Ghana Association of Science Teachers

Primary Integrated Science

Teacher's Guide 4

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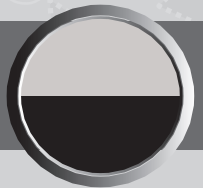


Primary 4 Course Structure

Section 1: Diversity of Matter

Unit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
Unit 1 Metals and non-metals	The pupil will be able to:		**Unit 1 Metals and non-metals**
	1.1.1 List some types of materials in the environment	Types of materials: metals, glass, plastic, paper, wood	1 Types of materials in the environment
	1.1.2 Describe some characteristics of metals	Characteristics of metals: • Usually hard • Shiny surfaces when new • Can be beaten into shapes • Conduct heat and electricity • Produce high-pitched sound when struck • Make musical sound • Metals are heavy, some are light • Often in solid state • Have different colours • Can be drawn into wires • Very strong	2 Looking at metals 3 Characteristics of metals
	1.1.3 Group materials into metals and non-metals	Metals and non-metals	4 Grouping materials into metals and non-metals
	1.1.4 Name some metals	e.g. silver, iron, copper, gold, zinc, aluminium, tin	5 Names of some metals

Unit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
	1.1.5 State some uses of metals in everyday life	Uses of metals: • construction • building cars, trains, airplanes	6 Uses of metals in everyday life
		• cutlery, agricultural tools • computers, etc.	
	1.1.6 Make simple tools and toys from metals	Making simple tools from metals	
	1.1.7 Name some non-metals	Non-metals, e.g. plastic, glass, polythene, sulphur, wood, rubber, carbon	7 Naming some non-metals
	1.1.8 List some characteristics of non-metals	Characteristics of non-metals: • Have dull surfaces • Poor conductors of heat and electricity • Make low-pitched sound • Usually break easily (brittle)	8 Characteristics of non-metals
	1.1.9 Describe some uses of non-metals	Applications of non-metals	9 Uses of non-metals 10 Electrical circuits
Unit 2 Rusting	The pupil will be able to:		**Unit 2 Rusting**
	1.2.1 Identify materials that rust	Rusting	1 Materials that rust
	1.2.2 Explain causes of rusting	Causes of rusting	2 Causes of rusting
	1.2.3 Explain the effects of rusting on iron	Effects of rusting on iron	3 Effects of rusting on iron
	1.2.4 Clean rust from the surface of iron	Cleaning rust from the surface of iron	4 Cleaning rust from the surface of iron

Unit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
	1.2.5 Demonstrate how to prevent iron from rusting	Prevention of rusting: • painting • oiling/greasing • insulating the surface of iron from air, etc.	5 Methods of preventing rust
Unit 3 Measurement of temperature	The pupil will be able to:		**Unit 3 Measurement of temperature**
	1.3.1 Infer that temperature is a measure of how hot a substance is	Meaning of temperature	1 Meaning of temperature
	1.3.2 State the units for measuring temperature	Units of temperature degree Celsius, 0C and degree Fahrenheit, 0F	3 The units for measuring temperature
	1.3.3 Read temperature on an analogue and digital thermometer	Reading temperature on analogue and digital thermometers	2 Reading temperature on analogue and digital thermometers 4 Reading temperature on a thermometer
	1.3.4 Handle and use different types of thermometer	Handling and using thermometers	5 Proper handling of a thermometer

Section 2: Cycles

Unit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
Unit 1 Ventilation	The pupil will be able to:		**Unit 4 Ventilation**
	2.1.1 Explain the concept of convection	Meaning of convection	1 Meaning of convection

Unit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
	2.1.2 Demonstrate convection current	Convection current	
	2.1.3 Explain ventilation in terms of convection current	Ventilation and convection current	2 Ventilation in terms of convection currents
	2.1.4 Identify applications of ventilation in everyday life	Applications of ventilation and convection: sea breeze, land breeze, air conditioning, fridge, chimney	3 Application of convection in everyday life 4 Sea and land breezes
	2.1.5 Explain the need to ventilate rooms for good health	Ventilation of rooms	5 Ventilation of rooms
	2.1.6 Describe what leads to poor ventilation in our homes	Causes of poor ventilation in the homes	6 Causes of poor ventilation in the homes

Section 3: Systems

Unit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
Unit 1 The Solar System	The pupil will be able to:		**Unit 5 The Solar System**
	3.1.1 Identify the components of the Solar System	Components of the Solar System: Sun, Earth, Moon and other planets	1 The Solar System 2 Components of the Solar System
	3.1.2 Describe the movement of the Moon around the Earth	Movement of the Moon around the Earth	4 Movement of the Moon around the Earth 5 Why the Moon seems to have different shapes

Unit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
	3.1.3 Identify the relative positions of the Sun, Moon and the Earth in the Solar System	Relative positions of the Sun, Moon and the Earth in the Solar System	1 The Solar System 2 Components of the Solar System
	3.1.4 Distinguish between luminous and non-luminous bodies	Luminous and non-luminous bodies	3 Luminous and non-luminous bodies
	3.1.5 Explain the concept of satellite	Satellite: a smaller body that moves round a bigger body	6 Satellites
	3.1.6 List some uses of artificial satellites	Uses of artificial satellites: • communication • space exploration • observation of weather patterns, etc.	7 Uses of artificial satellites

<A>Section 4: Energy

U nit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
Unit 1 Sources of Energy	The pupil will be able to:		**Unit 6 Sources of energy**
	4.1.1 Explain the term 'energy'	Meaning of energy	1 Energy
	4.1.2 Identify some sources of energy	Sources of energy: food, Sun, wind, water, cell/ battery, crude oil, natural gas	2 Sources of energy
	4.1.3 Demonstrate some uses of solar energy	Solar energy can burn Boiling water with solar energy	3 The Sun is a source of energy 4 Electricity is important to us

