch bulb or lamp motor battery (one cell) wire buzzer ammeter bell

2.



3. a) 0.4 A
   b) (i) The brightness decreases.
      (ii) The total current is divided equally between the two bulbs.
      (iii) It becomes difficult for the current to flow in the circuit.
      (iv) The cell is pushing the current through two bulbs.
4. a) i) B2
      ii) The circuit passing through B2 is complete.
   b) They will glow with equal brightness.
   c) a parallel circuit
   d) in homes, schools, offices, etc.
5. a) i) The reading on the ammeter also increases.
      ii) The wire wool becomes hotter.
   b) The wire wool should not be touched.
   c) It tries to stop the current from flowing through it.
   d) in an electric bulb, in fuses
6. a) i) 13 A
      ii) 3 A
   b) If the current flow becomes too large, the 13 A fuse will not break the circuit, and the food processor may burn out.
   c) i) 13 A
      ii) 950 / 230 = 4.13 A
      iii) 5 A

Project

Varying resistance

You will need a battery, 3 wires, a bulb, a soft pencil

Soak the pencil in water for one day. Strip the wood from the pencil until you have the bare lead. Use one piece of wire to connect the bulb and battery. Attach the other two wires to the bulb and battery so that their ends are free. Touch the pencil lead with the free ends, close together but not in contact. The bulb should light up. Move the wires apart so that there is more pencil lead in the circuit, increasing the resistance and making the bulb glow less brightly.

Multiple Choice Questions

1. Which of the following is not a conductor of electricity?
   A a copper wire   B an iron wire   C a nichrome wire   D a rubber band
2. Electric current is a stream of ____________ flowing through a conductor.
   A electrons   B molecules   C neutrons   D protons
3. Electric wires are usually made of
   A gold   B silver   C copper   D iron
4. A safety device which prevents the passage of too large a current is called
   A a fuse   B a switch   C an ammeter   D a motor

5. In a ________________ circuit the current is the same at all points

A parallel B series C ring main D switch

6. Which one of the following is most likely to be the hottest when the same amount of current is passed through them?

A a short, thin wire B a long, thin wire

C a short, thick wire D a long, thick wire

7. When an electrical current is passed through a nichrome wire, electrical energy is changed

A to heat energy B to light energy C to sound energy D to mechanical energy

8. The rating of fuse wires in household circuits is marked in

A amperes B volts C watts D ohms

9. In a three pin plug, the fuse should be placed on the

A earth wire B live wire C neutral wire D resistance wire

10. In a parallel circuit with two bulbs, if one bulb is removed what will happen to the other bulb?

A It will go out B It will glow dimmer

C It will glow brightly D It will stay at the same brightness

Answers

1. D	2. A	3. C	4. A	5. B
6. B	7. A	8. A	9. B	10. D

Chapter 7

The environment

Unit flow chart

Environment and ecosystems

↓

Living places of animals and plants

↓

Food relationships between plants, animals and the environment

Aims and learning objectives

- To develop knowledge of the environment and to show how animals and plants are adapted to a range of different environments
- To understand the feeding relationships between groups of organisms—food chains and food webs.
- To understand that changing one part of a food web can affect the other parts.

Background information

What is an environment? An environment can be defined as the conditions that act upon an animal or a plant. It includes all the physical conditions such as the amount of water, sunlight, temperature, and type of soil. These are called the abiotic factors. An environment also includes all the populations and communities of living things within the area. These contribute to the biotic factors.

There are various kinds of environments. Not all environments have the same temperature, rainfall, or sunlight. Biologists have divided environments into at least six types. These are large areas or regions called 'biomes'. A biome covers a large area or region of the Earth and contains many communities with many populations. The physical conditions such as the amount of rain, sunlight, temperature, and soil are similar throughout most of the biome's territory, making it possible for certain animals and plants to live there.

The major biomes on land are: Arctic-tundra area, coniferous-evergreen area, deciduous forest, grassland or savannah, desert and tropical rain forest. These environments do not go from one extreme to another. Some environments present on the edges of two distinct areas blend together. The animals and plants that live in boundary areas are adapted to both environments. For example, ponds and woods often appear together as do grasses and trees.

Unit introduction

Display a large chart with the word 'ecology' printed on it. Ask the students if they know what it means. Discuss what ecology means. 'Eco' comes from the Greek word *oikos* which means household, 'ology' means the study of something. Together it means the study of households in nature. Nature is our environment or our surroundings. Explain that ecology is the study of animals and plants in their natural surroundings and scientists who study ecology are called ecologists.

Teaching procedure

Ask the students: *where do lions and zebras live? Where do cockroaches live? Where do rabbits live? Why do you think they live in such places?*

Explain that animals have their own niche or territory in an environment. A niche is a special place to live that belongs to a population of animals. When there is a large variety of plants and animals living in a biome, such as in a jungle, there tends to be less competition for food. The great diversity allows each animal to have its own niche or territory to live in. Animals in a jungle rarely need to compete for the same food.

Adaptations

Show the students pictures of different animals and plants and discuss the special features each one has to protect itself from its enemies. Discuss the adaptive features of these organisms.

Adaptation means that a plant or an animal changes itself to fit into its environment so it can survive. What do the students think would happen if an animal or plant could not adapt to its environment? How do they think animals in zoos adapt to their environment?

Discuss the consequences if an animal or plant cannot change and adapt to its environment.

Ask the students: *why are there no more dinosaurs on Earth?*

Explain that they could not adapt to environmental changes: plant or animal species that do not adapt, die and might become extinct. The more versatile and flexible a plant or animal is with its growth, the more likely it is to survive.

Additional activity 1

Name the animal that has the following adaptation:

Animal	adaptation
	claws
	hoofs
	shell
	sharp teeth
	horns
	sharp beak
	spines
	scaly skin

Food chains and webs

Ask the students: *what did you eat today? Where do you think it came from?*

Explain that green plants are called producers. They produce their own food supply from the Sun's energy. Green plants provide food or energy for animals. Animals cannot produce their own food. All animals are dependent on plants even if they do not eat plants directly. If it were not for green plants, the herbivores or plant-eating animals would not grow up to be the food for the carnivores or meat-eating animals. Meat-eating animals consume other animals for food. Energy flows from the Sun (as light) to plants, then to plant-eating animals, and then to flesh-eating animals. This energy flow forms a food chain. Consumers often eat more than one kind of food, and so several food chains are connected to form a food web.

A food web is a complex system in which animals can be part of more than one food chain. The food chains are interlocked and interwoven like a spider web. If one small chain in the food web breaks, not a lot of damage is done. But the shape of the food web might change slightly. If a major part of the chain is broken, a lot of damage can occur. The whole food web could collapse.

Additional activity 2

Have the students cut out pictures of plants and animals from magazines that could make a possible food chain. Ask them what the first picture would have to be.

All animals need food. Most living things eventually become food for other animals or for bacteria and fungi when they rot or decompose.

Explain the terms carnivore, herbivore, and omnivore. Which category do most human beings belong to? Can the students name some other animals that are omnivores?

Additional activity 3

Ask the students to collect pictures of different kinds of animals. Have them sort the pictures into piles according to the food the animals eat—carnivores, herbivores, and omnivores.

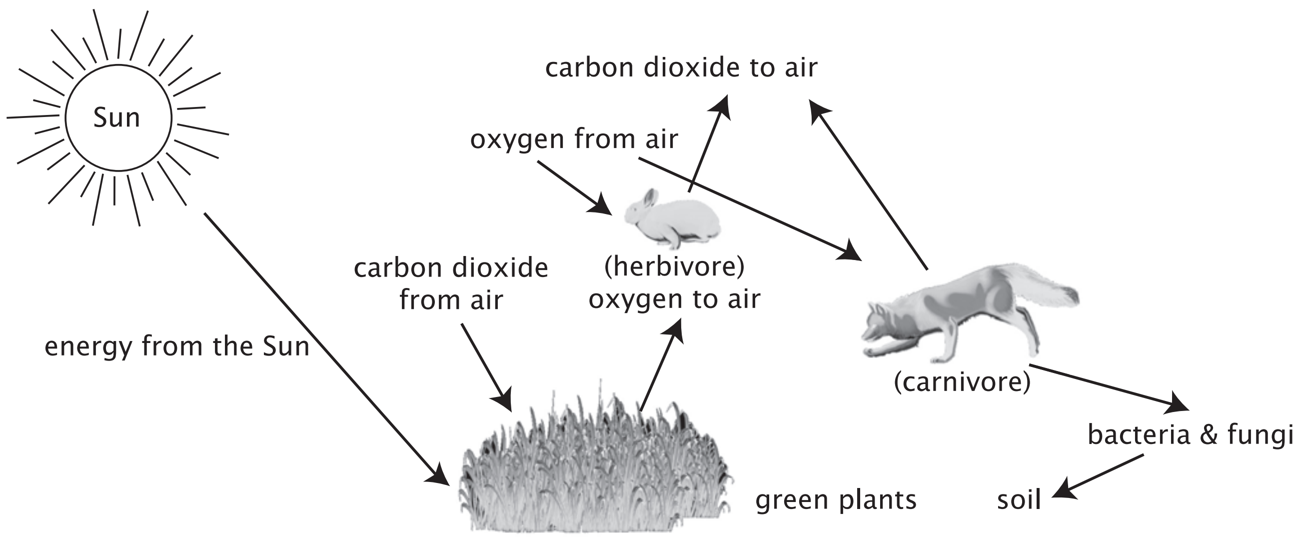
Help them to become aware that carnivores do not restrict themselves to eating just one kind of animal, for example, foxes and hawks can eat rabbits, squirrels, mice and birds.

The predator-prey relationship

The animal eaten by another animal is called its prey. The animal that does the eating is called a predator. Predators attack other animals and control the population of the prey. If foxes and hawks did not eat rabbits, there would be too many rabbits. The rabbits would destroy the balance of the biome by eating too many green plants. This would mean that other animals would not have enough to eat. Encourage the students to watch National Geographic programmes on television about food relationships between animals.

Food cycle

All life depends on energy. Green plants absorb light energy from the Sun and store it in the food materials that they produce. Other living things, such as non-green plants and animals, use these food materials to gain the energy that their bodies need. In animals most of this energy is utilized in the different activities of the body. The rest of it is given off as heat. Bacteria and fungi get their energy from dead plants and animals by using them as food materials.



Endangered species

Show the students pictures of oil-soaked beaches and animals, polluted waters and dead fish. Ask them to commet on what they see. Discuss the effects of pollution on the environment.

Poisons in food chains have led some animals to the verge of extinction. Such animals are called endangered species. Have the students find out what animals in their biome are endangered and how they are important to the food web. What measures can be taken to conserve them. Information about endangered species can be obtained from WWF or Green Peace Organization.

Additional activity 4

Ask students to use the Internet or reference books to answer the following questions.

What would happen to an ecosystem if:

- excess fertilizer ran off a field into a woodland?
- pesticide was accidentally sprayed onto the edge of a woodland?
- part of a woodland was burnt to the ground?

Answers

***The environment*: p 64**

1. Environment is a scientific term or word for surroundings.
2. The physical or the non-living parts of the environment are called the abiotic factors. For example, air, water, temperature, etc.

   The biotic factors are the living things in an environment. For example, plants, animals, human beings, etc.
3. a), b) c) Answers depend on the students.

4. a) Living things together with the abiotic parts of their environment form an ecosystem.
   b) A woodland ecosystem, where animals depend for food and shelter on the plants. The soil provides water and minerals for plants to grow.
5. a) The study of ecosystems is called ecology.
   b) Scientists who study ecosystems are called ecologists.

***Where things live (1):* p 65**

1. A habitat is a place where plants and animals live most of the time because it suits them best.
2. a) Adaptation is a special feature that a living thing develops to deal with the conditions in which it lives.
   b) Animals and plants are usually found in only one kind of habitat because they need each other for survival.
3. Primroses growing on the ground complete their life cycle early in the year before leaves appear on the trees and block all the sunlight.
4. Woodland birds feed on the insects which live on leaves and bark.

***Where things live (2):* p 66**

1. a) Mussels feed by filtering microscopic plants and animals from the sea water.
   b) Sea birds have strong beaks for cracking open the shells of crabs and mussels.
2. Sea weeds have to cope with the constant movement of the waves and also need to float near the surface of the sea to get light.
3. a) i) Camels have big feet to stop them sinking into the soft desert sand.
   ii) They have a hump to store fat to cope with situation when there is no food available.
   b) They store a lot of water in their body.
4. The leaves of desert plants are reduced to spines. This reduces surface area so less water is lost through evaporation. Water is stored in the fleshy green stem. The stem has a waxy surface to keep the water inside.
5. a) Animals that sleep during the day and only come out at night to hunt and feed are called nocturnal.
   b) Nocturnal animals avoid the high temperatures of the day by burying themselves in the sand during the day, and their dark colour prevents them from being caught by predators at night.
6. a) River plants have long stems so that they can hold on to the river bed. This is necessary as these plants are constantly pulled by the flow of the river.
   b) Fish have gills through which they can breathe in the water. They also have fins which help them to swim.

***Prey and predators*: p 67**

1. A predator-prey relationship between two species is that because one animal eats another, their populations affect each other. The number of predators affects the size of the population of its prey.
2. a) The number of snowshoe hares is reduced.
   b) When the young and healthy are eaten, the prey population begins to fall.
   c) There would be an overpopulation of snowshoe hares. They would start competing for food and ultimately they would start dying of scarcity of food and their numbers would gradually be reduced.
3. There is a predator-prey relationship between the two. There are regular ten year cycles in their population numbers.

***Food chains*: p 68**

1. a) Any living thing that makes its own food is called a producer. E.g. green plants are producers.
   b) Animals cannot make their own food. They obtain their food by eating plants or other animals. Therefore they are called consumers. E.g. Rabbits eat grass; lions eat deer and other animals, etc.
2. Most humans are omnivores as we eat both plants and animals.
3. All living things depend on sunlight for their food. Green plants use the Sun's energy to make their food. Herbivores obtain this energy when they eat plants. When herbivores are eaten by other animals, this energy is transferred from them to the flesh-eating carnivores. In this way energy from the Sun is transferred to all living things.

4. a) pond weed → tadpole → water beetle
   b) three
5. a) grass → cow → man
   b) grain → chicken → man

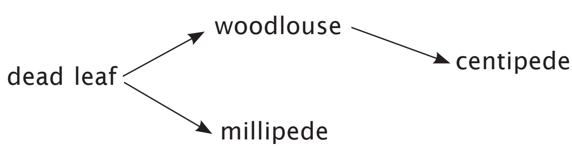
***Food webs*: p 69**

1. a) i) rose → bee
      ii) grain → dormouse → owl
      iii) lettuce → slug → thrush → sparrow hawk
   b) slug, rabbit, chaffinch, dormouse, greenfly
   c) Sparrow hawk has the most varied diet as it eats different birds and rabbits.
   d) i) The sparrow hawk eats rabbits which eat the farmer's lettuce.
      ii) Slugs spoil a gardener's lettuce plantation. Thrushes eat slugs thereby keeping a control on their population. By eating the thrush, the sparrowhawk allows more slugs to feed on the lettuce.
2. a) It will reduce the number of blue tits and in turn the number of sparrow hawks will be affected.
   b) Farmers could grow varieties that are resistant to green fly.

***Investigating food webs*: p 70**

1. a) leaf
   b) woodlouse or millipede
   c) centipede
   d) woodlouse
   e) centipede
2. dead leaf → woodlouse → centipede.

   In dish 1 the leaf was partly eaten and the woodlouse was alive. In dish 4 the woodlouse was partly eaten and the centipede was alive.
3.



4. a) They covered the dishes to prevent other insects visiting the dishes.
   b) The holes were provided for air to pass through.
   c) The insects prefer cool dark places to live in.

***Change part of a food web and…*: p 70**

1. Rabbits destroy all sorts if young plants by eating the young shoots. They also eat grass which could be used for grazing sheep and cattle.
2. a) Buzzards that fed mainly on rabbits became fewer in number.
   b) Plant-eating animals like deer increased in numbers because there was more to eat.
   c) Since the number of rabbits reduced, meat-eating animals had to look for other things to eat. For this reason smaller animals like mice were preyed upon and their populations began to decrease.
3. In Poland, otters were killed to protect fish stocks. In fact fish stocks fell. This is because otters often feed on diseased fish which are easy to catch. By killing the otters, the number of diseased fish increased leading to a fall in the fish stock.

   The DDT which was sprayed on to apple trees actually killed the small animals that lived in the barks of these trees and fed on the red spider mites. With the absence of a predator, the number of red spider mites increased.

   DDT that is sprayed on to fields to kill insects dissolves in rain water and is carried to rivers where the fish absorb it. This affects the fish-eating birds such as herons and grebes because DDT stays in the body tissues of any animal that consumes it.