U nit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
Unit 2 Basic Electronics	The pupil will be able to:		**Unit 7 Basic Electronics**
	4.2.1 Describe the behaviour of a P-N junction diode in an electronic circuit	P-N junction Semiconductor diode Forward bias Reverse bias	1 Semiconductors 2 P-N junction diode in an electronic circuit

Section 5: Interactions of Matter

Unit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
Unit 1 Forces	The pupil will be able to:		**Unit 8 Forces**
	5.1.1 Explain the term 'force'	Force: a push or a pull	1 What is a force?
	5.1.2 Describe different types of force	Examples of forces: • frictional force • elastic spring force • magnetic force • gravitational force • compression force	2 Types of forces
	5.1.3 Describe the effects of force on objects	Effects of force on objects: • a force can move a stationary object • a force can speed up, slow down or change the direction of an object in motion • a force can stop a moving object • a force may change the shape of objects	3 Effects of force on objects
Unit 2 Care of the skin	The pupil will be able to:		**Unit 9 Care of the skin**
	5.2.1 Name some diseases of the skin	Diseases of the skin: • ringworm • eczema • beriberi • scabies	1 The skin 2 Some diseases of the skin

Unit in the syllabus	Specific Objectives	Content	Unit in the Course and Unit sub-sections
		• leprosy • chicken pox • measles	
	5.2.2 Describe preventive measures for some common skin diseases	Prevention of skin diseases	3 Treatment and prevention of skin diseases 4 Personal hygiene

Introduction

This course has been written to deliver the new syllabus in Integrated Science published by the Curriculum Research and Development Division (CRDD) of the Ministry of Education (MOE), in September 2012. It has been developed by an expert team of Ghanaian teachers and educators and its aim is both to achieve the general aims and the specific objectives of the syllabus, and also to support teachers as they work with pupils through the year.

The course uses a child-centred approach, and works to develop the abilities of the pupils in line with the profile dimensions specified in the syllabus document. The course is designed to help the pupils to develop scientific attitudes and process skills, as well as their knowledge and understanding of science and their ability to apply that knowledge. The course is activity-based and proceeds on the assumption that children learn best when they are actively doing science, not just listening or reading about it. Accordingly, you will see that each unit of the Pupil's Book contains many activities for pupils to do.

This Teacher's Guide is designed to support teachers as they create the teaching and learning opportunities and the activities through which the pupils will develop their science skills, their attitudes and their knowledge and understanding of science. For each unit in the Pupil's Book, this Guide provides a list of the key words introduced in the topic, advice on lesson planning and a list of resources required so that these can be collected together before the teaching of the unit begins. Guidelines on how to present the teaching and learning activities are provided, and there is particular emphasis on opportunities for activities for both more able and less able pupils. This will help teachers to individualize their teaching so that they can offer the best learning opportunities to all the pupils in their class.

This course also provides plenty of assessment opportunities. There are questions for discussion throughout the Pupil's Book, and these can be used for ongoing evaluation of the pupils by the teacher. Each unit in the Pupil's Book ends with a summary of the topics covered, and a set of questions which may be used for self-evaluation by the pupils, for homework, or as an end-of-unit test. Answers to these questions are provided in the Teacher's Guide. In addition, the Teacher's Guide provides a set of Review questions for each unit which are designed to provide information both on the knowledge and understanding which the pupils have acquired, and also the development of their scientific skills and attitudes.

School-based Assessment (SBA) is an important feature introduced by the new MOE syllabus. The Review questions also serve to assist teachers with their School-based Assessment. These

are written in the same style as the SBA items to be provided by the Ministry of Education. These items may be used for assessment, for examination practice or as a way of reviewing the topics covered during the school year.

We hope that you enjoy using this course, and working with your pupils to develop their scientific abilities.

The authors

January 2012

Section 1: Diversity of Matter

Metals and non-metals

Syllabus objectives covered in this unit

By the end of this unit the pupils will be able to:

1.1.1 List types of materials in the environment.
1.1.2 Describe some characteristics of metals.
1.1.3 Group materials into metals and non-metals.
1.1.4 Name some metals.
1.1.5 State some uses of metals in everyday life.
1.1.6 Make simple tools and toys from metals.
1.1.7 Name some non-metallic materials.
1.1.8 Describe the characteristics of non-metals.
1.1.9 List some uses of non-metals.

Introduction and additional information

Looking at our environment, a key classification of the materials around us is to divide them into metals and non-metals. Metals are a group of elements which have a lot of features in common. They are defined as metals because of their chemical structure and their position in the Periodic Table of Elements. Metals are malleable (meaning that they can be bent or beaten into different shapes without cracking or breaking), ductile (meaning that they can be pulled and stretched out into thin wire), and bright and shiny when their surface is newly cut. Metal surfaces often do not stay shiny after being exposed to the air once they have been cut, but become grey or tarnished. This is due to oxidation by the oxygen in the air. Metals which are unreactive, such as gold and silver, stay shiny for the longest because they do not react with the air. Metals are also good conductors of heat and electricity.

Take care with references to tin and zinc. Both of these metals are used to coat iron to prevent it from rusting. A tin can, for example, is not made of pure tin, but from iron or steel coated with tin. Many cans these days are made from aluminium, which is a lighter metal – drink cans are often aluminium. You can tell which ones are tin-coated steel by seeing if they are attracted by a magnet.

Similarly, zinc roofing sheets are not made from pure zinc, but from iron coated with zinc. You can see that this is so, because very old roofing sheets tend to rust where the zinc coating has broken away or worn off.

Brass is a common material which is actually a mixture of metals, usually copper and zinc. A mixture of metals is called an alloy. Copper is a reddish metal, and zinc is silvery, so when mixed they make a yellowish metal, which is hard and strong and resistant to corrosion. At this level, brass can be included as a metal in its own right, and can be put into the list of metals.

Steel is also an alloy of iron mixed with other metals and with carbon. There are many different types of steel: stainless steel is an alloy of chromium, carbon and iron; manganese steel provides a very hard steel used in making construction equipment and earth-moving tools, and so on. Alloying the iron with carbon makes it stronger. Steel is stiffer, stronger and more resistant to rust than iron.

All metals are solid at room temperature with the exception of mercury, the silver liquid used in the thread of thermometers. Mercury becomes solid at -38^0C.

Key words introduced

metal, non-metal, copper, silver, gold, aluminium, iron, steel, brass, zinc, hard, ringing, conduct, brittle

Planning

Build up a good collection of metal objects for this part of the course, with as wide a variety of metals as you can find. Try to show the pupils some pieces of gold and silver jewellery, so that they can see that these metals do retain their shine for a long time. Make sure that valuable items such as these are carefully looked after, and that they are not left in the classroom. It is also a good idea to ask the pupils to bring into school examples of metal objects which they have at home, so that this resource for the class can be as large as possible.

Similarly, it is also useful to collect non-metallic objects, and this collection should also be as large as possible.

This unit involves a visit to a local blacksmith. This will require advance planning. First locate the nearest blacksmith, and then check that it will be practicable to bring the class to watch his work. This will also need to be cleared with the head teacher.

Resources and low cost or no cost materials required

Try to collect the following metal objects:

- copper wire, piping or sheet
- brass door knob or handle
- steel knife or fork
- gold ring
- silver ring or earring
- tin can
- aluminium can
- aluminium cooking pot
- iron cooking pot
- shiny wheel hub cap.

Try to collect the following non-metal objects:

- plastic cups
- a plastic bucket
- plastic bags
- glass bottles
- plastic bottles
- wooden boxes or furniture
- paper books
- clay pots
- cups and plates made from porcelain.

For the activities:

- Activity 2 – String and small sticks.
- Activity 3 – A metal strip about 20 cm long, a wooden stick about 20 cm long, a candle, matches.
- Activity 5 – A torch light bulb, a dry cell, connecting wire.
- Activity 6 – A selection of mostly metal objects (see above for those you may already have collected) such as plumbing pipes, roofing sheet, cooking pan with wooden handle, a metallic spoon, a metallic bracelet, ring, metal rod, etc

- Activity 8 – Empty milk or Milo tins, scissors or tin cutters, thin card, nails, electric motors, connecting wires, dry cells, switches, Plasticine®, protective gloves.
- Activity 10 – Clay, leaves or grass, sticks.
- Activity 11 – Electric circuits.

Guidelines for the teaching and learning activities

1 Types of materials in the environment *Pupil's Book pages 2-3*

In the course so far this year the pupils have been looking at living things – plants and animals – and classifying them into groups. In this unit they are asked to study non-living objects, and to begin to classify them. Start by making sure that they are comfortable with the distinction between living and non-living objects, and turn their focus to non-living objects.

The first activity is important, as it is necessary for pupils to consider the materials from which objects are made, not just the objects themselves. Get them to build up a long list of objects that they can see around them, and through classroom discussion and question and answer techniques, get them to complete their tables listing what common objects are made from.

2 Looking at metals *Pupil's Book pages 3-4*

3 Characteristics of metals *Pupil's Book pages 4-8*

The chief characteristics of metals have been listed in the background information above. These are not always easily demonstrated – for example hitting a zinc roofing sheet with a hammer does not give a nice ringing sound. But for most of the metals that the pupils will be familiar with, the chief characteristics can be observed.

In Activity 2, the pupils have an opportunity to find out for themselves some of the properties of metals. Then in Section 3 we have two further activities to explore metal characteristics more carefully – the ability of metals to conduct heat, and their ability to conduct electricity. In the experiment on conducting heat (Activity 3), do ensure that this is done safely. If the metal strip is held in the flame too long, the end that the pupils are holding will become very hot, so take care that no-one is burned. Conversely, the other end of the wooden stick will not become hot at all, even if the hot end catches fire. This shows that heat has not been conducted along the wooden stick.

The visit to a blacksmith (Activity 4) should have been planned at the start of this unit. It forms a good addition to the classroom experiments, as it helps pupils to relate to what is going on around them in their community. Make sure that the visit is fully recorded by the pupils, and ensure that there is a good discussion of what they have seen after they return to the classroom.

Go through Activity 5 on the conduction of electricity, to show the pupils that a paper strip cannot conduct electricity, while metal wire can.

4 Grouping materials into metals and non-metals

Pupil's Book pages 8-9

Pupils will now have a greater understanding of what characterizes a metal, and of the difference between metals and non-metals. Bring out this understanding in classroom discussion, so that you can build on what the pupils already know. Go through Activity 6 classifying the objects you have brought to the classroom in discussion with the pupils. If any objects are placed in the wrong column, ask why they want to put the objects in that column, and get the class to discuss which is the better column to use. Encourage the pupils to use the properties of the materials to distinguish them. The main value of this activity is in the discussion about which objects are metals and which are non-metals, rather than in building up a long list.

Pupils may suggest tests that could be done if a particular material is difficult to assign to either group.