***Test yourself*: p 71–72**

1. a) i) Green plants can make their food during the day time. When the Sun sets the process of photosynthesis stops and the plant makes use of the stored food.

   ii) In summer, trees make food by photosynthesis and store it in their stems. In winter the trees lose their leaves and can survive by using the food stored inside their stems.

   b) i) Examples of competition

   Two stags fighting for control over a herd of deer.

   Trees in a forest growing upwards to get light.

   A seagull chasing off other birds from food in a garden.

   Examples of predation

   Farm cats killing mice, stopping them eating cereal crops.

   Lions hunting a zebra for food

   A spider catching a fly in its web.

   ii) zebra, fly

2.

	habitat	animal
a)	damp grass near a pond	frog
b)	farmland growing crops	owl
c)	damp ground with lots of soft-leaved plants	snail
d)	a rose garden	bee
e)	fast running water	fish
f)	an apple orchard	green fly

3. a) i) An eagle has sharp claws and beak.

   ii) The leaves of a cactus are reduced to spines, and the stem is covered with a waxy coating to reduce water loss.

   iii) Its mouth is shaped like a long tube.

   iv) It has sharp, pointed canine teeth and strong jaws.

   b) i) Not urinating and staying in their holes during the day helps gerbils to avoid water loss from their body.

   ii) Feeding at night helps gerbils to avoid being seen by their predators.

4 a)

plant that makes its own food	producer
animal that eats plants	herbivore
animal that eats other animals	carnivore
animal that feeds on both plants and animals	omnivore

   b) There are four links.

   The arrows indicate flow of energy along the food chain.

   Energy comes from the Sun.

   Energy enters the food chain from sunlight by photosynthesis.

5. a) elodea ⟶ snail ⟶ water beetle

   milfoil ⟶ tadpole ⟶ water beetle

   b) i) duckweed

   ii) snail

   iii) stickleback

   c) The number of water beetles will be reduced greatly.

   d) Bacteria and fungi decompose the dead remains of the organisms living in this pond, thereby helping to recycle the elements.

Workbook 1 Chapter 7

1. a) The environment of an organism consists of all the living and non-living things that occur naturally in that area, with which the organism interacts.

   b) The living organisms in an environment are called the biotic factors.

c) The physical features (non-living factors) of an environment such as the air, water, landscape, soil, etc. are called the abiotic factors.

d) fox, deer, birds, squirrel

e) land, water, air

2.

Animal	Adaptation
eagle	accurate vision to see prey from a long way off
whale	thick layer of fat beneath the skin to keep it warm
cheetah	long legs and stretched body to catch prey on grassland
bat	'sees' by sending out sound waves (sonar) to hunt insects at night
camel	stores food to help it live for a long time without eating or drinking
polar bear	thick fur to keep it warm

3. a) Answers depend on students.

b) Answers depend on students.

c)

predator	prey
spider	butterfly
lion	deer
fox	rabbit
owl	mouse
seal	fish
lady bird	green fly

4. a)

slug	herbivore	it eats lettuce (plant)
thrush	carnivore	it eats slugs (animal)
cat	consumer	it eats thrush (animal)

b) lettuce

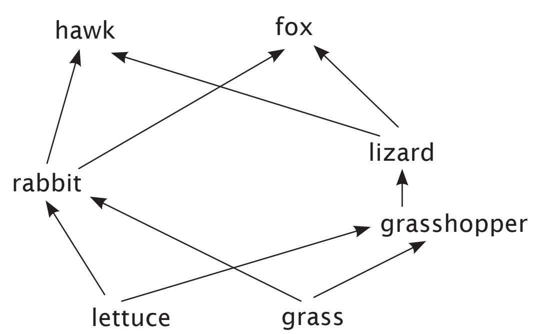
c) a green plant

d) the flow of energy down a food chain

5. a)

b) i) The number of lizards will reduce because with the grasshoppers dead, the lizards will not have any food. They will die of starvation.

ii) Grass and lettuce plants will grow and spread more as the numbers of one of their consumers have reduced.



iii) With the grasshoppers dead, the rabbits would be able to get plenty of grass and lettuce to eat. Their number would increase, which means foxes would have more rabbits to prey on. Thereby the population of foxes will also increase.

6. a) for the last 60 years

b) They have been living together quite happily in many areas of woodland.

c) The red squirrels are unable to digest acorns.

d) The squirrels are competing for food.

e) More coniferous woodland, especially pine trees, should be grown so that red squirrels can have their staple diet.

Problems to solve

1. Why must there be green plants in every community of living things?
2. How do humans disturb the balance of living things?
3. There were many deer in a forest. Hunters killed the lions, wolves and other predators of the deer. What changes do you think took place as a result?

Answers to problems

1. Green plants are the producers in every community of living things. They provide the food for all the members of the community either directly or indirectly.
2. by killing animals and by destroying their habitats
3. By killing the predators of the deer, the number of deer increased and there became a shortage of food for them. The deer began to die due to starvation.

Project

- Make a list of all the animals that you think are likely to live in your local ecosystem. Find out what each animal eats. Work out food chains which start with plants. Try to link the food chains into a food web. Draw the food web on a large poster. Use the poster to explain to others what happens to the energy from sunlight falling on your ecosystem.
- Find out what plants and animals provide our most important foods. Then make a report to your class. Collect pictures of these plants and animals and prepare a chart to illustrate your report.
- Use reference books or the Internet to read about the following topics: photosynthesis, decay, nitrogen fixing bacteria, earthworms, parasitism, ecology, plant diseases, weeds, carnivores, herbivores and omnivorous animals, social animals. Discuss your gathered information with your teacher and fellow students.

Multiple Choice Questions

1. The study of relationships between animals and plants and their physical environment is called
   A geography B ecology C physiology D geology
2. Any living plant or animal is called an
   A organ B organism C organ system D organelle
3. The place where a particular species of plant or an animal usually lives is called its
   A home B cage C habitat D community
4. A characteristic that makes an organism particularly well-suited for an environment is called
   A variety B adaptation C habit D characteristic
5. Seaweeds have sticky feet which help them to
   A catch fish B get light
   C hold them on to rocks D float near the surface of the sea
6. Green plants which can make their own food are called
   A omnivores B herbivores C producers D carnivores
7. Animals that feed on both plants and animals are called
   A producers B omnivores C herbivores D carnivores
8. Which organism is herbivore in this food chain?
   lettuce ⟶ slug ⟶ thrush ⟶ sparrow hawk
   A lettuce B slug C thrush D sparrow hawk
9. Pesticides are chemicals that kill ____________ when they are sprayed on plants
   A plants B animals C insects D human beings
10. A food web shows the feeding relationships between
    A animals and plants B human beings and plants
    C human beings and animals D insects and plants

Answers

1. B	2. B	3. C	4. B	5. C
6. C	7. B	8. B	9. C	10. A

Chapter 8

Particles

Unit flow chart

Matter can exist in more than one state: solid, liquid, or gas.

↓

The state of a substance depends on how the particles in it are arranged.

↓

Evidence for the existence and behaviour of particles.

↓

Many phenomena can be explained by the particle theory.

Aims and learning objectives

- To organize and classify matter into solids, liquids and gases
- To consider the particle theory as a possible way of explaining the nature of matter with particular reference to a number of experimental observations.
- To develop the idea that not only are particles very small and numerous, but that they are also able to move.
- To understand that the states of matter depend on the arrangement of the particles as well as the way they move.
- To associate phenomena such as expansion and contraction of materials, and change of pressure in gases with variations in energy levels of the molecules.

Background information

The world is made up of matter. The Earth's crust is solid, the sea is liquid and the air is a mixture of gases. Solids are hard; they do not change their shape. Liquids can flow easily. If you pour a liquid into a container it flows to fill up the shape of the container. The surface of the liquid is always level. Gases spread to fill any space. Substances can be solid, liquid or gaseous at certain temperatures. If they are heated or cooled, they change their state.

For example: liquid water changes into solid ice if you pour it into a container and leave it in the freezer for some time. If you heat water until it boils, it changes into steam. In other words, the liquid water becomes a gas.

The state of a substance depends on the movement of its particles. The particles of a solid are very close together and attract each other strongly. They do not move about freely, therefore, a solid has a definite shape and volume. The particles of a liquid are further apart. Because they can move about freely, a liquid has no shape of its own. But the particles still attract each other strongly enough so that a liquid has a definite volume. The particles of a gas are much further apart than those of a solid or a liquid, such that the attraction between the particles is almost negligible. Because of this free movement of the particles, a gas has no definite volume and no shape of its own.

Unit Introduction

The main purpose of this unit is to interest students and help them develop an inquiring and observing approach towards the materials around them. Use the pictures and the text to arouse interest and encourage the students to ask questions.

A preliminary discussion should be held on the diversity and complexity of different materials referring to those pupils are familiar with, such as items that they see around them at home, in the school laboratory, or when they go out.

Discuss the aspects of materials that are familiar to everyone—solids, liquids, and gases and then the less familiar ones such as the ways in which solids, liquids, and gases are alike and how they differ.

Teaching procedure

Explain that scientists call all materials 'matter'. Matter must be studied very closely as scientists must know what materials are made of, how they are made and how they can be changed. Materials exist in three different states: solid, liquid, and gas. Each state has certain characteristics. The particle model helps to explain the existence, nature and behaviour of matter.

The lesson can start by discussing with students how they think wood, water, and air are different and how they are alike. With guidance from the teacher, the students should work out the elementary classification of materials into solids, liquids, and gases and mention some of the characteristics of each state. After the students have given their ideas, have them read the text on page 74 to confirm or correct their ideas. Stress the meaning of matter as it is presented in the text.

Experiment: To show that air takes up space.

Materials: a large glass bowl filled with water, drinking glass, cork.

Method: invert the empty glass into the bowl of water. Does the water rise in the empty glass? Make sure that the students see that water does not rise to its own level inside the inverted closed vessel. To clarify further, place a glass tube in the bowl and observe. Comparison of the results in the two cases will then be sure to illustrate the effect of the air confined in the closed container.

Clarify that by using the particle model, scientists can explain the characteristics and behaviour of matter. All matter is made up of tiny particles which are in constant motion. It also explains the difference between the states of matter (see description earlier). Introduce the terms 'atoms and molecules' and their arrangement as shown in the diagrams of the scientific models on page 75 of the text book.

After the particle model has been discussed and explained have them read the text on page 75.

Demonstrate the arrangement of particles in solids, liquids, and gases. Have a group of students stand very close to each other in regular lines. Explain that they are close together; they are linked to each other. They are arranged in a regular pattern. This formation represents a solid.

Similarly, have the students stand slightly away from each other. This formation represents a liquid. They are close together, but they are not bonded. Some students can move freely within a certain limit due to some spaces between them.

Now have the students stand further apart to represent gaseous state. Explain that they are not linked and can move freely. There are wider spaces between them than those in a liquid.

Try to perform the balloon and diffusion experiment given on page 76 in class. Elicit from the students that they have understood the concept.

***Experiment**:* To show gas particles can move.

Materials: an empty gas jar, a gas jar filled with brown gas [nitrogen(IV)oxide]

Method: Remove the cover glasses and invert the brown gas jar over the empty jar. Observe carefully. What happens? Look at them again after 10 minutes. What do you see? In what direction do the particles move?

Once the concept of the particulate nature of matter has been discussed and understood by the students, move on to page 77. Try to make the necessary arrangements and carry out the smoke cell experiment in the laboratory. Explain to the students that the smoke particles are moving because they are being pushed by the moving molecules in the air.

Demonstrate the rice and pea experiment practically in class.

Expansion and contraction with changes in temperature are common principles which are applied in different walks of life. The experiments on page 78 should be done at the beginning of the lesson so that the terms expansion and contraction are clear to the students.

Perform the ball and ring experiment to show that solids expand on heating.

Ask the students if they have seen or heard about anything that might have happened because a material contracted or expanded. Read page 78 and have them check to see whether their ideas are correct.

Study the pictures on page 78. Discuss the problems faced by engineers in designing bridges, roads, and buildings. Evidently sufficient allowance has to be made for expansion or contraction to avoid severe damage to these structures.

Experiment: To show the presence of pressure in gases.

Method: Connect a plastic bottle to a vacuum pump. Switch on the pump. Ask the students what happened. What is the function of the vacuum pump? Later explain that the pump removes the air inside the bottle and the bottle collapses due to the air pressure outside the bottle.

Ask one of the students to blow up a balloon. Tie its mouth with string. Ask another student to press the balloon. What happens? Explain that gases can be compressed.

Bring an inflated balloon close to a lighted candle. What happens? The air inside expands due to heat and the balloon bursts.

Show the students a mercury barometer. Explain how it is used to measure air pressure.

Answers

***Particles:* p 74**

1. The three physical states of matter are solid, liquid, and gas.
2. a) A solid has a well-defined shape.
   b) A gas does not have a well-defined shape.
   c) A liquid has a specific volume.
   d) A solid has a definite volume.
3. Natural gas has a specific smell which spreads through the air.
4. Water exists in all three states: solid (ice), liquid (water), steam (gas).

***The particle model of solids, liquids and gases:* p 75**

1. a) The particle model helps to explain the behaviour of solids, liquids, and gases.
   b) The particle model is based on three assumptions:
      - all matter is made up of tiny particles which are continually moving
      - when the particles are close together they are attracted to each other
      - heating a material affects the movements of the particles

2. a) The smallest particle of which matter is made is called an atom.
   b) Groups of atoms joined together are called molecules.
3. a) In solids, strong forces of attraction hold the atoms or molecules close together in rows. This is why solids cannot flow.
   b) In gases, the atoms and molecules are far apart. Since there are large distances between the particles, gases can be compressed easily.
4. a) The particles in a solid vibrate but they are unable to break free. This is why solids have a fixed shape and volume.
   b) The particles in a gas are far apart and move so fast that they do not really attract each other, so gases spread quickly.

Evidence for the particle model (1): **p 76**

1. The 'skin' of the balloon has millions of tiny holes in it. The air molecules are small enough to pass through these holes and so the balloon deflates slowly.
2. When we stick a pin in an inflated balloon, it deflates quickly because we have enlarged the hole through which the gas particles escape.
3. A slowly deflating balloon proves the existence of particles.
4. a) The spreading of one substance through another is called 'diffusion'.
   b) Fill a beaker with water. Add a drop of blue ink carefully to its centre. The ink particles will gradually diffuse outwards to mix completely with the water molecules and the water will become blue.
5. This is because some of the perfume molecules have escaped, collided with the air molecules and spread by diffusion.
6. Diffusion does not happen in solids because the particles are held together by strong forces of attraction. Although the particles vibrate, they are unable to break free.

Evidence for the particle model (2): **p 77**

1. Smoke particles move about in air because they are bombarded by moving molecules in the air.
2. The random motion of particles in matter is called Brownian motion. It is named after the Scottish scientist Robert Brown, who, in 1872, noticed the random motion of pollen grains when placed in water.
3. Brownian motion supports the particle model as it explains that molecules, in any state, are always in motion. Their movement is random or irregular and takes place in all directions.
4. The final volume of the mixture of peas and rice after shaking is 80 cubic centimetres. The total volume is less than expected because if we look closely, there are spaces between the peas and rice. When they are mixed together, some rice fills the spaces between the peas and vice versa.
5. When water and alcohol are mixed, their particles fill up the spaces between each other. Therefore, the total volume is less than expected. This shows that there are spaces between the particles.
6. Tea, being a liquid, has more space between its particles as compared to sugar which is a crystalline solid. When sugar is added to tea, its particles fill up the spaces between the tea particles and there is no apparent change in the volume of the tea.

Expansion and contraction: **p 78**

1. a) Expand means to increase in size or volume.
   b) Contract means to decrease in size or volume.
2. a) When a metal bar is heated, its molecules gain energy and begin to move faster. They bump into each other more often and with greater force. This makes them move further apart and the space between them increases, thus causing the bar to expand.
   b) When water is cooled its atoms and molecules lose energy. They move closer together resulting in a contraction of the water.
3. Expansion causes serious problems for engineers because it produces very large forces.

   One such problem is that of expansion at the end of bridges in hot weather which causes the bridges to warp. To overcome this problem, engineers leave gaps at the ends of bridges to allow for expansion in hot weather.
4. The electric cables are left slack in summer to allow for their contraction in winters.
5. Heating gives atoms and molecules more energy. This causes them to move faster and bump into each other more often and with greater force. As a result, they move further apart. Since the particles are much further apart in gases as compared to solids, expansion is more in gases than in solids.

***Pressure in gases:* p 79**

1. Gases are squashy and can easily be compressed. If a sealed container can resist the expansion when a gas is heated, gas pressure will be produced inside it.
2. Millions of air molecules inside the balloon move rapidly in all directions, bouncing off each other and the walls of the balloon. Each time a molecule hits the wall of the balloon, it gives the wall a tiny push. Millions of tiny pushes add up to one big push, leading to increasing air pressure that inflates the balloon.
3. Air pressure is highest inside the balloon. That is why it remains inflated: otherwise it would become squashed.
4. Passenger aircraft have pressurized cabins to maintain the same air pressure throughout the flight. Air pressure outside the aircraft may vary depending on the atmospheric conditions.
5. A barometer is an instrument which is used to measure air pressure. Air pressure varies depending on weather conditions. A fall in pressure may mean that it might rain. So it helps weather forecasters to predict the weather.

***Test yourself:* p 80–81**

1. a) gas b) solid c) solid d) liquid e) gas f) liquid g) gas
2. In a gas, particles are ***far apart*** and move very ***quickly***. They frequently change ***position***, moving in ***straight*** lines and ***bouncing*** off each other and the walls of the ***container*** they may be in. Gases have no ***shape*** and they can be easily ***compressed*** because the particles are not packed closely together. Gases usually have a low ***density*** because there are few particles in a small ***space.***
3. Hundreds of tiny bright specks can be seen jerking about in all directions.
   a) It is called Brownian motion.
   b) The particle model explains that particles are always moving.
   c) The particles would move much faster due to the warm air in the room.
4. a) Particles of the two gases have moved from a region of higher concentration to a region of lower concentration.
   b) diffusion
   c) Ammonia gas diffuses at a faster rate than hydrogen chloride gas.
   d) The formation of the ammonium chloride ring would be much slower because low temperature decreases the rate of diffusion
5. a) Heating gives atoms and molecules more energy, which makes the particles move at a much faster rate. They bump into each other more often and with greater force, thereby pushing each other further apart and causing an increase in size or volume of the material.
   b) Aluminium expands three times as much as concrete.
   c) i) It will bend with the steel strip inwards as brass expands more than steel when heated.
      ii) It will straighten out.
6. a) Air rushes into the nozzle because air pressure is lowered in the bag due to the electric fan.
   b) It has tiny holes through which air particles escape, leaving the dust particles behind.
   c) A hose made of thin rubber tubing would bend and collapse and would restrict the flow of air through the vacuum cleaner.

Workbook 1, Chapter 8

1. a) i) bricks, timber, tiles
      ii) They are solids and they have a specific shape and volume.
   b) i) Paint and polish
      ii) They are liquid in consistency. They are stored in screw-top containers as they expand on heating and might pop out if not opened gently.
   c) i) Propane, butane and compressed air.
      ii) They are stored under high pressure and must be tightly sealed otherwise they might explode violently.
2. a) liquid
   b) The particles are held close together but not tightly. They are not arranged in any particular pattern.
   c) The particles have enough energy to move about.

3. a) melting b) boiling c) cooling
   d) freezing e) melting and boiling

4. a) The particles of water fill the spaces between the alcohol particles and this makes the volume smaller than expected.
   b) There are tiny holes in the skin of the balloon through which the air particles escape.
   c) The molecules of the gas collide with the moving air molecules and spread through the room by diffusion.
   d) The air pressure inside the tyre increases as more air particles will be pumped into it and it will get harder.

5. a) i) There will be an even light brown colour in both jars.
      ii) No, the result should be the same. The gases would mix evenly irrespective of their position.
   b) Since particles are always in motion, some of the manure particles collide with the air particles and the smell of the manure will spread by diffusion.
   c) The smell of food cooking in the kitchen spreads throughout the house.

6. a) It would expand and come off easily.
   b) The particles of the metal screw top will gain heat energy and will start moving faster, thus bumping into each other and pushing each other away and causing it to expand.
   c) Plastic being a bad conductor of heat does not expand and so plastic tops keep the jars sealed for a longer period.

Problems to solve

1. If a spoonful of sugar is added to a cup of cocoa, the cocoa soon becomes sweet. Explain.
2. Even after a glass is filled to the brim with water, you can add a considerable amount of salt without making the water spill over. How is this possible?
3. The hole in the bottom of a flower pot was sealed with wax. Then the pot was filled with water. Soon the outside of the pot became moist. How did the water get through the pot?
4. If a burner on a gas stove is turned on and left unlit, you can quickly smell the gas in all parts of the room. Why?
5. Scientists are quite sure that the particle model holds true. Why do you suppose they think so?

Solutions to problems

1. Sugar particles take up the spaces between the cocoa particles and the whole mixture becomes sweet.
2. Salt particles fill the spaces between the water molecules and so there is no apparent increase in volume.
3. The pot has tiny holes in it through which the water molecules escape.
4. The gas molecules spread across the room by colliding with the moving air molecules.
5. The particle model helps to explain the existence, nature, and behavior of particles of matter.

Project

Fill a beaker almost to the top with crushed ice. Quickly place a thermometer in the ice and record its temperature. Heat the beaker over a Bunsen burner and record the temperature of the ice/water every 30 seconds. Continue to do this till the water has been boiling for about 3 minutes. Plot the results as a graph. Explain the temperature changes at each stage.

Multiple Choice Questions

1. Which of the following is liquid at room temperature?
   A ice B water C steam D oxygen
2. When we pour a liquid from a beaker into a flask, the liquid
   A has a larger volume B keeps the same volume
   C fills up the flask D keeps the same shape
3. Which state of matter always takes up the whole space of the container?

A solid only B liquid only C gas only D liquid and gas only

4. A balloon filled with gas gets smaller after a few hours. This is because
   - A the gas has no fixed shape
   - B the gas particles become smaller
   - C the gas is being compressed
   - D the gas particles are smaller than the holes on the wall of the balloon
5. Which of the following statements about diffusion is not true?
   - A diffusion is not affected by gravity
   - B diffusion takes place in all directions
   - C particles move from a higher concentration area to a lower concentration area
   - D diffusion occurs in gases only
6. The spaces between the particles in a gas are
   - A the same as those in a solid
   - B the same as those in a liquid
   - C bigger than those in a solid or liquid
   - D smaller than those in a liquid or a solid
7. We cannot compress a solid easily because
   - A a solid has many particles
   - B the particles in a solid are very big
   - C the particles in a solid are closely packed
   - D the particles in a solid have the same shape
8. Electric cables are left slack so that
   - A they can expand on hot days
   - B they can contract safely in cold weather
   - C less wire can be used
   - D the electric current can pass through faster
9. The collapsing can experiment is used to demonstrate that
   - A the air pressure inside and outside the can is the same
   - B the air pressure inside the can is greater than the outside pressure
   - C the outside air pressure is greater than the inside pressure
   - D pressure has nothing to do with the collapsing of the can
10. Solids, liquids, and gases expand when heated because
   - A the molecules lose energy and are pushed apart
   - B the molecules absorb energy and are pushed apart
   - C the molecules lose energy and are brought closer together
   - D the molecules absorb energy and are brought closer together

Answers

1. B	2. B	3. C	4. D	5. D
6. C	7. C	8. B	9. C	10. B

Chapter 9

Forces and their effects

Unit flow chart

We experience forces constantly in our daily lives

↓

Forces can be measured

↓

Forces occur in pairs

↓

What is weight?

↓

What is friction?

Background information

We experience different kinds of forces in the simple every day activities that we do. We usually think of force, which is actually exerted by inanimate objects, as involving the use of muscles.

A force usually causes or prevents movement. Forces of different sizes can be compared. This acquired knowledge can then be used to design, build, and learn to use a force meter with the help of a spring. Force can be measured with a spring balance and its unit is the Newton.

Unit introduction

This unit should extend students' knowledge of forces so that they can use the term in a more general context. Students should realize that forces do not depend on muscle only, but can be exerted by other agencies as well. They should understand that forces are concerned with pushing, pulling, turning, and compressing. Do not spend too much time explaining the forces involved in each activity in detail, as this is only meant to be an introduction to forces. Explain that forces can change the shape of a moving body, and the speed and direction of the motion of a body. Give examples of each case. Forces can also act at a distance, such as magnetic force and the gravitational pull on objects.

Teaching procedure

Ask the students some questions which involve the terms force, movement and energy. Questions about common activities such as running, jumping, cycling, kicking a ball, digging a garden, hammering a nail, chopping wood, etc. would prove very helpful. Then ask the students to explain the terms. The responses may be varied and confused. You can then say that it is worth looking at forces more closely.

Stretch a rubber band and ask the students what has happened. Squeeze a lump of plasticine and get responses from students. Explain to them that you are exerting a force in both cases, but the objects react differently. Discuss, using examples, some of the things forces can do.

- forces cannot be seen, but we can feel or detect their effects
- forces can act on objects when they are in contact with these objects
- forces can act at a distance
- forces can make stationary objects move
- forces can make moving objects travel faster
- a force can alter the direction of a moving object
- a force can change the shape of an object

Measuring forces

All forces are measured in Newtons. It requires force to make a mass or body accelerate. The greater the mass, the greater is the acceleration. Therefore, more force is needed. Small forces can be measured with a spring balance. The greater the force, the more the spring is stretched and the higher the reading on the scale.

Some typical force values are:

force to switch on a light	5N
force to open a cola bottle	20 N
force on a tennis ball	2000 N
force from a jet engine	200,000 N
force of a motorcycle engine	3000 N

1 N force is needed to accelerate a mass of 1 kg at 1 m/s^2

In all cases force is equal to mass x acceleration or

F = ma or a = F/m or m = F/a

Additional activity 1:

To calculate the force exerted by a body.

Find the force on the following:

mass (kg)	acceleration (m/s^2)	force (N)
2	2	________
4	2	________
8	5	________

Which masses have the same acceleration?

mass (kg)	force (N)	acceleration (m/s^2)
4	8	________
2	6	________
3	3	________
1	2	________

Balanced forces

Most objects have several forces acting upon them. For example, when we walk, a moving force helps us to travel in a particular direction, while the pull of gravity ensures that we keep walking on the ground. Forces can also act on a body in opposite directions, for example, when a car is speeding down the road, the force of friction is acting against its tyres.

When two forces of equal size but in opposite directions act upon an object, the forces will balance each other. As a result, the object does not move in any direction and remains stationary.

Additional activity 2

The following activity can be performed to observe upthrust and apparent loss in weight in an object.

Pour some water in a beaker and mark its level. Using a force meter, hang a medium sized stone in the beaker of water. Notice that the reading on the force meter is smaller than the actual weight of the stone. The object has appeared to have lost weight. Also notice that the level of water in the beaker has risen a little.

Ask the students: *why do you think the level of the water in the beaker has risen? Is there an increase in volume or a decrease in weight?*

Explain that the object has not really lost weight, but it was the water pushing up on it that made it appear as if it had. The Greek philosopher Archimedes noticed this about 2000 years ago. He suggested that the object had not really lost weight, but it was the water pushing up on it that made it seem so. He discovered that the amount of upward push or upthrust was equal to the weight of the water that had been displaced by the object.

An example of upthrust can be observed in a boat floating in water. It is upthrust that keeps it afloat. It balances the weight of the boat.

Density

Fill two beakers with water and lead shot, respectively, to the same volume. Ask the students which of the beakers will be heavier. Explain that the beaker containing lead shot is heavier than that containing water because lead is denser than water. Scientists use density to describe how dense a material is. Density is the mass per unit volume.

Density = mass / volume

Stretching in materials

Explain to the students that forces can cause materials to stretch. When the forces are removed, the material may spring back to its original length. This is called elasticity. Ask the students to bend a ruler a little and then release it. What happens? The ruler goes back to its original shape. Similarly ask students to press a lump of plasticine and then release it. They will notice that the plasticine does not return to its original shape.

If we stretch a rubber band it will increase in length, but it will return to its original size when we release it. Rubber is a very elastic material. Metal spring will also stretch and spring back into shape if the force is small. But if the forces are too large, the wire will go beyond its elastic limit and it will be permanently stretched. Many materials obey a simple law when compressed or stretched.

Take the case of the spring on page 84 of the student's book. The spring is stretched in stages by hanging different masses from one end. The stretching force is called load. Each time the load is changed the extension of the spring is measured.

Inform the students that Robert Hooke, an English scientist, showed that when a spring is fixed at one end and force is applied at the other, the extension in the spring is proportional to the applied force, provided the force is not large enough to stretch the spring permanently.

Additional activity 3

Ask the students to plot a graph of extension against load using the reading shown in the chart below.

Load in Newtons	0	1	2	3	4	5
Extension in mm.	0	10	20	30	40	60

What does the graph indicate about the relation between load and extension?

What happens when a load of 5 Newtons is added?

Hooke's law states:

'Materials extend evenly when stretched by forces, provided the forces do not get too large'.

How does the graph explain Hooke's law?

Additional activity 4

Pull a spring made of thin wire. Let it go. What happens?

Pull the spring again with greater force this time. Let it go. What happens? Why?

Explain the elastic limit of the spring. If this point is passed, the spring does not go back to its original length, even when the load is removed. It ends up longer than before.

Weight

Ask the students: *what effect does gravity have on an object?*

Demonstrate this by hanging a weight from the end of a spring balance. Explain to the students that this way we can measure the downward pull of the Earth. This is called Gravitational force.

All masses attract each other. The greater the masses, the stronger is the pull. The closer the masses, the stronger is the pull.

The pull between two small masses such as two people sitting together is far too weak to measure (about one-millionth of a Newton), but the Earth has such a huge mass that the gravitational pull is strong enough to hold most things firmly on the ground.

Weight is another name for the gravitational force on the Earth. As weight is a force, it is measured in Newtons. On Earth each kilogram weighs 10 N.

People often use the word weight when they really mean mass. If you weigh 50 kg on the weighing scales, you actually have a mass of 50 kg and a weight of 500 N i.e. the gravitational field strength is 10 N/kg.

Try using the equation F = ma to find the mass of a body of 50 kg under the influence of gravity. Here a = g (gravitational field strength) = 10 N/kg.

F = mg

F = 50 x 10 = 500 N/kg

Ask students: *how can you lose weight quickly?*

Explain to the students that since weight is actually the gravitational pull on a body, it differs when the pull of gravity varies. On the moon, the gravitational pull is one-sixth of that of Earth. It reduces further if we go deep into space, and far away from all planets.

place	mass	weight
on Earth	50 kg	500 N
on the moon	50 kg	80 N
on Jupiter	50 kg	2700 N
deep in space	50 kg	zero

Friction

Ask students if they have seen hawkers moving their goods in carts. Hawkers do not like to drag heavy objects along the ground. Can anyone say why?

Explain that friction is the force that tries to stop materials sliding across each other. There is friction between our hands when we rub them together, and friction between our shoes and the ground for gripping purposes. Friction is partly due to the tiny bumps on the surfaces and partly due to the atoms of the two materials which tend to stick to each other. Liquids and gases are called fluids. They can also cause friction.

When a car is travelling fast on a motorway, air resistance is by far the largest frictional force pushing against it. Car bodies are designed so that the air flow is as smooth as possible. Less air resistance means less wasted fuel. This type of designing is called streamlining. Oil or grease can be used to reduce friction in moving parts of a machine. Ball-bearing can be used to reduce friction between two surfaces sliding over each other such as the wheels of a bicycle and the pedals.

Discuss friction and road safety. Explain that we could not drive a car without friction between the tyres and the road. If large puddles form on a road when it rains, a car travelling at high speed may ‘skid’ on top of the water. The driver cannot brake or steer. Special road surface materials have been developed which allow the car to stop quickly without skidding. To prevent accidents on icy roads, grit is spread to help increase friction.

Discuss the speed-time graphs on page 87 of the student’s book. One of the things that we can work out from a speed-time graph is the distance which the moving object has travelled. The area of the shaded triangle is given by half its base length multiplied by its height.

Answers

Why do things float?: **p 83**

1. a) A forcemeter has a spring inside which is attached to a pointer and a hook at the end. When an object is hung on a forcemeter, the spring stretches and the pointer indicates the weight of the object on the scale.

   b) A forcemeter is used to measure force.

2. a) It seems to lose weight.
   b) When submerged in water, the water pushes against the object giving an impression that the object has lost weight. In other words, the upward push or upthrust is equal to the weight of the water that had been displaced by the object.
3. This means that one cubic centimetre of water weighs one gram.
4. a) Upthrust is the upward push of a liquid on an object.
   b) Objects having a density less than the liquid they are immersed in will float, whereas objects having a density greater than the liquid they are immersed in will sink.
5. A floating boat displaces a large volume of water. This water provides enough thrust on the hull to balance the weight of the boat pushing downwards.
6. Because of the high salt content in the Dead Sea, the density of the water is very high. The body of the swimmer will float because it is less dense than the sea water.