5 Names of some metals

Pupil's Book pages 9-10

Use classroom discussion techniques to get pupils to bring out the names of all the metals that they know. Show them the metal objects that form your classroom collection, and make sure that they can write down the names of all the metals in this collection.

6 Uses of metals in everyday life

Pupil's Book pages 10-13

Because of their characteristics, metals are extremely useful to us as tools, for protection and in all sorts of other ways. Activity 8 gives instructions for making a toy fan, which the pupils can make from old milk tins or other pieces of metal. Make sure that the pupils use the cutting tools safely and take care when handling metal with sharp edges. Gloves will protect their hands.

Some pupils may prefer to make toy cars out of wire; this is another good activity to show how the characteristics of metals make them useful to us.

7 Naming some non-metals

Pupil's Book pages 14-15

Non-metallic materials are actually much more common in our environment than metals, so it is important that pupils look at these too. Take the pupils on an observation walk to see how many non-metallic substances they can see in their local environment. They do not need to go far from the classroom for this. When they have made their list of non-metals, go through the characteristics of non-metals with them, so that they can begin to use the correct terms to describe the properties of non-metals.

8 Characteristics of non-metals *Pupil's Book page 15*

Not all non-metals are brittle. For example, many plastics are not brittle, but although they are common they are the exception. Generally, non-metals are more of the nature of pieces of chalk: dull in colour, easily broken and not able to conduct heat or electricity.

9 Uses of non-metals *Pupil's Book pages 16-18*

The table that pupils complete in this section can be long, especially for more able pupils. Again, most of the names of the materials used and the reasons for using them can be brought out be classroom discussion with the pupils.

The activity to build a model house shows how well non-metal materials can be combined together to make useful products.

10 Electrical circuits *Pupil's Book page 18*

Activity 11 reinforces the usefulness of the ability of metals to conduct electricity, and of non-metals to act as insulators.

Multi-ability learning – activities for the more able and the less able

3 Characteristics of metals *Pupil's Book pages 4-8*

More able pupils can explore other metals to see if they also conduct electricity. They may notice that some other metals are not as good as copper as conductors. They could tell this by noticing that the light bulb does not shine as brightly if other metals are used. If there is an ammeter available, more able pupils could measure the current passing through different metals in the circuit.

4 Grouping materials into metals and non-metals *Pupil's Book pages 8-9*

Try to ensure that more able pupils build a longer list of metals and non-metals and make sure that they get all the names correct. For less able pupils it should be sufficient if they are able to distinguish two or three metals from non-metals.

5 Names of some metals *Pupil's Book pages 9-10*

For less able pupils, continue to show them more examples of different metals, until they are able to name as a minimum iron, aluminium and gold. Gold has long been a part of Ghanaian culture, and all pupils should be familiar with this metal.

6 Uses of metals in everyday life

Pupil's Book pages 10-13

For more able pupils there is ample opportunity here for them to engage in further research. Ask them to find the names of more metals in use in our towns and cities, and also metals used in industry. As well as collecting more names, they should also say what the metals are used for. Let them report on the research to the whole class.

9 Uses of non-metals

Pupil's Book pages 14-17

For less able pupils, the activity to build a model house out of non-metal materials is a good opportunity for them to shine. Many pupils who struggle with academic school work are gifted when it comes to practical projects such as building models. Encourage less able pupils to do their best in this activity.

Answers to end-of-unit questions

Objective questions

Pupil's Book pages 19-22

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

Essay questions

Pupil's Book page 22

1 Any six metals, such as iron, steel, brass, copper, zinc, tin, gold, silver, aluminium.

2 We use metals to make cooking pots because metals are good at conducting the heat from the fire to the food. Metals are also strong, so that the cooking pot will not break easily. Metals can also be shaped, so they can easily be formed into a pot shape.

3 We use metals to make tanker trucks because metals are very strong, they are not brittle and do not break easily, and they can be formed easily into shapes.

4 We use copper in electrical wires because copper is a metal which conducts electricity very well.

5 Any six non-metals such as wood, plastic, glass, clay, rock, cement, paper, cloth, leather, rubber.

6 Any four items such as plates, glasses, books, furniture, plastic buckets, water bottles and so on.

7 Cooking utensils often have wooden handles because wood does not conduct heat well, so the cook's hands do not get burned when the pot or pan is heated.

8 Metals are hard, shiny, easily shaped, can be drawn into wires, and conduct heat and electricity well.

9 Non-metals are dull, hard, brittle and are poor conductors of heat and electricity.

10 There are many non-metals liquid at room temperature. The most obvious example is water. Others include oil, kerosene, petrol, diesel and alcohol.

Review questions for the pupils

These questions may be given to pupils as an end-of-unit test, for homework or as a review of the topics in the unit.

1 Give the names of four metals and say what they are used for.

2 Give the names of three non-metals, and say what they are used for.

3 Suppose your brother brings you a lump of material he found on the beach, which is shiny, hard, heavy, and gives a ringing sound when hit. Would you tell him it was a metal or a non-metal? What further test could you do to confirm your prediction?

4 Give four common properties of non-metals.

5 Why is gold popular for jewellery?

6 Why are metals good for making tools?

7 Explain why light switches are covered by a non-metal plastic.

8 Explain how you can tell that plastic bottles are made from a non-metal substance.

Answers to Review questions

Where questions ask for examples, pupils may give different examples which may also be correct. Check carefully the answers the pupils have given.

1 Iron is used for making cars and trucks, aluminium is used for cooking pots, gold is used for jewellery and copper is used to make electrical wires.

2 Clay is used to make building blocks, glass is used to make windows, and plastic is used to make drinks bottles.

3 It would seem to be a metal. You could use an electrical circuit with a light bulb in to test if the material can conduct electricity.