***Stretchy materials*: p 84**

1. a) The ability of the body to return to its original length after being stretched is called elasticity.
   b) Elastic limit is the maximum amount of force beyond which the material which is being stretched will not come back to its original length.
2. a) Rubber is a very elastic material. It can stretch several times its original length so it is useful for making rubber bands.
   b) Since bicycle tyres need to bear a lot of pressure of the air inside them, the elasticity of the rubber helps them to bear the pressure without bursting.
3. Springs are good force measurers because when forces are applied, they stretch and spring back into shape evenly afterwards.
4. Students can come up with their own approaches which can be checked for logic. Following is a sample answer:

   Hang a metre-rule and a strong spring from a nail. Mark the position of the end of the spring on the ruler. Hang the given standard masses to the end of the spring and note the extension in the spring on the ruler.

   Now hang the unknown object on the spring and mark the extension of the spring on the ruler. Use the obtained information to plot a graph and calculate the weight of the unknown object.
5. a) i) 5 cm ii) 0.5cm iii) 7.5 cm
   b) 15 cm

***What is weight?:* p 85**

1. a) 50 x 9.8 = 490 N
   b) 50 x 9.85 = 492.5 N
   c) 50 x 1.6 = 80 N
   d) 50 x 3.7 = 185 N
2. Mass remains constant as it is the quantity of matter in a body and is measured in kilograms. Weight is the pull of gravity which is acting on the body. So weight changes with the distance of the body from the centre of the Earth whereas mass will remain constant no matter where the body is.

***Slowing things down*: p 86**

1. The force that is produced when two surfaces rub against each other is called friction.
2. a) wood, rubber, sand, concrete
   b) water, oil, ice
3. a) Friction can be a nuisance when the tyres rub against the road.
   b) Friction can be very helpful when we apply the brakes of the bicycle.
4. The molecules of the gases in air bump into moving objects causing a force which is called air resistance.
5. Air resistance can be overcome by using shapes which let the air slip past more easily. This is called streamlining.

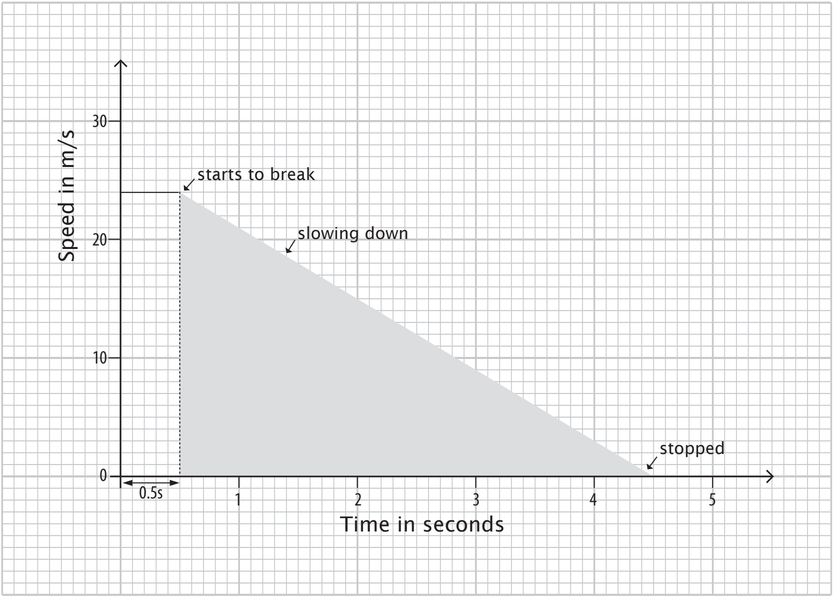
***Stopping a car*: p 87**

1. a) The distance covered by a car from the time the driver thinks about applying the brakes to the time the car actually stops, is called the stopping distance.

b) The thinking distance is how far the car travels before the brakes are applied.

c) The braking distance is how far the car travels after the brakes have been applied.

2. a)



b) The total stopping distance will be the area of the right-angled triangle that has been formed.

Area of triangle = ½ x base x height

= ½ x 4.5 x 24

= 54 m

***Test yourself*: p 88–89**

1. a) lawn mower, digging, weight-lifting

   b) pulling the arrow, dragging a sledge, rowing

   c) Magnetic force such as a bar magnet attracting iron filings. Frictional force, for example, a bicycle wheel rubbing against the road when brakes are applied.

   d) Gravitational force

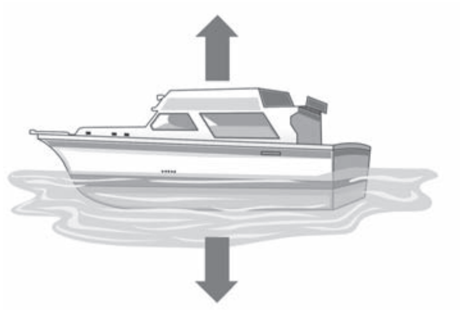
2. a) The density of an object is the ratio between its mass and volume.

   b) 1g/cm^3

   c) i) oil ii) gold and lead iii) hydrogen iv) wood

   d) Water has an upthrust which is the force that opposes the weight of wood. That is why wood floats on water.

3. a) i)



(ii) The gravitational force pushes downwards on the boat, whereas upthrust, or the upward push of the water, pushes against the boat from below to keep it afloat.

b) The boat displaces water according to its weight. The upthrust of the water is equal to the weight of the boat.

c) When the boat is fully loaded, it floats lower in the water because its weight is more than the upthrust.

4. a) Almost 6 times
   b) (i) 250 N
      ii) 50 N
      iii) 10 N
      iv) 5 N
   c) 1000 divided by 6 = 166.66 N
   d) The gravitational pull of the Earth increases as we move from the Equator to the Poles because the shape of the Earth is not a perfect sphere. It is slightly flattened at the poles, so as the explorer moves north, her weight will increase.
5. a) i) thin tyres of the cycle, proper oiling of parts
      ii) pointed helmet of the cyclist
   b) By reducing friction, the cyclist would be able to move faster. More friction would require the cyclist to apply more force and energy to ride the cycle.
6. a) i) The car's streamlined shape allows air to slip past easily.
      ii) The big, wide rear wheels help to keep the car balanced at high speed.
   b) The parachute increases air resistance due to its width, and so helps to increase friction which causes the car to stop quickly.

Workbook 1 Chapter 9

1. a)

Press the rubber pads against the wheels	To the wheels	Stops the wheels	By metal wires
Pushes the central axle gear	To the rear gear	Pushes the wheels forward	Metal chain

   b) i) by pressing the brakes to stop the bicycle
      ii) by lubricating the moving parts and by wearing a pointed helmet
   c) i) The force of friction increases.
      ii) Action and reaction are equal and opposite. Friction increases with an increase in speed.
2. a) A life jacket is filled with air so its weight is less than the upthrust of the water.
   b) A ship displaces less water as compared to a block of steel. The upthrust of water on the ship is greater than that on the steel block due to the difference in surface area.
   c) As the load increases, the weight of the ship becomes greater than the upthrust of the water.
   d) When in water, upthrust acts upon the whale's body making it feel relatively light. On land, its weight pulls down on it making it difficult for the whale to move.
   e) Upthrust of the sea water acts on our feet, therefore, reducing the force being applied on the pebbles and causing less pain.
3. a) copper block
   b) cork, wood, magnesium, china, aluminium, copper
   c) wood 6 / 8 = 0.75 g/cm^3
      cork 2.4 / 8 = 0.3 g / cm^3
      copper 70 / 8 = 8.75 g/cm^3
      magnesium 14 / 8 = 1. 75 g/cm^3
      aluminium 22 / 8 = 2.75 g/ cm^3
      china 19 / 8 = 2.38 g/cm^3
   d) (i) wood and cork
      (ii) They have a density less than that of water.
4. a) 4 kg b) 10 N c) 10 N d) 1 kg
5. a) 10 N
   b) mass = 20 / 10 = 2 kg

c) six times heavier

d) i) zero kg

ii) Weight is the mass of a body multiplied by the force of gravity. Since there is no force of gravity in outer space, the astronaut will be weightless.

6. a) large b) otherwise it would slip

a) large b) otherwise the person's hand would slip and not grip the handle

a) small b) otherwise it would need a lot of force to open and close the door

a) small b) otherwise it would be difficult for the ship to move in water

a) small b) otherwise it would move slowly

a) small b) otherwise the skier would not be able to ski downhill

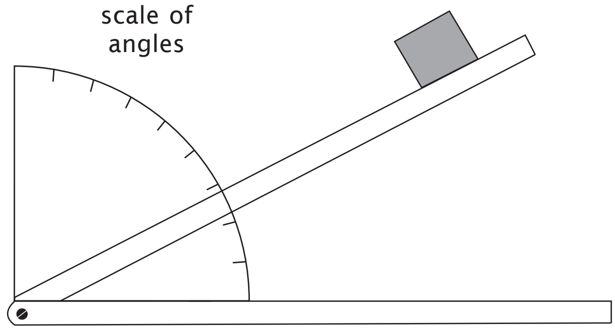
Projects

- Investigate friction created by different surfaces with this adjustable slope.

  You will need a cardboard scale, a pen, a protractor, a ruler, knife, a wooden block, two pieces of plywood, hinge and screws, screw driver, drawing pins, some test surfaces.

  Join the two pieces of wood to the hinge to make the adjustable slope.

  Using the protractor, draw a scale of angles on the card. Fix this to the base at the hinge with drawing pins. Set the slope up on a table for the tests.



  Put the block on the slope. Tilt the slope until the block just starts to slide. Note the angle.

  Now try the test with different surfaces such as felt, shiny plastic, aluminium foil, sandpaper, etc. At what angle does the slope start to slide on each of these?

  Now try different lubricants such as oil and water on the slope.

- You can show how liquids of different densities float on each other. This only works with liquids that do not mix such as oil and water.

  You will need a tall glass, syrup, glycerol, water coloured with red food colour, cooking oil, spirit coloured with blue food colour.

  Start with the heaviest liquid, syrup. Pour it into the glass. Then add the next heaviest, glycerol, pouring it slowly so that the syrup is not disturbed. When the layer has settled, carefully add the water and then the oil. Finally trickle in the lightest liquid, spirit. You will end up with a striped effect in the glass.

Multiple Choice Questions

1. The kind of force which attracts objects on Earth downward is called

   A force of friction B gravitational force C electrical force D magnetic force

2. The unit of force is

   A Newton B joule C ampere D ohm

3. The pull of the Earth on a body is called

   A mass B weight C force D gravity

4. Which of the following is not true?

   A Friction opposes and stops motion.

   B Gravity is a magnetic force.

   C Forces always act in pairs in opposite directions.

   D Forces produce a turning effect.

5. What force makes a moving roller skate stop?

   A gravitational force B electrostatic force C frictional force D electromagnetic force

6. If a load of 20 N is suspended at the end of a spring balance, the reading on its scale will be

   A 2 kg   B 4 kg   C 20 kg   D 40 kg

7. If the extension of a spring is 2 cm when a load of 1.5 Newtons is applied, what is the extension if the load is 3 N?

   A 1 cm   B 2 cm   C 3 cm   D 4 cm

8. Which of the following will produce the largest frictional force?

   A A trolley with wheels rolling on the ground.
   B A wooden box being pushed forward on the ground.
   C A cylindrical log rolling down a slope.
   D A piece of ice sliding down a slope.

9. Which of the following is incorrect?

   A Friction reduces the speed of motion of objects.
   B Energy will be lost to overcome friction in motion.
   C An object will become cold when energy is lost due to friction.
   D Lubricant can be used to reduce friction.

10. How are vehicles shaped in order to reduce friction?

   A spherical   B streamlined   C rectangular   D lubricant

Answers

1. B	2. A	3. B	4. B	5. C
6. A	7. D	8. B	9. C	10. B

Chapter 10

Variation and classification

Unit flow chart

Variety in living organisms

↓

Classifying organisms

↓

Who's related to whom

↓

Keys

Aims and learning objectives

- To develop an appreciation of variation in humans and other living organisms
- To identify characteristics that are inherited
- To suggest ways in which variation can be acquired within a species
- To introduce the scientific classification of living things and to consider the importance of classification
- To identify some of the main classification groups
- To understand why each species has its own scientific name
- To understand how keys are used to identify organisms

Background information

No two people are exactly the same. Even identical twins are different in some ways. People have different heights and weights. Their hair and eyes are of different colours and their faces have different shapes. This means their eye colour and hair colour show variation. We all started life as a fertilized egg with 46 chromosomes: 23 chromosomes from the father and 23 from the mother. This is why we have some characteristics of our fathers and some of our mothers.

All children inherit characteristics from their parents. This is called ***inheritance***.

Differences such as those of height and weight are called ***continuous variations***. We can fit anywhere within a continuous range of possible measurements. However, some features are distinct. An individual is either male or female. Either we have brown eyes or black. There is no other option. Fingerprints are formed at birth and remain unchanged throughout life. Such variations are called ***discontinuous variations***. A person may know how to play tennis, to swim or may have a scar from a cut. These are acquired characteristics. A person is not born with them, we pick them up as we go through our life. Such variations are called ***acquired variations***.

Variation has led to the development of so many different kinds of organisms that it has become very difficult to name all of them. This is where the idea of classification comes in.

Classifying things is an everyday activity. In homes, items are classified according to the room in which they belong, a grocer classifies things in his store, books are classified or sorted in a library, etc. But why do we classify things?

If things are arranged in order, we know where to find them. Also when we group together things that are alike in some way, we can talk about them more easily because we can give a name to each group. Scientists classify living things for the same reasons that we classify other things. Classifying living things makes it possible to give each kind a name.

In this part of the unit students will extend their knowledge of living things. They will compare different organisms, noting the similarities and differences between them. Then they learn how to identify a wide range of animals and plants and classify them into groups. They will also learn to name animals and plants.

Teaching procedure

Arrange a group of students according to their heights from the shortest to the tallest. Explain that their height is an example of continuous variation. It varies from short to tall with many small differences in between. Intelligence also shows continuous variation. Can the students think of other examples?

Ask the pupils to roll their tongues. Some can but some cannot.

Explain that this is an example of a discontinuous variation. Hair colour, eye colour, face shape, blood groups are all examples of discontinuous variations. Variations are important because they help species to evolve.

Additional activity 1

Pick out some students in the class who have contrasting characteristics such as hair colour, eye colour, height, weight, hair length, hand span, shoe size, etc.

Discuss variations with the class.

The same comparison can be made of different leaves picked up from the same plant species.

Additional activity 2

Ask students to make a family tree of their relatives and try to find out about their characteristics. Ask about things like hair colour, eye colour, height, colour blindness, tongue rolling ability, etc.

Are the students able to identify where their characteristics came from?

Discuss the material on page 92 and teach the students to plot a frequency graph from the given example. Explain that the bell shape of the graph is called a ***normal distribution curve***. It shows that most people are of average height; only a few are very short or really tall.

Ask students why our skin becomes dark if we stay out in the Sun for a long time? Why does one put on weight?

Discuss acquired variation. Explain that people acquire certain characteristics as a result of what they do during their lives. Plants are also affected by the amount of sunlight, water, and temperature. These factors can affect their growth or their fruit formation.

Additional activity 3

Make groups of two or three pupils each. Using a stamp pad, ask the students to make their fingerprints and label them according to the patterns on page 93 of the student's book. Ask them to compare the prints with other students in their group.

Explain that fingerprints are unique and help police to identify criminals.

Who is related to whom?

Start the lesson on classification by asking the students why scientists classify living things.

Explain that over 2000 years ago, people tried to classify living things. Many plans were thought up but none worked well. For hundreds of years people could not work out a good method of classification. They had not learned how to study living things as scientists do today. About 225 years ago a Swedish student called Carl von Linné (later called himself Carolus Linneaus) classified living things according to their structure. He grouped together living things whose bodies were alike in some way. He also gave each kind of living thing that he studied a special name.

Today, all over the world, scientists use a plan for classifying and naming living things on the work of Linneaus. When a scientist in our country writes to a scientist in Mexico or Japan about some kind of animal or plant, he uses its scientific name. The other scientist knows exactly which animal or plant is meant because each kind of living thing has a specific name of its own.

If we see a strange animal or plant, we may ask what it is. Sometimes it is hard to answer. However, scientists have worked out a way that will help to study living things.

Living things can be separated into two large groups: animals and plants. Each of these groups can be divided into other groups until we come to the smallest group called species. Discuss the main characteristics of all living organisms. Allow the students to demonstrate their knowledge. Most students will have some rather poorly organized knowledge of living things. Find out whether the students know the correct names used by scientists to describe different groups of living organisms. Ask them how living organisms can be sorted into different groups. Make sure that the students begin classifying living things by examining them carefully and noting the similarities and differences between them.

Additional activity 4

Ask students to collect as many pictures as they can of different types of animals and plants from old magazines and newspapers. Ask them to bring the pictures to class and divide the class into groups of four. Ask them to classify all the pictures into groups given below.

a) animals: live on land and have fur
live in water only
have feathers
live in water and have fur
can fly
have scales

b) plants live on land
have flowers
do not have flowers
live in water

Have them arrange the pictures into a chart. Display and discuss the chart.

Keys

Keys are charts, lists or diagrams which help people identify plants and animals. Clarify to students that if we can use the features of plants and animals to sort them into groups, we can make keys for other people to use.

The material on page 99 of the student's book should first be discussed to ensure that the students understand how a key is built and how it is used. Then the students may begin to study and classify some living organisms using the keys given in the book.

Ask the students to make a key. Explain, with diagrams on the board, how a key is constructed step-by-step.

Additional activity 5

The table shows the five main groups of vertebrates.

Ask the students to complete the table by putting a tick or a cross into each space.

Feature	fish	amphibians	reptiles	birds	mammals
backbone					
fins					
scales					
lay eggs					
have babies					
hair					
damp skin					
feathers					
mammary glands					
gills					
lungs					
warm-blooded					

Answers

***Variation and classification*: p 90**

1. Homo sapiens
2. They have the same general body shape, all of them have two eyes, a head, two hands, they have hair, they are wearing clothes.
3. They have different face shapes and features, hair colour, eye colour and heights.
4. a) They inherit their characteristics from their parents.
   b) variations
5. a) They have different heights, flower colour and size of flowers.
   b) They are green. Their leaves and flowers are of the same shape or type.

***Variety*: p 91**

1. a) 158 cm b) brown c) black
2. a) 5, 6, 8 b) brown
3. a) Mark: height 170 cm, shoe size 8, hair colour brown, eye colour brown, left handed, has freckles.
   b) Janine: 162 cm, shoe size 6, hair colour black, eye colour brown, right handed, no freckles.
4. Height and shoe size might change. Freckles may disappear.

***More about variation*: p 92**

1. differences between members of the same species
2. A normal distribution curve is in the shape of a bell. The average measurement is shown in the middle of the curve. Most of the measurements will be close to this average on either side of the curve.
3. a) continuous variations: weight, height, freckles
   b) tongue rolling, eye colour, ear lobes

***Looking at fingerprints*: p 93**

1. The patterns of ridges in the skin of the fingertips.
2. These ridges help us to grip things firmly.
3. Types of fingerprint patterns:
   arch: the lines run like waves across the fingertip
   whorl: the lines make circles on the fingertips
   loop: the lines from one side form a loop in the middle of the fingertip then return to the same side
   mixed: this is a combination of arches, loops, and whorls
4. Press a finger on a glass surface. With the right light you can see your fingerprint.

5. No two prints made by different fingers are the same so fingerprints of the complete hand must be made in order to identify the person.
6. Police databases contain billions of unique fingerprints so that any fingerprint detected at the scene of a crime can be checked with those on police records. This way it might be possible to identify a criminal even in the absence of witnesses.

***Classifying organisms*: p 94–95**

1. Classification is necessary for all known living things found on Earth as no one can ever hope to know the names of each of them.
2. a) species b) kingdom
3. mammals, aves, reptiles, amphibians, pisces
4. a) Latin was chosen because it was the international language of science.
   b) Latin is a pure language and it was understood by most scientists of that time.
5. a) kingdom: Animal
   phylum: Chordata
   class: Mammalia
   order: Carnivora
   family: Ursidae
   genus: Ursus
   species: arctos
   scientific name: *Ursus arctos* (brown bear)
   b) kingdom: Animal
   phylum: Chordata
   class: Mammalia
   order: Carnivora
   family Mustelidae
   genus: Mustela
   species: erminea
   scientific name: *Mustela erminea* (stoat)

***Who's related to whom? (1):* p 96**

1. Some are rod shaped, others are round.
2. Blue-green algae live in the sea near the surface, giving the blue-green colour.
3. They do not have a true nucleus.
4. They belong to the algae group.

***Who's related to whom? (2):* p 97**

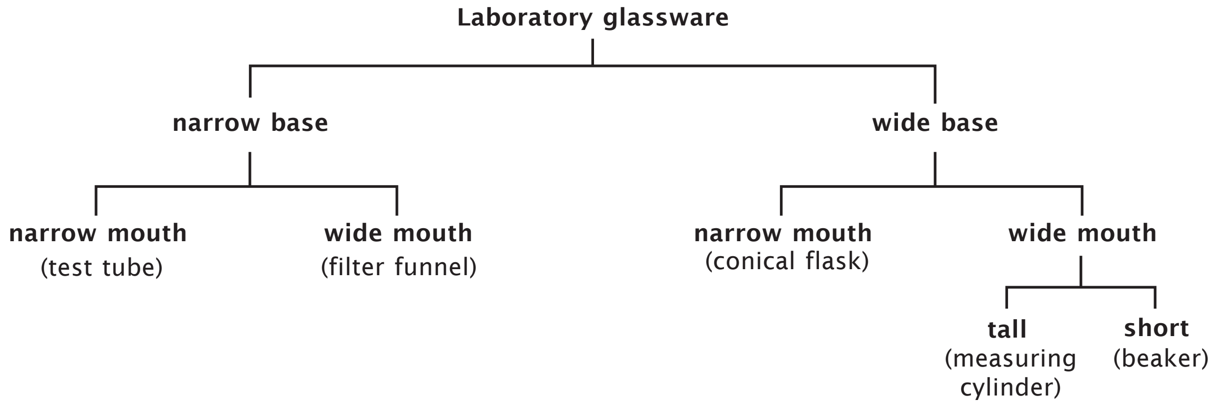
1. plants with seeds and plants without seeds
2. a) both are seedless plants
   b) The leaves of the mosses are arranged in a spiral. In ferns the leaves are arranged in whorls.
3. Conifers have no ovary and they produce naked seeds.
4. a) monocotyledons and dicotyledons
   b) Monocots have narrow leaves and the seeds have a single cotyledon. Dicots have broad leaves and the seeds have two cotyledons.
   c) monocot: tulip dicot: rose
5. Moss plants grow together in clumps for support and to prevent themselves from drying out.

***Who's related to whom? (3):* p 98**

1. coelentrates
2. a) insects b) arachnids, e.g. spider c) crustaceans, e.g. crab
3. Fish have soft scales whereas reptiles have hard scales.
4. wings
5. Decapod means having ten legs. They are called decapods because they have 8 legs and a pair of antennae which resemble legs.

***Keys*: p 99**

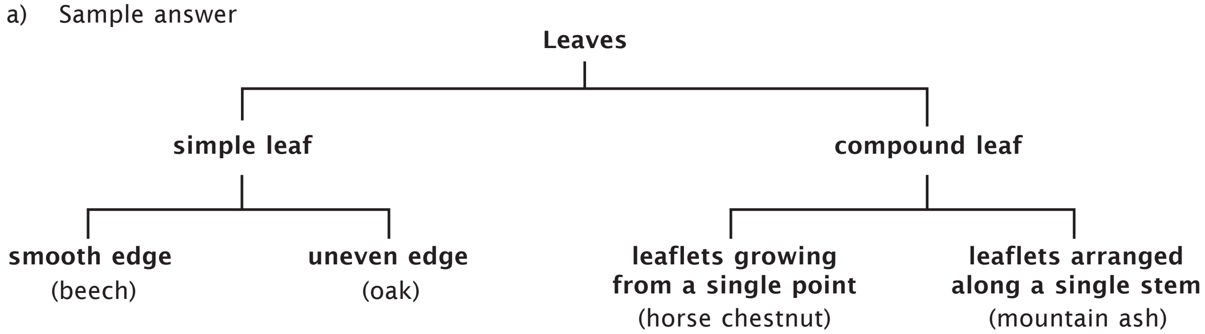
1. Keys are useful for finding the names of organisms that we cannot recognize.
2. A key is a series of questions. Each answer leads on to another question. This continues until the name of the organism is found.
3. A bat, B dolphin, C squirrel, D otter, E vetch, F sundew, G charlock, H bluebell, I bell heather.
4. Sample answer



5. Classification of living organisms is difficult because there are millions of them and some have still not been found, identified or named.

***Test yourself*: p 100-101**

1. a) mother b) mother c) 2 d) Alison, Tom and Jane
   e) This is a continuous variation. The length of one's hair is dependent on preference rather that inheritance.
2. a) They have two pairs of wings, a pair of antennae, and their bodies are divided into three parts.
   b) They differ in colour, wing shape and size.
   c) It is a continuous variation.
   d) It is a discontinuous variation.
   e) The eye factor makes the peacock butterfly look larger and more dangerous to its predator. The dead leaf effect provides a camouflage which helps brimstone butterflies to hide from enemies.
3. a) 32
   b) i) 150–4 ii) 135–9 or 165–9
   c) 150–4
   d) bar graph
   e) weight, hand span size
4. a) An insect has 6 legs and the body is divided into three parts. A spider has 8 legs and the body is divided into two parts.
   b) Millipedes have long thin bodies, whereas crabs have a hard, chalky shell.
   c) i) 4 ii) insect iii) crustacea
5. a) A wasp b) B housefly c) C earwig d) D butterfly
6. a) Sample answer



   b) Answers depend on students.

Workbook Chapter 10

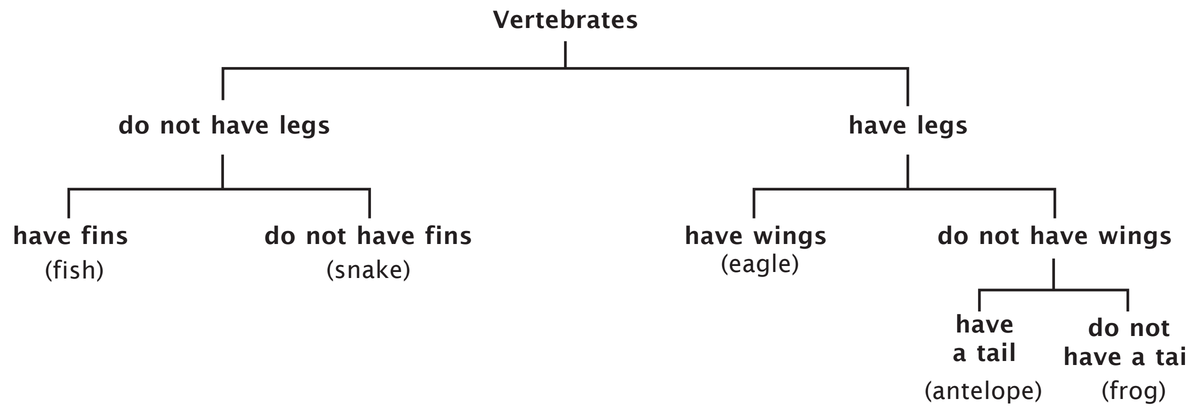
1. a) Similarities: both holding a book, carrying a bag, wearing belts, smiling.
   Differences: different sexes, hair of different lengths, dresses different, heights different.
   b) Answers depend on students.
2. a) 1 b) 13 cm c) 20 d) continuous variation
3.

dog	mammals
snake	reptiles
hen	aves or birds
shark	pisces or fish
seal	mammals
lizard	reptiles

4.

algae	No stem, leaves and roots. Produces spores.
moss	Simple stem, leaves and roots. Produces spores.
fern	Has stem, leaves and good root system. Produces spores.
conifer	Has stem, leaves and good root system. Produces cones.
flowering plant	Has stem, leaves and good root system. Produces seeds inside an ovary.

5. A = dolphin B = squirrel C = bat D = otter
6. Eastern cat Anteater Cuscus Opossum
7. Sample answer



Problems to solve

1. Which group of vertebrates have these characteristics?
   a) hair or fur b) scales or hard plates c) lungs
   d) skeleton e) feathers f) cold-blooded
   g) gills h) warm-blooded i) lay eggs
   j) milk glands k) body divided into three segments l) spinal cord
   m) fins n) produce living young
2. To which group of vertebrates do humans belong? Explain.
3. How do you think that scientists decided that a whale is not a fish and a bat is not a bird?
4. Which group of plants have these characteristics?
   a) leaves, stems and roots b) spores
   c) tubes that carry water d) seeds
   e) body made of one cell.
5. Why do you think fungi are often parasitic on other plants and animals? Explain your answer.

Answers to problems

1. a) mammals b) reptiles c) mammals, reptiles, birds and amphibians
   d) all vertebrates e) birds f) reptiles, amphibians and fish
   g) fish h) mammals and birds i) fish, amphibians, birds and reptiles
   j) mammals k) insects l) vertebrates
   m) fish n) mammals
2. People are mammals. They have hair, they have mammary glands and they produce live young.
3. A whale has mammary glands and it gives birth to live young.
   A bat is also a mammal as it gives birth to live young and it has fur.
4. a) spermatophyta (plants that have seeds) b) plants without seeds
   c) spermatophyta d) spermatophyta
   e) protoctista kingdom.
5. Fungi are non-green plants. They cannot manufacture their own food, so they have to depend on other plants for their food.

Multiple Choice Questions

1. People inherit their characteristics from their
   A brothers B sisters C cousins D parents
2. Features such as height and weight are examples of
   A continuous variation B discontinuous variation
   C chemical variation D acquired variation
3. The system of naming organisms is called
   A variation B classification C ordering D organizing
4. The smallest classification group is
   A genus B order C species D family
5. The biggest group of organisms is called
   A phylum B kingdom C class D species
6. Paramecium is a single-celled organism which moves by
   A feet B tentacles C cilia D arms
7. Plants which produce naked seeds are called
   A mosses B ferns C conifers D dicotyledons
8. An insect has
   A 4 legs B 6 legs C 8 legs D 10 legs
9. An animal which has hair and swims in water could be
   A amphibian B reptile C mammal D fish
10. A fish is a vertebrate because it has
    A fins B a tail C scales D a backbone

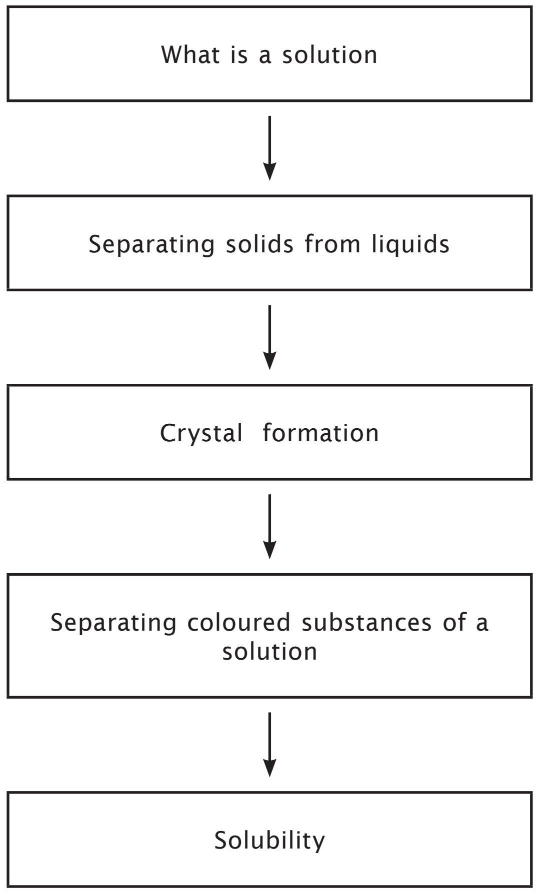
Answers

1. D 2. A 3. B 4. C 5. B
6. C 7. C 8. B 9. C 10. D

Chapter 11

Solutions

Unit flow chart



Aims and learning objectives

- To classify solids on the basis of their solubility
- To explain different types of mixtures
- To describe various methods of separating mixtures
- To introduce the relationship between temperature and solubility of solids and gases.

Background

We know that a material can be a solid, a liquid or a gas. But materials in the same state or in different states are often mixed together. One special kind of mixture of two or more materials is called a 'solution'. The most common type of solution is made by dissolving a solid in a liquid.

If we put sugar in lemonade we make a solution. Perhaps you have sprayed a solution on plants to keep them from being eaten by insects. Solutions are so important in our body that we cannot stay alive without them. We cannot use the air that we breathe or the food that we eat until they are in our blood in solution.

Unit introduction

Some realization of the nature of solutions and of the fact that liquids and gases as well as solids dissolve in one another is necessary. This can help to avoid careless and confused thinking about different types of mixtures with which people come into contact every day.