4 Non-metals are dull, they do not conduct heat well, they do not conduct electricity well and they are often brittle.

5 Gold is popular for jewellery because it is yellow, shiny and does not tarnish easily,

6 Metals are good for making tools because they are hard, strong and can be formed into useful shapes.

7 Light switches are covered in non-metal plastic so that when touched, the electricity passing through the switch is not conducted to the user.

8 Plastic bottles are poor conductors of heat and electricity.

Diagnostic assessment

These diagnostic assessment exercises will assist you as the teacher to evaluate the impact of the teaching and learning activities in this unit and to assess the extent to which the unit objectives have been achieved.

1 Look back over the weeks teaching about metals and non-metals. Which lessons went well? Can you say why this was? Did pupils find the work on metals more exciting than the work on non-metals? If so, why do you think this was?

2 Did you have sufficient samples of different types of metals and non-metals to show to pupils? It was suggested that pupils be asked to bring in samples of different metals from their home environment. Did this work well? Did you get a good response from pupils? Was it a useful exercise?

3 How successful were the pupils when they did the Review questions above? Was the class:

A All successful (all pupils scored 6 out of 8 or above)

B Mostly successful (most pupils scored 6 out of 8 or above)

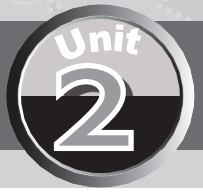
C Some were successful (between 2 and the number in B of pupils scored 6 out of 8 or above/between quarter and half the class scored 6 out of 8 or above)

D Not really successful? (fewer than a quarter of the class scored 6 out of 8 or above)

4 Can pupils carry out these objectives? Again, rate your pupils as A (all), B (most), C (some) or D (few).

- State two characteristics of metals.
- Distinguish between metals and non-metals.

5 List two aspects of the teaching and learning activities that went well for this unit. Decide how you can build on this success for future teaching.



Rusting

Syllabus objectives covered in this unit

By the end of this unit the pupils will be able to:

1.2.1 Identify materials that rust.

1.2.2 Explain causes of rusting.

1.2.3 Explain the effects of rusting on iron.

1.2.4 Clean rust from the surface of iron.

1.2.5 Demonstrate how to prevent iron from rusting.

Introduction and additional information

Rusting is the oxidation of iron. Iron reacts quite readily with oxygen, in the presence of water, which is necessary for the reaction. Rust itself is chemically a hydrated oxide of iron. Rusting is a major problem with using iron to create tools, machines and other products, as it weakens the iron, causes increased friction and wear, and it can ultimately lead to breakdown and failure of the iron product. In most respects iron is an ideal metal to use for complex machines such as cars: it is readily available, which makes it cheap; it is strong, though still malleable to an extent, but it has enough strength to hold a sharp edge for cutting; and it is a good conductor of heat and electricity. So industry often chooses to use iron, but because it is prone to rusting a whole range of processes to control or prevent rusting have been developed. The best way of preventing rusting is to coat the iron so that it is not in contact with the air. The commonest coatings are paint, which has to be renewed on a regular basis, oil or grease, which are effective but can rub off, and zinc or tin coatings, which are effective and fairly permanent but rather more expensive.

Very often, for example with cooking pots, iron is left with a thin film of iron oxide, sometimes mixed with oil and fat compounds, which prevents further rusting because the fresh iron underneath cannot interact with the oxygen.

This surface can provide a perfectly hygienic surface for cooking utensils, especially where it is heated on a regular basis.

Key words introduced

rust, wear, damage, oxygen, prevention, painting, oil, grease

Planning

Activity 2, to investigate the causes of rusting, uses a set of nails in jars with different conditions. However, this takes a long time to yield a result. It is best to leave the nails in the jars for about a month. You will therefore either need to set up this investigation while doing work in the previous unit on metals, or you will have to set it up and return to it after having done further teaching on the next unit on temperature.

Also, find some good rusty objects to bring into the classroom for the discussion on rust. If the objects are weakened, damaged or broken, this will serve to make the point more strongly.

Resources and low cost or no cost materials required

- Selection of rusty objects as described in 'Planning' above.
- Activity 1 – six new iron nails (not galvanized or steel nails), three glass jars, water, cotton wool
- Activity 2 – six new iron nails (not galvanized or steel nails), six glass jars, lemon juice or vinegar, cold water, cooled boiled water, oil, salt
- Activity 4 – some rusty objects, some sandpaper, some lemon juice, detergent, water if required
- Activity 5 – two iron nails, two jars, metal paint, paint brushes, water.

Guidelines for the teaching and learning activities

1 Materials that rust

Pupil's Book pages 23-25

With pupils, look at the illustrations and the photographs to bring out the idea of rusting. Show them some rusty objects which you have brought into the classroom, so that they understand the problem.

2 Causes of rusting

Pupil's Book pages 25-27

The activity in this section to show the requirements for rust works well, but it is important to get basic iron nails for the investigation. They should not be steel, or galvanized or treated in any way, but should just be basic iron nails. The purpose of the third jar is to have a nail in water, but with no oxygen in contact with it.

Oxygen dissolves in water to a limited extent, but this dissolved oxygen can be removed by boiling the water strongly for 5 minutes. It should then be allowed to cool while covered with oil, so that no oxygen can re-dissolve in it. Make sure that the nail in jar 3 is fully covered with the boiled water and that the water is covered by a layer of oil.

Go through what is happening in this activity with the pupils. Delegate pupils to observe the progress of the investigation each week, and to report back to the whole class. After a month it should be clear that the jars where rusting has occurred most strongly are jars 2, 4 and 5, where oxygen is in contact with the nail, in the presence of water.