Teaching procedure

Start the lesson by asking the students: *have you ever dissolved anything in a liquid? What happened to the material that was dissolved? What did you have when the material was completely dissolved? Could you always dissolve a material when you tried?*

After listening to the students' ideas about solutions, have them read the text on page 102 of the student's book.

Additional activity 1

Take two test tubes half filled with water. Put a pinch of common salt in one and a pinch of sand in the other. Shake them vigourously. What do you see? We can say that salt is soluble in water whereas sand is not.

Explain that when a solid is dissolved in a liquid, the solid disappears. Ocean water, well water, and red ink all contain dissolved solids. But even with a powerful microscope you cannot see solid particles floating in the liquid.

Kinds of solutions

Solutions are usually made by dissolving solids in liquids. Ask the students to give some examples. Ask them if solids can be recovered from a solution easily.

Explain that dissolved materials cannot be removed by filtering a solution. No matter how fine the filter, we cannot take the salt out of sea water, the minerals out of well water or the colouring out of red ink. Even letting a solution stand for a long time would not cause the dissolved materials to rise to the top or sink to the bottom.

Students must not get the idea that all solutions are made by dissolving a solid in a liquid. Some solutions contain one liquid dissolved in another. Water and alcohol are both liquids. When they are mixed, they form a solution. Acetic acid (vinegar) is another liquid that can be dissolved in water.

Ask the students: *how do fish breathe? Where does the oxygen that they breathe come from?*

Explain that water has some oxygen dissolved in it. This is an example of a solution of a gas dissolved in a liquid. The air that fish breathe is dissolved in the water they live in.

Ask the students: *how do we know that air is dissolved in water?*

When we heat water in a pan, we can see small bubbles forming on the sides and bottom of the pan. These are bubbles of air that were dissolved in water. Similarly, when we open a bottle of cola we see bubbles of carbon dioxide gas rise to the top of the liquid. The carbon dioxide gas gives the drink its sharp, stinging taste. This gas was forced into the liquid under pressure. When the bottle is opened some of the gas comes out. There is no longer enough pressure to keep all the gas dissolved in the liquid.

Characteristics of a solution

Every liquid solution has three characteristics:

- the liquid is clear
- the dissolved material will pass through any filter that the liquid will go through
- the dissolved material stays evenly spread in all parts of the liquid

Water is the greatest 'solvent' or dissolver in the world. It dissolves more materials than any other liquid. Yet there are many materials that water does not dissolve. Ask students if they have ever tried to use water to get paint off their hands. It does not work. But when we use petrol, kerosene or nail polish remover it quickly comes off.

Experiment: What are the characteristics of a solution?

Method: Put a teaspoonful of tea leaves in a glass and pour in hot water. Does the water change colour all at once? Does the colour spread gradually?

Fold a filter paper and put it in a funnel. Set the funnel in a test tube. Carefully pour some of the tea solution through the filter. Examine the filtered liquid in the test tube. Is it still coloured? Taste the filtered liquid. Is there tea in it? Hold the test tube up to the light. Is the liquid clear or cloudy? Can you see particles of tea in it. Let the tea solution stand for several hours. Does the coloured material from the tea settle to the bottom? Taste the solution. Is there still tea in it? Write down three characteristics of the tea solution.

Repeat the experiment with sugar and copper sulphate. DO NOT TASTE THE COPPER SULPHATE SOLUTION. IT IS POISONOUS.

Experiment: What happens when oil is mixed with water?

Method: Half-fill a test tube with water. Add about 1 cm of lubricating oil. Is the oil soluble in water?

Cover the mouth of the test tube with your thumb and shake it vigourously. What happens?

Let the mixture stand a while. What happens to the mixture?

Solubility

When we add one spoonful of salt to a beaker of water, it dissolves. The salt particles spread evenly through the water. The solid that dissolves is called the solute. The liquid in which a solid dissolves is called the solvent. The mixture is called a solution.

Experiment: To find out how much solute can dissolve in a solvent

Materials: packets of sugar, salt and potassium nitrate (fertilizer), copper sulphate crystals, beakers, stirrers, teaspoons, tripods, wire gauze, thermometer, Bunsen burners

Method: Divide the class into five groups.

Give each group samples of sugar, salt, and fertilizer on clean, dry sheets of paper and mark them A, B, C and D, respectively.

Measure 20 cm^3 of water into a beaker. Add one spoonful of solute A to it. Stir thoroughly.

Repeat by adding one spoonful of the solute at a time till no more solute can dissolve. Repeat the test with the other solutes. Find out how many spoonfuls can dissolve in 20 cm^3 of water.

Record your results in the table below.

	name of solute	**number of spoonfuls dissolved in 20 cc of water**
1.		
2.		
3.		
4.		

Which solute dissolves most in water?

Which solute dissolves the least in water?

Experiment: To find out if temperature affects solubility

Method: Heat 20 cm^3 of water in a beaker to 50˚C with a low Bunsen flame. Maintain the temperature at 50˚C.

Repeat the steps in the above experiment to find the solubility of different solutes. Use the results to fill the table below.

	name of solute	**number of spoonfuls dissolved at 50 degrees C**
1.		
2.		
3.		
4.		

Compare the amount of solute dissolved at room temperature and 50˚C. What do you find?

Draw a graph to compare the rate of solubility of salts at room temperature and at 50˚C.

Generally speaking, the solubility increases with the increase in temperature. The same kind of activity can be used to find the solubility of solutes, based on the size of the crystals, by stirring and by increasing the temperature.

Separating solids from liquids

Sometimes we need to purify a substance. We can separate the impurities from a chemical substance using several different methods.

Filtration can be used for separating mixtures of substances. If we have a mixture of two substances; one soluble and the other insoluble in water, we can separate them by filtering. The solution obtained can then be evaporated to recover the soluble substance in the form of crystals.

Distillation

Distillation can be used to separate a soluble substance from water. Distillation can also be used to separate two liquids having different boiling points. This is called fractional distillation.

Take the students to the laboratory and set up the apparatus for distillation as shown on page 105 of the student's book. Explain that they are going to separate a mixture of ink and water. The students should observe the water vapours that cool and condense, and then are collected in the beaker. Explain the process of distillation which involves the process of evaporation first and then condensation.

Set up the apparatus for fractional distillation and demonstrate the method of separating a mixture of alcohol and water to the students.

The basic principle is the same as distillation, but because the liquids have different boiling temperatures, alcohol, which has a lower boiling point than water, distils out first. Water is left behind in the flask.

Chromatography

Recall the methods of separating substances which students have learnt earlier in the unit. The theme of chromatography can then be introduced. Chromatography usually fascinates students and they should do as much as they can with this or other techniques.

Help the students to practise some simple separation techniques in chromatography. Explain that it is a method to identify different substances in a mixture and to see whether a given substance is pure or not. Chromatography is used in industry and scientific research to identify many different dissolved substances.

Additional activity 2

Most felt pens separate well with water as the solvent. Students will find this activity more interesting if they are allowed to use their own pens.

Give the students a piece of filter paper. Tell them to put a drop of ink from their own pens in the centre of the filter paper. Leave it to dry. Carefully squeeze drops of water on to the ink spot. Leave a little time between drops to let the ink spread.

Ask questions such as: *is the ink made up of one substance only? How many dyes does it contain?*

The chromatograms should be dried and stuck in their notebooks as a record. Ask the students to compare the patterns of chromatograms from other groups. They will notice that different brands of inks of the same colour may be made up of different dyes.

Answers

***Solutions*: p 102**

1. a) The substance in which a solute dissolves is called a solvent.
   b) The substance which dissolves in a solvent is called a solute.
   c) A solution is formed when two substances mix completely with each other.
   d) A suspension is formed when small particles of an insoluble substance float in a solvent.
2. a) sugar
   b) water
3. Sand, oil. We call them insoluble.
4. Fizzy drinks contain carbon dioxide dissolved in flavoured water. When the bottle is opened the carbon dioxide rushes out causing the drink to foam.
5. Sugar and salt are soluble. The rest all are insoluble in water.

***Separating solids from liquids*: p 103**

1. a) Suspended solid particles can be removed from a mixture by pouring the mixture through filter paper. This process is called filtration.
   b) The liquid part of the mixture which passes through the filter paper is the filtrate.
   c) The solid particles that are left on the filter paper are the residue.
2. Filtration is not a good method for removing dissolved solids because all the solution would pass through the filter.
3. a) Filter the sea water to remove the suspended insoluble matter from it. Heat the filtered sea water in a china dish. Dry salt crystals will be left behind.
   b) The water will evaporate.
4. Add water to the mixture and stir it. Sugar will dissolve in the water and chalk will float on the surface. Filter the solution. Chalk will be left as residue on the filter paper. Sugar can be recovered from the filtrate by heating it to dryness.

***Crystals from solutions*: p 104**

1. All crystals have a regular shape, flat faces, and sharp edges.
2. Basalt was formed by the cooling of molten substances inside the Earth until they solidified into crystalline rocks.
3. Crystallization is the separation of solids from concentrated solutions by slow cooling.
4. a) Make a solution of copper sulphate. Heat the solution to evaporate some of the water. Stop heating when the solution becomes concentrated. Leave the solution in a warm place to cool slowly. Small crystals of copper sulphate will be formed.
   b) Heat the solution gently and do not shake the solution while it is cooling.

***Liquids from solutions*: p 105**

1. The steam will be colourless because it is only the water that is evaporating and not the ink particles.
2. a) distilled water.
   b) It is used in car batteries and laboratories.
3. a) boiling b) condensing
4. As the solution is heated and the temperature rises to 56˚C, the liquid with the lowest boiling point that is A evaporates first. It condenses and can be collected in a beaker. When the temperature begins to rise, it means that liquid A has evaporated completely. Continue heating and when the temperature reaches 72˚C, liquid B begins to evaporate. This can be condensed and collected in a second beaker. The liquid that is left behind in the flask is water. It can be tested by heating the solution further to 100˚C as pure water boils at that temperature.

***Separating coloured substances*: p 106**

1. water
2. The movement of the colours depends on their solubility. The most soluble moves the furthest.
3. Absorbent paper is rolled up and stood in a solvent. The solvent rises up the paper carrying the substances with it. Each substance travels a different distance.
4. The base line is drawn so that all the chemicals start from the same point and accurate results can be obtained.
5. Some coloured dye (not chemical) could be added so that the distance the amino acids travelled could be seen easily.

***Solubility*: p 107**

1. a) A saturated solution is one which cannot dissolve any more solute at that particular temperature.
   b) Take 100 cm^3 of water in a beaker, add a teaspoonful of sugar and stir it well. Keep adding sugar and stirring until no more sugar can dissolve in it. Sugar will start settling at the bottom of the beaker. This is a saturated sugar solution at room temperature.
2. a) 180 g b) 250 g
3. i) ammonia ii) nitrogen
4. 700 cm^3
5. Oxygen and nitrogen are soluble in water. When water is heated, these gases cannot stay in solution: as the temperature rises they appear as bubbles.

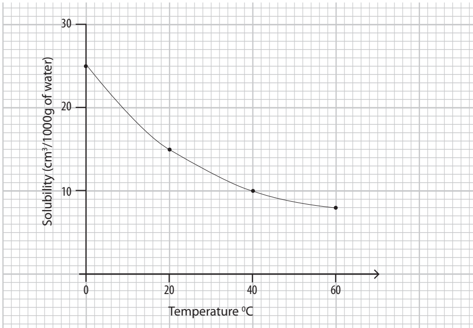
***Test yourself*: p 108–109**

1. a) The filtrate is brown.
   b) to remove or hold back the insoluble particles in a mixture
   c) i) the dissolved particles of coffee
      ii) the undissolved particles
   d) i) the insoluble particles will be seen floating or settled at the base of the coffee
      ii) suspension
      iii) When some of the insoluble particles settle at the bottom of a liquid, they form sediment.
2. a) Refer to the diagram of the apparatus on page 105 of the student's book.
   b) by reading the temperature on the thermometer which should be 100°C
   c) Place a drop of ink at the centre of a piece of filter paper. Carefully squeeze drops of water on to the ink. Leave a little time between the drops to let the ink spread out. As the water moves across the filter paper it will carry the colours with it.
3. a) Heat the solution till its volume is reduced to half and leave it in a warm place for the water to evaporate slowly. Crystals of copper sulphate will be formed.
   b) i) salt
      ii) Salt that was sprinkled dissolved in the water when the ice melted. As the water evaporated, salt was left behind.
      iii) Salt crystals are smaller and white. Copper sulphate crystals are blue and larger.
4. a) fractional distillation b) filtration and evaporation
   c) fractional distillation d) filtration
   e) evaporation f) paper chromatography
5. a) 100 g b) 105 g c) 22°C
   d) The solubility of sodium nitrate increases with the increase in temperature.
   e) The solubility begins to decrease and crystals of sodium nitrate start forming.
6. a) 100 g b) 360 g c) 20 g d) 36 g
   e) i) 40 g ii) 40 g iii) 40 g

Workbook 1, Chapter 11

1. When sugar dissolves completely in water a ***solution*** is formed. The solid sugar is called the ***solute*** and the water is called the ***solvent***. Because it dissolves, sugar is described as ***soluble***. Sand will not dissolve in water, it is described as ***insoluble***.
2. a) evaporating b) filtering c) sieving d) sieving e) sieving f) filtering
3. Weigh a sample of lawn sand. Put it in a beaker, add water to it and stir. The fertilizer will dissolve in the water, and sand will settle at the bottom as sediment. When filtered, sand will be left on the filter paper and the solution will pass through. Heat the solution to dryness in a china dish. Dry the sand by heating it in a china dish. Weigh both the sand and the fertilizer thus obtained. If the manufacturer's claim is genuine, their weights should be equal.
4. a) 2
   b) A, C, D, E
   c) i) B
      ii) Its components have separated into 2 spots which are similar to the homework pen.
   d) A spot of each ink is placed on the base line on a sheet of absorbent paper. The paper is rolled up and stood on a solvent. The solvent rises up the paper carrying the substances with it. Each substance travels a different distance.
   e) chromatography
5. a) i) sodium chloride ii) potassium nitrate
   b) sodium chloride
   c) approximately 40 g
   d) 24°C

6. a)



b) Solubility decreases with an increase in temperature.
c) 30 cm^3
d) i) carbon dioxide ii) nitrogen
e) The gases dissolved in water escape when water is heated and appear as bubbles.
f) As water heats up in hot weather, oxygen gas comes to the surface of the water.

Project

You will need copper sulphate crystals, water, cotton thread, a card, and a glass jar.

First make up a strong solution by dissolving the copper sulphate in water. Pour a little of the solution in a saucer or shallow dish and leave to evaporate. After a day or so, small crystals will have started to form at the bottom of the dish. After a week, select the biggest crystal, tie a piece of cotton thread round it and suspend it from the card in your main stock of the solution. This acts as a seed for crystallization and, after a few weeks, a large regular-shaped crystal should have formed.

Multiple Choice Questions

1. When a substance dissolves in a liquid, it forms a
   A suspension B solution C sediment D emulsion
2. Fizzy drinks are an example of
   A a solid dissolved in a liquid B a gas dissolved in a liquid
   C a solid dissolved in a gas D a liquid dissolved in a solid
3. When an insoluble substance is mixed with a liquid and small particles are seen floating around in the liquid, the mixture is called a
   A solution B suspension C emulsion D sediment
4. A suspended solid can be separated from a liquid by
   A filtration B distillation C evaporation D crystallization
5. Nail varnish dissolves in
   A trichloroethane B white spirit C propanone D ethanol
6. The best method for separating liquids from solutions is
   A evaporation B distillation C filtration D condensation
7. Chromatography is used to separate mixtures of
   A solids B liquids C oils D coloured substances
8. The amount of solute which dissolves in a solvent at a particular temperature is called its
   A solubility B gravity C chromatography D purity
9. To separate two liquids having different boiling points we use
   A distillation B evaporation C crystallization D fractional distillation
10. To separate a dissolved solid from a liquid we can use
    A evaporation B crystallization C distillation D filtration

Answers

1. B	2. B	3. B	4. A	5. C
6. B	7. D	8. A	9. D	10. A

Chapter 12

The solar system

Unit flow chart

How did the universe begin?

↓

What is the solar system?

↓

Days, month and years

↓

The seasons

↓

The moon and eclipses

↓

Information from space

Background information

The universe contains everything that exists. We do not know how big the universe is. A galaxy is a star system. Our Earth is part of a galaxy called the Milky Way. There are thousands and thousands of stars in the Milky Way. These stars give a milky appearance to the sky, hence the name.

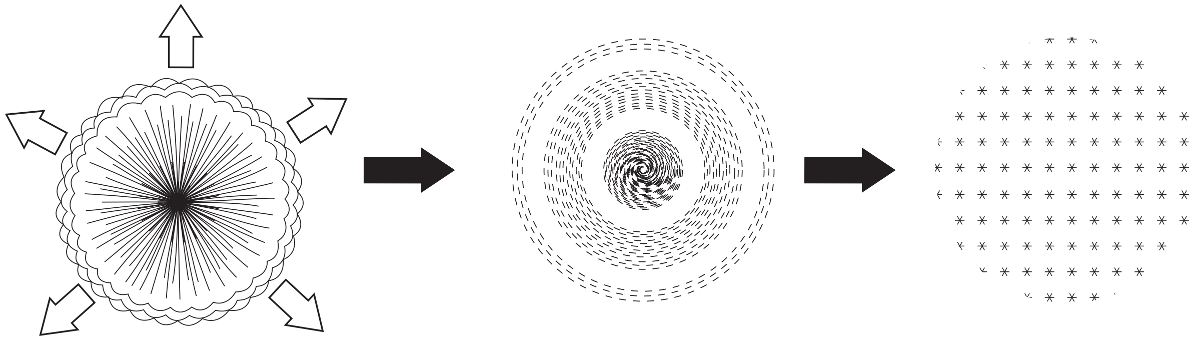
Galaxies are very far apart. The nearest galaxy to the Milky Way is called *Andromeda*. *Andromeda* is two million light years away. This means that the light we see from Andromeda has taken two million years to reach us. We are seeing it as it was two million years ago. Astronomers believe that there are many more galaxies further out in space that cannot be seen.

Unit introduction

There are several theories regarding the origin and formation of the universe.

The big bang theory

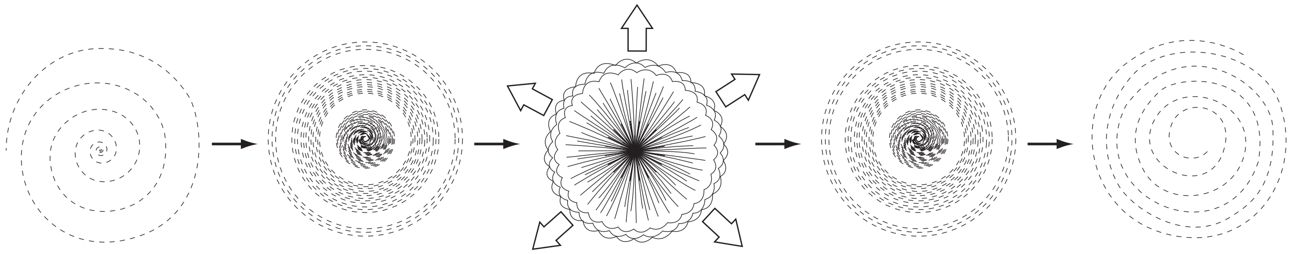
This theory suggests that the universe began 10,000 million years ago with an enormous explosion. Scientists believe that all matter now in the universe was contained in one primitive atom. They call this atom a primordial atom, but they have no idea of its size. This atom blew up and its contents flew off in all directions. As the material spread out, it cooled down, joined together and formed galaxies.



Big bang theory

The pulsating universe theory

Scientists assume the universe to be continually contracting and expanding. When the universe has expanded to a certain size it will begin to shrink. The galaxies will be pushed closer and closer together. Eventually they will explode causing the universe to expand again.



Pulsating universe theory

The expanding universe theory

Scientists suggest that the universe will never collapse but keep on expanding. This theory implies that there has only ever been one big bang.

Facts about the Sun

- The Sun is a star of our solar system
- Its mass is 330,000 times that of the Earth
- Its diameter is 1,384,000 km
- The distance between the Earth and the Sun is about 149 million km
- Scientists think the Sun was formed from gas and dust over 5000 million years ago
- Temperatures at the centre of the Sun are estimated at over 14,000,000°C. The surface temperature is about 6000°C
- Sun spots are dark patches on the surface of the Sun. Charged particles are shot out of sunspots far into space. Sometimes they reach the Earth's atmosphere and produce brilliant light displays called *aurorae.*

Teaching procedure

The planets of our solar system.

All planets and other bodies revolving around the Sun are held in orbit by the force of gravity. The Sun is by far the biggest body in our solar system. It, therefore, exerts a gravitational force strong enough to hold the largest and the most distant planets.

Additional activity 1

Think of an easy way to remember the order of planets in our solar system. You could try making up a sentence with words beginning with the initial letter of each planet.

The planets

Mercury is one of the smallest planets and is nearest the Sun. It is slightly less than half the size of the Earth. It turns on its axis very slowly but it is the fastest moving planet, travelling round the Sun at 100 000 miles per hour.

Venus is our closest planet and about the same size as the Earth. It is always covered in thick white clouds. It rotates slowly in the opposite direction to the Earth. Due to its high surface temperature and atmospheric pressure, there is no life on Venus.

Like Earth, Mars has two polar ice caps. There are four seasons on Mars similar to Earth, but because Mars takes twice as long as Earth to orbit the Sun, its seasons are twice as long. The variations in temperature cause large pressure differences leading to winds up to 500 km/h, but the winds lack energy as there is little atmosphere on Mars.

Jupiter is the giant of the solar system. It has nearly twice the mass of all the rest of the planets put together. Since the planet is so massive, it can attract many moons (at least 16). An interesting feature in the cloud belt around Jupiter is the Red Spot. This is a massive cloud of gases which swirls around like a tornado. The red colour is due to the helium in the gas cloud.

Saturn is the second largest of the planets and probably the most beautiful to look at. It is surrounded by hundreds of narrow rings. The appearance of Saturn and its chemical composition are very similar to those of Jupiter.

Saturn spins on its axis almost as fast as Jupiter. This fast rotation produces very fast winds of up to 1400 km/h which constantly blow around the planet. The biggest and brightest of Saturn's moons is called Titan. Titan is 8000 km in diameter, larger than planet Mercury.

Uranus is thought to be the first planet to be discovered by the use of the telescope. Uranus is also a very large planet and has a blue-green colour. Uranus is very cold and clearly no life could exist there. Ariel, Titania, and Oberon are the largest of its moons.

Neptune is about the same size as Uranus and is the last of the large planets. Three complete rings have been discovered. Because of its great distance from the Sun it does not have a proper day. Winds on Neptune reach speeds of over 1100 km/h. Neptune has seven moons. Triton is by far the biggest and has signs of volcanoes.

Pluto was the last planet to be discovered. It is very small and has a very low density. In 1978, a moon called *Sharon* was discovered close to Pluto. However, in 2006, some astronomers decided that Pluto was no longer a planet. They think that it was one of Neptune's moons which broke out of its gravitational field and went into orbit around the Sun.

What shape is the Earth?

In the middle ages, most people believed that the Earth was flat. They thought that if ships sailed too far, they would fall over the edge.

Evidence that the Earth is spherical:

- If the Earth were flat, the same stars would be seen from anywhere on its surface. But this is not so.
- If we stand on the seashore and watch a ship sail out to sea, we will notice that it not only appears smaller but also disappears over the horizon. This could only happen if the surface of the Earth were curved.
- During a lunar eclipse the shadow of the Earth falls on the moon. This shadow is always circular, no matter what the position of the Earth and Sun is.

Leap year

Ask the students: *does anyone know how many days are there in a year? What about a leap year?*

Explain how we can calculate whether a year is a leap year or not. A year has an extra day if its number divides exactly by four, eg. 1992, 2000, 2008. This keeps the solar calendar in line with the movements of the Sun and stars.

Change of seasons

The Earth's axis is tilted slightly at an angle of 23° to its orbit. It is not perpendicular.

Ask the students: *what effect will this tilt cause on the rays of the Sun reaching the different parts of the Earth?*

Additional activity 2

Show the students a globe. Tilt it and rotate it on its axis from west to east. Shine a torch on to the Equator of the globe as it spins.

Explain that the globe is a model of the Earth. It rotates, or spins, on its axis. The torch is a model of the Sun's light.

Now ask the following questions:

- Does the Sun move?
- What is happening on the part of the Earth which is facing the Sun?
- What happens on the part that is away from the Sun?
- How long does it take for the Earth to rotate once on its axis?
- What does this rotation cause?
- Where do the rays of the Sun fall directly?
- Would the temperature of this area be high or low?
- Is the sunlight equally strong on the top and the bottom of the Earth?
- Would the temperatures at the top and bottom of the Earth be high or low?
- In which direction does the Earth spin?

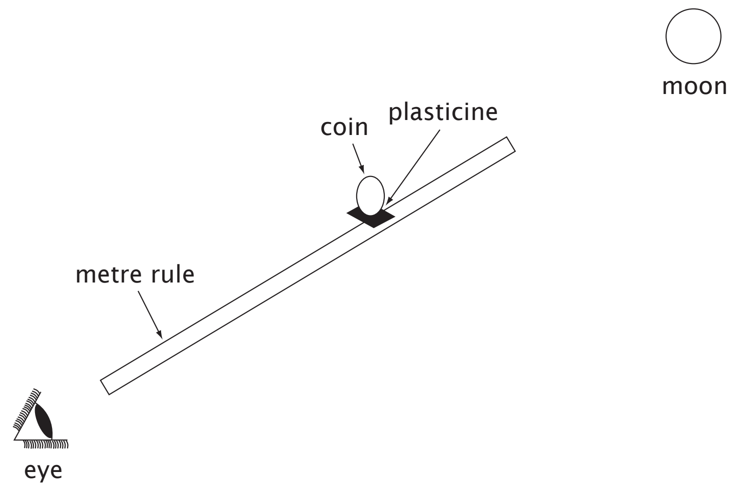
Facts about the Moon

- The moon is the Earth's natural satellite
- It is at about 384,000 km away from the Earth
- Its diameter is about 3500 km
- Its gravity is 1/6 that of the Earth
- It has no atmosphere and hence no life
- It rotates once in the same time as it takes to complete one orbit of the Earth
- Moon days and moon nights last for 14 Earth days. During a moon day the temperature rises as much as 120°C
- At night its temperature falls to –150°C
- The surface of the Moon is dry, hard and covered in loose dust. It is pitted with many large craters, some more than 100 km across, caused by the impact of meteorites.

Additional activity 3

We can calculate how far the moon is from the Earth. You will need a metre rule, a one rupee coin, some Plasticine, a clear night with a full moon.

Arrange the apparatus as shown in the diagram.



Make sure that your eye, the metre rule, and the moon are in line. Move the coin up and down the metre rule until it just covers the moon. Measure the distance from the coin to the end of the stick nearest your eye and note it. Substitute the value in the given equation:

$$\text{The distance of the moon to the Earth} = \frac{\text{moon diameter (m)} \times \text{coin to eye distance (m)}}{\text{coin diameter}}$$

[Note: the diameter of the moon is 3500 km.]

Information from space

Much of our knowledge about the solar system has come from investigations carried out by people or machines. To send people and machines into space, powerful rockets had to be developed. These rockets have to be strong enough to break out of the Earth's gravitational field. The space shuttle is a true space vehicle. It takes off like a rocket, moves about in space, and lands like an aeroplane. Like rockets, the Space Shuttle can carry heavy loads into space and its orbiter can be used over and over again.

Answers

***The solar system*: p 110**

1. a) A galaxy is a huge mass of stars.
   b) The Milky Way
   c) The stars are so clustered together that they appear to form a milky white pathway.
2. a) A light year is the distance that light travels in one year moving at 186,000 miles per second.
   b) 186,000 x 60 x 60 x 24 x 365 = 5,865,696,000,000 miles
3. a) Scientists have estimated that the universe contains 100 billion galaxies.
   b) The Earth is only a tiny part of the Milky Way galaxy.

***The planets of our solar system*: p 111**

1. eight planets
2. We see the planets and the moon because of the light that they reflect from the Sun.
3. Objects that reflect light are called luminous objects. Objects that do not reflect light are called non-luminous objects. The planets and their moons are luminous objects.
4. Astronomers have noticed that as comets pass beyond Pluto, they appear to be influenced by other gravitational fields.
5. All the planets and other bodies revolving around the Sun are held in orbit by the force of gravity.

***Planet facts*: p 112–113**

1. a) 4500 million km b) Jupiter c) –23˚C d) 10 hrs
2. a) Mercury b) Neptune
3. a) between Mars and Jupiter b) It takes 1679 days to orbit the Sun
4. a) Mars
   b) For Mars to rotate once takes 24 hrs 30 min.
   Its surface is rocky.
   It has nitrogen gas.
5. Venus has a much higher temperature than expected because its atmosphere contains carbon dioxide which has a greenhouse effect.

***Days, months and years*: p 114**

1. Night-time falls when our part of the Earth faces away from the Sun, towards where there is no light.
2. When the side of the moon lit by the Sun faces the Earth, we see a full moon. When the moon is on the side of the Earth nearest the Sun it is called a new moon.
3. a) The time taken for the Earth to complete one rotation on its axis is called a day.
   b) 30 or 31 rotations of the Earth on its own axis completes a month.
   c) One complete orbit of the Earth around the Sun takes about 365.25 days or one year.
4. Please refer to the diagram on page 114 of the student's book.
5. Since the Earth takes 365.25 days to orbit the Sun, we cannot have a quarter of a day at the end of each calendar year. So the quarters are added together to produce an extra day every four years. Years that have an extra day are called leap years.

***The seasons*: p 115**

1. 23 degrees
2. a) The part of the Earth which is tilted towards the Sun receives more light and is warmer, therefore, it experiences summer.
   b) The part of the Earth which is tilted away from the Sun receives less light and is colder, therefore, will be having the winter season.

3. a) The northern half of the Earth is tilted towards the Sun in June.
   b) The southern half of the Earth is tilted towards the Sun in December.
4. In December the northern half of the Earth, where UK is located, is tilted away from the Sun while the southern part, where Australia is located, is tilted towards the Sun. So it is warmer in Australia than in the UK.
5. a) and b) Answers depend on students.

***The moon and eclipses*: p 116**

1 a) The craters were caused mainly by meteorites as they collided with the moon.
  b) The moon's seas are areas of basalt rock.
2. The moon rotates once as it completes one orbit of the Earth. This means that the same side of the moon is always facing the Earth.
3 a) An eclipse takes place when one planet or moon blocks off light from another.
  b) i) During a solar eclipse, the moon passes between the Earth and the Sun. As a result, light from the Sun is hidden and the moon appears to us as a black disc surrounded by a halo of bright light.
     ii) During a lunar eclipse, the Earth is positioned between the moon and the Sun. The moon dims as the shadow of the Earth moves across the face of the moon.
  c) The moon's orbit is slightly tilted so solar eclipses do not happen every month.

***Information from space (1): observation*: p 117**

1. a) We look at the stars from the Earth which is slowly revolving. So, like the moon, the stars appear to move across the night sky.
   b) The Pole Star stays in the same position because it is in line with the Earth's axis.
2. The modern telescope uses large mirrors instead of lenses to focus light on to detectors. High quality images are then generated by computers.
3. Radio telescopes detect radio waves sent out by objects in space. These telescopes have large reflectors which focus the radio waves on to detectors.
4. The Hubble space telescope is not affected by dust and other pollution in the air.
5. Computers help to generate high quality images from the telescope detectors.

***Information from space (2): space probes*: p 118–119**

1. a) Megellan flew to Venus.
   b) From May 1989 to August 1990.
   c) He found out that most of the planet was covered with volcanoes / lava.
2. Viking 2, Galileo and Cassini used space probes to gather information from planets.
3. a) The first man in space was Yuri Gagarin.
   b) He was a Russian cosmonaut.
4. The space ship was launched in 2001, which was part of the title of the movie.
5. a) The strong evidence that Mars had water suggests that it could have supported life.
   b) From April to October 2001.

***Test yourself*: p 120–121**

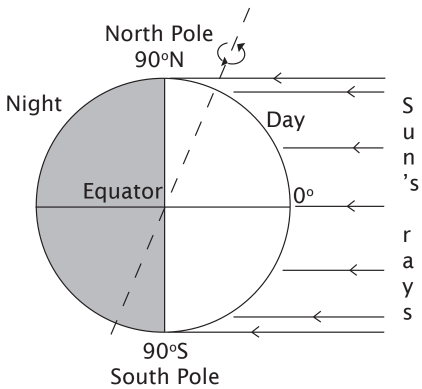
1. The ***Universe*** contains everything that exists. Planet Earth is just a tiny part of a galaxy called the ***Milky Way***. Our galaxy is only one of many star systems scattered throughout the Universe. Each galaxy contains millions of ***stars*** together with clouds of dust and ***gases***. Galaxies are very far apart. The nearest large galaxy to ours is called ***Andromeda*** which is two million light years away. This means the light we see from this galaxy has taken two million ***years*** to reach us on Earth.
2. a) i) Jupiter   ii) Pluto
   b) i) Mercury   ii) Pluto
   c) Pluto
   d) Mercury
   e) i) They found frozen water.
      ii) Its average temperature (–23 degrees C) is too low to support life.
3. a) i) Stars have light of their own, so they shine all the time.
      ii) Planets reflect the light of the Sun so they can only be seen at night.

b) Stars can be seen all the time.

c) i) When we look at the stars from Earth, which is slowly revolving, the stars appear to move across the night sky. In the northern hemisphere the whole night sky appears to rotate in an anticlockwise direction.

ii) The Pole Star does not appear to move because it is in line with Earth's axis.