3 Effects of rusting on iron

Pupil's Book page 28

The effects of rusting are best understood by looking at rusty objects. Make sure that pupils can see as many of these as possible. Bring in old metal buckets, rusty hoes or forks and any pieces of roofing that have been damaged by rust. Make sure pupils understand that rust actually consumes the iron, so that rusting objects become thinner and weaker, and can eventually collapse.

4 Cleaning rust from the surface of iron

Pupil's Book page 29

Rust coats the outside of iron, where it is in contact with the air, so it can be removed by physically scrubbing it off with an abrasive such as sandpaper or a metal sponge. However, removing it in this way is only temporary. Rust can also be removed using acids such as lemon juice. Kitchen detergent by itself is less effective, unless an abrasive is used.

Ensure that the pupils follow through the steps of Activity 4, and record their results in a neat and tidy way. This activity is a good example of a scientific investigation.

5 Methods of preventing rust

Pupil's Book pages 30-31

Discuss the illustrations on the prevention of rust with pupils. Then allow a group of pupils to carry out Activity 5, an investigation into the prevention of rust. The group carrying out the investigation should lay out the equipment carefully, make proper records of what they have done, and then report back on the whole investigation to the class.

Multi-ability learning – activities for the more able and the less able

2 Causes of rusting

Pupil's Book pages 25-27

More able students could suggest other tests on the nails which might induce faster rusting, such as using bottled water or river water in two additional jars. They can be given further investigations of this type to carry out after the main class has completed its investigation.

For less able pupils, ensure that they are clear about why there are six different jars, and particularly the complicated jar 3. Ensure that they understand that this is the jar where the iron nail should not be in contact with any oxygen from the air.

4 Cleaning rust from the surface of iron

Pupil's Book page 29

Some pupils may be able to suggest other traditional ways of cleaning iron.

5 Methods of preventing rust

Pupil's Book pages 30-31

Pupils may know other traditional ways of preventing rusting. This is a good opportunity to hear from pupils of all abilities, as they can tell how traditional cultures have looked after farms tools, hunting weapons such as arrowheads and knives, and so on.

Answers to end-of-unit questions

Objective questions

Pupil's Book pages 32-33

1 D **2** A **3** D **4** C **5** D **6** B

Essay questions

Pupil's Book page 33

1 Iron rusts most easily. Some kinds of steel can also rust.

2 Rust is made from iron, reacting with oxygen in the presence of water.

3 Copper, gold, silver, aluminium and most other metals do not rust.

4 Car manufacturers prevent their car doors from rusting by covering them in several coats of paint.

5 An iron kitchen knife is best kept rust free by frequent scrubbing with an abrasive such as a metal sponge. Using lemon juice with the metal sponge is even more effective. The knife could also be coated in a thin layer of oil after being washed and dried.

6 Rusting iron can be a problem because rusting weakens the iron object. Also, if the iron object is part of a machine, rust increases wear and tear on the machine. Rust can make holes in pipes and tanks so they become useless.

Review questions for the pupils

These questions may be given to pupils as an end-of-unit test, for homework or as a review of the topics in the unit.

1 What is rusting?

2 Why is rusting a problem?

3 List three ways in which rusting can be prevented. Explain if there is any difficulty with each of the methods of prevention you have listed.

4 In the activity to investigate rusting of nails, why was one nail put in boiled water with oil on top?

5 Sometimes ships sink at sea. If the hulls of the ships are made of iron, what would you expect to happen to the ships' hulls under the sea over the years?

6 Since iron is prone to rusting, why do we not use other metals which do not rust, such as gold, for building cars?

Answers to Review questions

1 Rusting is a chemical reaction between iron and oxygen, which happens in the presence of water.

2 Rusting of iron weakens the metal, removes iron metal from the object and causes increased wear and tear.

3 Rusting can be prevented by painting, but paint flakes off in time. Rusting can be prevented by oiling the metal, but the oil dries off in time. Rusting can be prevented by coating the iron with another metal, such as zinc, but this can be expensive. Covering the iron or steel in plastic or rubber can also prevent rusting, but the cover will wear away.

4 The nail put in boiled water under oil was being exposed to water, but with no oxygen present. Boiling the water removes dissolved oxygen, and putting oil on the surface prevents oxygen from the air reaching the nail.

5 The iron hulls of ships that sink will gradually rust away. There is enough dissolved oxygen in sea water for fishes to live, and for ships' hulls to rust.

6 Gold is too soft and too expensive for use in building cars.

Diagnostic assessment

These diagnostic assessment exercises will assist you as the teacher to evaluate the impact of the teaching and learning activities in this unit and to assess the extent to which the unit objectives have been achieved.

1 Review your lessons on Rusting. Which lessons went well? Can you say why this was? This work follows on from earlier work on metals. Did pupils find this connection useful?

2 The experiment to investigate the causes of rusting using six nails in different types of water is a good school investigation, but its disadvantage is that it takes up to 4 weeks to

see really clear results. Did this work well? Did you get a good response from the pupils? Was it a useful exercise, or did the time taken to get results cause difficulties?

3 How successful were the pupils when they did the Review questions above? Was the class:

A All successful (all pupils scored 4 out of 6 or above)

B Mostly successful (most pupils scored 4 out of 6 or above)

C Some were successful (between 2 and the number in B of pupils scored 4 out of 6 or above/between quarter and half the class scored 4 out of 6 or above)

D Not really successful? (fewer than a quarter of the class scored 4 out of 6 or above)

4 Can pupils carry out these objectives? Again, rate your pupils as A (all), B (most), C (some) or D (few).

- State the conditions necessary for rust.
- Explain why rusting is a problem.

5 List one feature of the work that went well for this unit. Decide how you can build on this success for future teaching.

Measurement of temperature

Syllabus objectives covered in this unit

By the end of this unit the pupils will be able to:

1.3.1 Infer that temperature is a measure of how hot a substance is.

1.3.2 State the units for measuring temperature.

1.3.3 Read temperature on an analogue and digital thermometer.

1.3.4 Handle and use different types of thermometer.

Introduction and additional information

Temperature is a concept with which pupils will be familiar from their homes, but which science uses in a more accurate way than in everyday life. The first activity in this unit shows that while hands are sensitive to temperature, and will warn us when an object is too hot or too cold, hands only really measure differences in temperature. Scientists have therefore developed thermometers, which are able to measure temperature more accurately than our hands can.

There are several different temperature scales, but of these, the Celsius scale is now the most commonly used, particularly in science. The Fahrenheit scale was in common use, and it is still widely used in the US for weather forecasting, but it is not as convenient to use as the Celsius scale. In Fahrenheit, the freezing point of water is 32°F and the boiling point of water is 212°F. The scale was devised in the eighteenth century by the Dutch physicist Daniel Fahrenheit. The Celsius scale was devised 50 years later by the Swedish astronomer Anders Celsius as a simpler alternative to the Fahrenheit scale. In the Celsius scale water freezes at 0°C and boils at 100°C, so there are 100 degrees between water's freezing point and its boiling point. This is why it used to be known as the Centigrade scale (Centigrade means 100 degrees). But when the scale was adopted as an official part of the SI system of measurements, the name of the scale was changed to Celsius in memory of its developer.

Key words introduced

temperature, thermometer, laboratory thermometer, clinical thermometer, digital thermometer, body temperature, warmer, hotter, cooler, colder

Planning

The activities in this section require access to a supply of water, access to hot water or means of heating water, and also access to plenty of ice cubes. Make sure that these are going to be available when you are doing your teaching.

Resources and low cost or no cost materials required

- Water, ice cubes, water heaters (or hot water), several laboratory thermometers, some clinical thermometers, some digital thermometers if possible, plastic bowls or glass beakers.

Guidelines for the teaching and learning activities

1 Meaning of temperature

Pupil's Book pages 35-37

Discuss with the pupils what they understand by the word temperature. Use words such as 'warmer', 'hotter', 'cooler' and 'colder' in your discussions. Ask the pupils how they can tell when an object like a cup of tea is hot or cold.

The activity in this section shows clearly that our hands are sensitive to different temperatures, but that they are not completely reliable guides. Pupils should find that when they have one hand in hot water and the other in cold water, and they then put them both together into water at room temperature, they will find that the hand that was in hot water will think it is cool, while the hand that was in cold water will think that the very same water is warm. Pupils can experience their two hands telling them two different things about the same bowl of water at the same time!

This helps to show why it is necessary to have instruments such as thermometers for more accurate measurement of temperature.

2 Reading temperature on analogue and digital thermometers

Pupil's Book pages 37-38

Show to the pupils the different types of thermometer that you have been able to collect. Explain to them the need for care with the glass instruments, as they are easily damaged and broken.

When making their drawings of thermometers in their notebooks, ensure that the pupils label their drawings clearly with all the key features of a thermometer. These should include the difference in overall length of the laboratory and clinical thermometers - the clinical one is usually much shorter; the difference in the scales - that on the clinical one covers a much shorter range - around 37°C; the constriction or 'kink' in the clinical one. Discuss the need for

the constriction in a clinical thermometer so that the mercury does not go down before the temperature can be read.

3 The units for measuring temperature

Pupil's Book page 39

If you have not already talked about the range of the scales on the different types of thermometer, do so now. Ask pupils to tell you what the scales go to and from on each type of thermometer. Elicit why this is. (Because laboratory thermometers have to be able to measure a much wider range of temperatures.) Laboratory thermometers can vary in the range of their scales. Common ones go from just below 0°C to either 50°C or to just over 100°C. Those used in schools often only go up to 50°C, as pupils are not expected to measure temperatures hotter than this. This difference in their scales is one of the main differences between the laboratory and the clinical thermometer.

4 Reading temperature on a thermometer

Pupil's Book pages 39-43

In the first activity in Section 4 (Activity 3), the pupils will measure the room temperature, the temperature of their hands, the temperature of iced water and the temperature of hot water. Iced water, where the ice has been well stirred and has stopped melting rapidly, should be at about 0°C. The temperature of the hot water will vary.

In the second activity (Activity 4), the pupils are asked to use a clinical thermometer and a digital thermometer, if these are available, to take measurements of their own body temperature. They can read their temperature both under their armpit and under their tongue. Normal body temperature is about 37°C, but it can vary between about 36.1°C and 37.5°C and still be considered in the normal range. Readings from under the arm can be about 0.5°C lower than under the tongue. A person's temperature can also vary according to their age or what activity they have just been doing.

Safety: There are two very important safety issues here.

Clinical thermometers must **never** be passed from one person to another without careful sterilization in between each use. Have methylated spirits available to rinse and clean the thermometer between each use. Many infectious diseases can be passed from pupil to pupil if they put something in their mouth, and this is then passed to another pupil. Sterilization before the next child uses the thermometer is vital.

Mercury is poisonous, so pupils must be extremely careful when handling the thermometers, especially when putting them in their mouths. If a thermometer is broken, they must call a teacher immediately.

5 Proper handling of a thermometer

Pupil's Book page 43

Stress that thermometers are very fragile instruments. If a thermometer containing mercury is broken, pupils should call an adult to deal with it, as mercury is poisonous and it must be cleared up and disposed of safely.