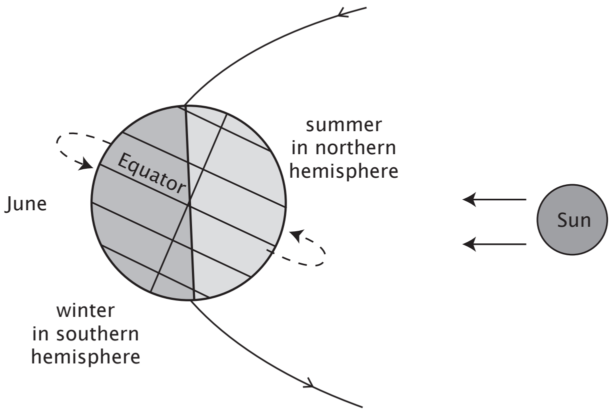
4. a) The rays of the Sun fall directly on the Equator throughout the year, so the days and nights are of equal lengths.



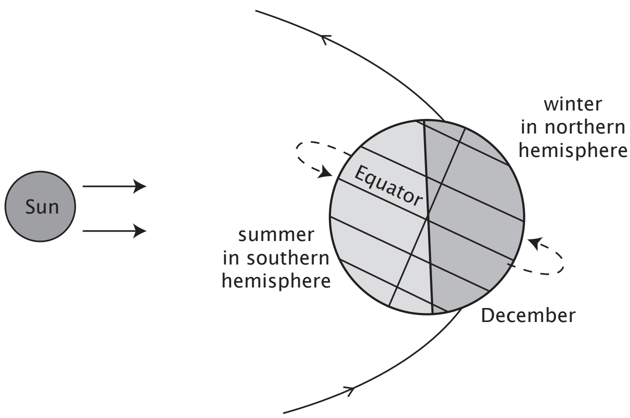
b) During spring and autumn, UK gets equal amounts of light because the Earth is tilted neither towards nor away from the Sun at these times of the year.

See page 115 of the student's book for reference.

c) In the month of June, the northern hemisphere is tilted towards the Sun because of the Earth's axis. Therefore, the North Pole receives light even at night.



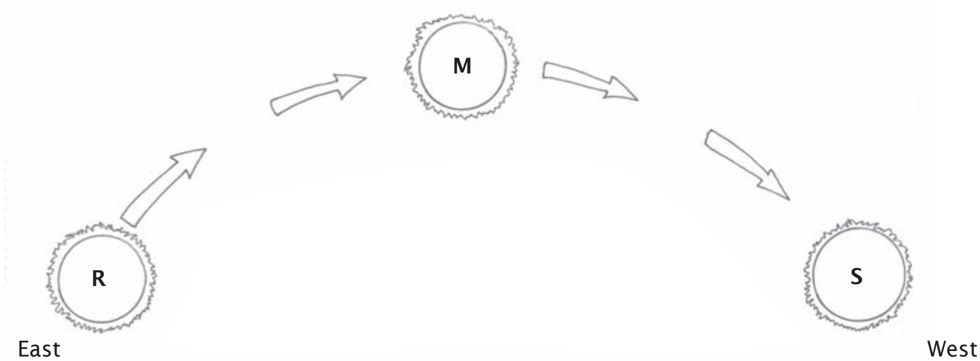
d) On December 21st, the southern hemisphere of the Earth faces the Sun. As a result, Australia experiences midsummer.



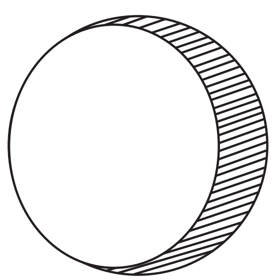
5. a) It does not reflect light.
   b) Sun
   c) i) B and C ii) A
   d) 24 hours
6. a) An eclipse is a shadow which is formed when one planet or moon blocks light from another.
   b) Refer to diagrams on page 116 of the student's book.
   c) As the moon orbits the Earth, it sometimes passes between the Earth and the Sun. Light from the Sun is blocked and the moon appears to us as a black disc surrounded by a halo of bright light.
   d) If the orbits of the Earth and the moon were in the same plane there would be a lunar eclipse every month. However, the moon's orbit is slightly tilted so it does not occur very often.

Workbook 1, Chapter 12

1. Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
2. a) i) Mercury ii) Neptune
   b) i) Jupiter ii) Mercury
   c) i) Mercury ii) Neptune
   d) Mercury
   e) The further the planet is from the Sun, the longer it takes to orbit it.
   f) This is because Neptune is very far away from the Sun.
3. a) A b) E c) C d) A e) E
4.



5. a) It reflects the light of the Sun.
   b)



   c) 1
   d) 5
   e) 27.3 days
   f) The moon rotates once in the same time as it takes to complete one orbit of Earth. That is why the same side of the moon faces the Earth.
6. A solar eclipse happens when the ***moon*** passes between the ***Sun*** and the ***Earth***. Light from the ***Sun*** is hidden and the ***moon*** appears to us as a black disc surrounded by a halo of bright light.

   A lunar eclipse happens when the ***Earth*** passes between the ***Sun*** and the ***moon***. The shadow of the ***Earth*** covers the face of the ***moon***.

Project

As the Sun moves from east to west during the day, the shadow it casts also moves. The Babylonians learned to tell the time by this over 4000 years ago, making the first shadow clock, or the sundial.

In order to make a sundial, you will need a flower pot, a stick (twice the height of the pot), black marker, and a sheet of white paper.

Turn the flower pot upside down and push the stick through its base hole into the ground.

Place the pot on a sheet of white paper, in the Sun. Mark the position of the shadow cast by the stick every hour. Every time it is sunny, you will be able to tell the time from the marks on your sundial.

Multiple Choice Questions

1. A light year is the distance light travels in
   A 1 year B 2 years C 3 years D 4 years
2. A huge mass of stars is called a
   A universe B galaxy C Milky Way D solar system
3. Which one of the following is called a dwarf planet?
   A Mercury B Venus C Pluto D Mars
4. The average distance of the Earth from the Sun (in million km) is
   A 60 B 108 C 150 D 230
5. The main gases in the atmosphere of the Earth are
   A helium and argon B carbon dioxide
   C hydrogen, helium and methane D nitrogen and oxygen
6. Which planet takes the longest time to orbit the Sun?
   A Mercury B Earth C Saturn D Neptune
7. The moon moves around the Earth once every
   A 25.2 days B 26.4 days C 27.3 days D 28.5 days
8. A solar eclipse occurs when the ________________ comes between the Earth and the Sun.
   A moon B Sun C stars D Earth
9. The orbiter Viking 2 took close up photographs of
   A Jupiter B Mars C Venus D Saturn
10. Which planet other than Earth do scientists believe could have supported life?
   A Mars B Mercury C Venus D Saturn

Answers

1. A	2. B	3. C	4. C	5. D
6. D	7. C	8. A	9. B	10. A

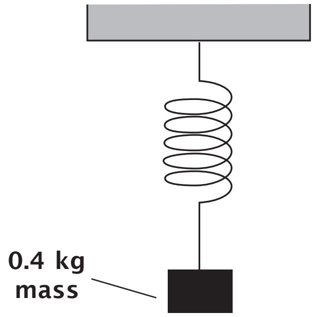
Sample lesson plan

	Topic	Time	Objectives		Plan (Activities) Time	Resources Needed
			Knowledge	Skills		
1	Particles States of matter p 74	1 period 40 mins	To organize and classify matter into solids, liquids and gases	To understand the existence and behaviour of matter and to be able to classify matter into solids, liquid and gases	Background Info: 5 mins Introduction: 10 mins	samples of solids, liquids and gases. Charts to demonstrate the grouping of materials in solids, liquids and gases.
2	The particle model of solids, liquids and gases p 75	1 period 40 mins	To study the characteristics of matter	To understand the particulate nature of matter and movement of particles in different states	Background Info: 5 mins Introduction: 10 mins	charts of the particle model. Group activity to demonstrate arrangement of particles in three states.
3	Evidence for particle model (1) p 76	2 periods of 40 mins each	To prove the existence of particles and their behaviour	To explain that particles of matter exist and that they are always moving. There are spaces between the molecules	Background Info: 10 mins Introduction: 10 mins Discussion: particles exist and are always moving. There are spaces between the molecules: 20 mins Assessment tasks: 10 mins	balloons, beakers, ink smoke cell, microscope slide, pollen grains, water, peas, rice, graduated cylinder, 2 gas jars; one empty and one filled with a brown gas.
4	Evidence for particle model (2) p 77 Expansion and contraction p 78 Pressure in Gases p 79	2 periods of 40 mins each	To study the behaviour of particles under the influence of heat and its effects on the nature of materials. To understand that gases can be compressed and that pressure thus developed is called 'gas pressure'	To explain expansion and contraction of materials due to changes in temp. To study the effects of expansion and contraction on materials. They learn that gases can be compressed easily due to their moleculer arrangement	Background Info: 10 mins Introduction: 20 mins Discussion: 20 mins Practical activities: 20 mins Assessment tasks: 10 mins	test tube, beaker, cork fitted with glass tube, beakers, ball and ring apparatus, balloons, vacuum pump, plastic bottle, bell jar.

	Assessment Tasks	Homework	Teachers evaluation of the lesson
1	Classify materials into solids, liquids and gases	Attempt the questions on p 74	
2	Explain why liquids can flow, why gases can be compressed	Attempt questions on p 75	
3	Explain diffusion by an example	Attempt questions of p 76,77	
4	Give a few everyday examples of expansion and contraction and their effects.	Attempt the questions on p 78 and 79	
5	How does gas pressure build up inside a balloon.		

Test Paper

1. The figure shows a 0.4 kg mass hanging from a spring.



a) State what is meant by the mass of an object.

____

____

____

b) i) On the figure above, draw an arrow showing the direction and the line of action for each of the two forces that act on the mass. Write the name of the force next to each arrow.

ii) The gravitational field strength is 10 N/kg. Calculate the size of each of the two forces acting on the mass.

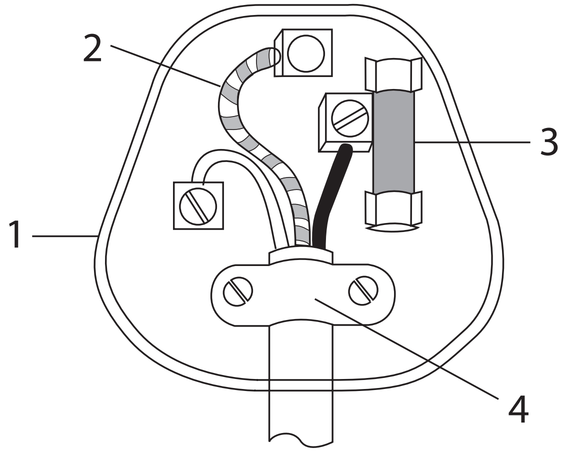
first force = ____________ second force = ____________

2. Power stations use energy sources to generate electricity.
Which **two** types of power station use a renewable source of energy?

coal-fired
hydroelectric
nuclear
oil-fired
tidal barrage

____

3. Each part of a plug has a job to do.
   Match words from the list with the labels **1–4** on the diagram.



connects metal case of appliance to the Earth __________

holds the cable firmly __________

insulates the plug __________

wire inside melts if current is too high __________

4. Match words from the list with the numbers **1–4** in the table.

carbon dioxide __________

hydrogen __________

oxygen __________

sulphur dioxide __________

Gas	Fact about the gas
1	it is formed when sulphur burns in air
2	it is produced when magnesium carbonate reacts with an acid
3	it gives a squeaky pop when tested with a lighted splint
4	it reacts with carbon to form carbon dioxide

5. The devices shown below transfer electrical energy in different ways.

washing machine

____

kettle

____

torch

____

radio

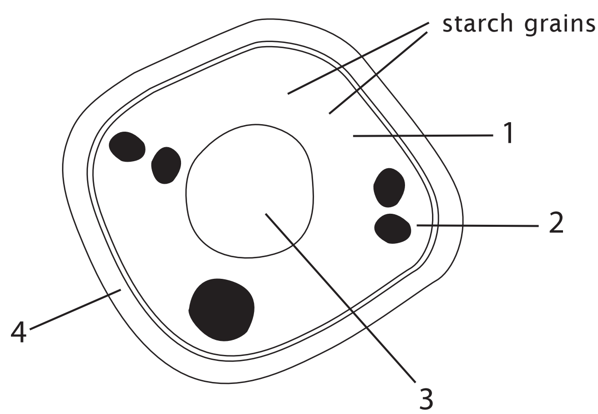
____

Match the devices with the numbers **1–4** in the table.

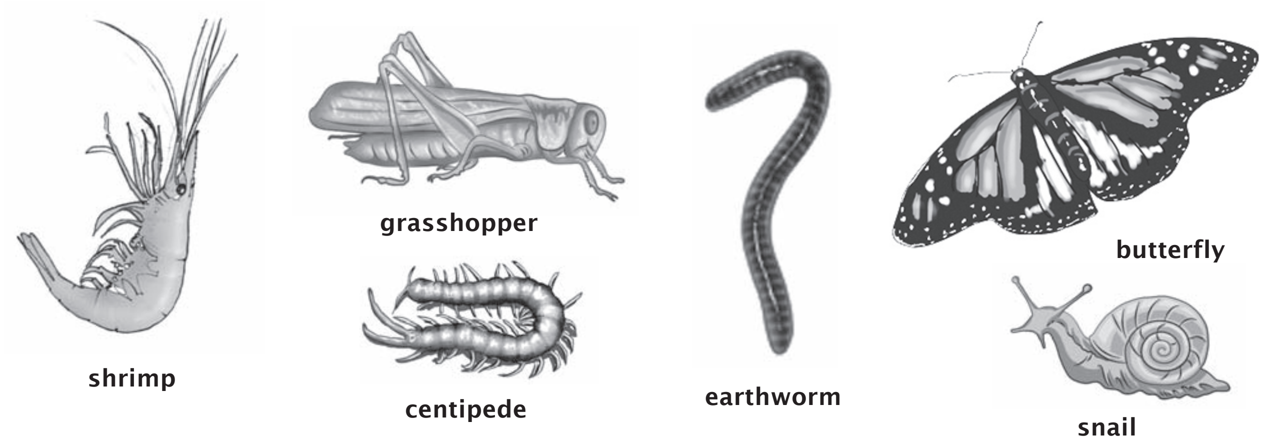
	Designed to transfer electrical energy as
1	heat
2	light
3	movement
4	sound

6. The diagram shows a plant cell.
   Match words from the list with the labels **1–4** on the diagram.

cell wall ________
choroplast ________
cytoplasm ________
vacuole ________



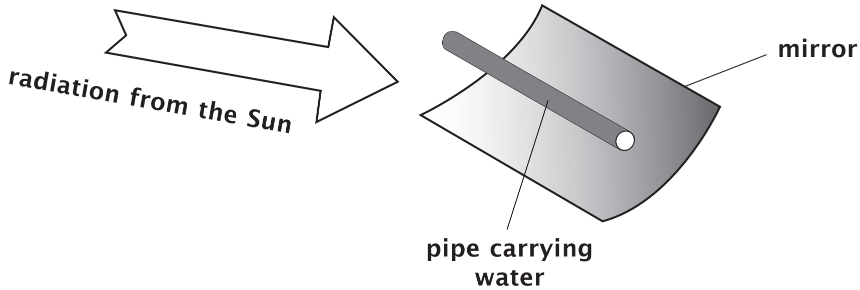
7. Classify the following animals with the help of the key below:



Invertebrates

- **do not have legs**
  - **have shell** ______________
  - **do not have shell** ______________
- **have legs**
  - **have wings**
    - **have strong back legs** ______________
    - **do not have strong back legs** ______________
  - **do not have wings**
    - **have claws** ______________
    - **do not have claws** ______________

6. The diagram shows part of a solar-powered power station.



Match words from the list with the numbers **1–4** in the flow chart to explain how the power station works.

a turbine turns a generator
radiation is refelected onto the pipe
steam drives a turbine
water in the pipe absorbs energy

radiation from the Sun falls on the mirror
↓
1
↓
2
↓
hot water changes to steam
↓
3
↓
4
↓
electricity is produced

Notes

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