Multi-ability learning – activities for the more able and the less able

1 Meaning of temperature

Pupil's Book pages 35-37

Some pupils may be familiar with radio and television weather forecasts which make frequent reference to temperature. Ask them to tell the whole class what the temperature is when the weather is very hot (probably 28°C or more) and what the temperature might be when the weather is cool (probably less than 22°C).

2 Reading temperature on analogue and digital thermometers

Pupil's Book pages 37-38

More able pupils can be stretched by being asked to find more types of thermometer. Some homes will have wall thermometers which measure the temperature of the rooms in a house. There are also different types of laboratory thermometer, with different ranges. Ask them to see how many types of thermometer they can find out about.

Answers to end-of-unit questions

Objective questions

Pupil's Book pages 44-46

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

Essay questions

Pupil's Book page 47

1 Temperature is a measure of how hot something is.

2 Three common types of thermometer are the laboratory thermometer, the clinical thermometer and the digital thermometer.

3 You read a laboratory thermometer by seeing which mark on the scale is level with the top of the mercury in the tube. This mark on the scale is the temperature of whatever is being measured. The pupils should draw a diagram that shows the scale and that the temperature is read at the top of the thread of mercury.

4 You read a digital thermometer just by reading the numbers shown on the display.

5 The temperature of iced water is 0°C.

Review questions for the pupils

These questions may be given to the pupils as an end-of-unit test, for homework or as a review of the topics in the unit.

1. Can we measure temperature with our hands?
2. What are thermometers used for?
3. What is the name of the temperature scale that you saw on the laboratory thermometer? Name another temperature scale that is sometimes used.
4. How is a clinical thermometer different from a laboratory thermometer?
5. Why is it important that a clinical thermometer is sterilized before it is used?
6. Hot cooking oil can reach temperatures as high as 200°C. Can you use a normal -10°C – 110°C laboratory thermometer to measure the temperature of this oil? What might happen?

Answers to Review questions

1. We can measure temperature with our hands, but not very accurately.
2. Thermometers are used to measure temperatures accurately.
3. The Celsius scale. Another scale is the Fahrenheit scale.
4. A clinical thermometer measures over a more limited range around 37°C. It is usually smaller than a laboratory thermometer. It is more accurate than a laboratory thermometer. It has a constriction to prevent the mercury from moving back until it has been read.
5. It is essential to sterilize a clinical thermometer before use, so that no infections are passed from one person to another.
6. No, the oil is too hot to use a laboratory thermometer. If you put the thermometer in such hot oil it will break.

Diagnostic assessment

These diagnostic assessment exercises will assist you as the teacher to evaluate the impact of the teaching and learning activities in this unit and to assess the extent to which the unit objectives have been achieved.

1. Review the teaching and learning activities on measurement of temperature. Which lessons went well? Can you say why this was? Did you have access to enough thermometers for the pupils to be able to take part in the activities fully?

2 Good hygiene is crucial in using clinical thermometers with pupils. Were there any difficulties in ensuring that good hygiene was maintained? Did the pupils understand why it was important?

3 How successful were the pupils when they did the Review questions above? Was the class:

A All successful (all pupils scored 4 out of 6 or above)

B Mostly successful (most pupils scored 4 out of 6 or above)

C Some were successful (between 2 and the number in B of pupils scored 4 out of 6 or above/between quarter and half the class scored 4 out of 6 or above)

D Not really successful? (fewer than a quarter of the class scored 4 out of 6 or above)

4 Can pupils carry out these objectives? Again, rate your pupils as A (all), B (most), C (some) or D (few).

- Draw and label an analogue clinical thermometer.
- Explain the difference between a clinical and a laboratory thermometer.

5 What were the problems in teaching this topic? List two areas which raised problems (perhaps the practical activities, perhaps enabling enough pupils to participate, and so on) and plan remedies for these problems which you can implement for future teaching.

Section 2: Cycles

Ventilation

Syllabus objectives covered in this unit

By the end of this unit the pupils will be able to:

2.1.1 Explain the concept of convection.

2.1.2 Demonstrate convection current.

2.1.3 Explain ventilation in terms of convection current.

2.1.4 Identify applications of convection in everyday life.

2.1.5 Explain the need to ventilate rooms.

2.1.6 Describe what leads to poor ventilation in our homes.

Introduction and additional information

Convection currents are a good example of a naturally occurring cycle. They are a process by which air and liquids move to even out temperature differences, and are caused by thermal expansion of the air or the liquid causing it to become less dense than surrounding cooler air or liquid.

Poor ventilation can become a problem where many members of a family sleep together in a small room, and they do not leave windows or doors open for ventilation. In this situation rooms can become 'stuffy' by the end of the night. 'Stuffy' is usually taken to mean air that has become too humid, too low in oxygen and relatively high in carbon dioxide.

Air conditioning units are generally placed high in the walls of a room so that the cooler air which they pump into the room sets up a convection current. Cooler air at the top of the room from the air conditioner will be denser than the surrounding air, and will therefore tend to fall, moving it away from the air conditioning unit and around the room.

Key words introduced

ventilation, convection, convection currents, humid, moist, oxygen, expand

Planning

Ensure that you have available the equipment necessary for the demonstration of convection currents in water. Potassium permanganate crystals can be obtained from a pharmacy. (Locally these are called ka nsu a bere).

Resources and low cost or no cost materials required

Beaker, heat source (a kerosene burner or a coal pot and charcoal), cotton cloth, potassium permanganate crystals (ka nsu a bere), a straw or glass tube. It is possible to use a pawpaw leaf stalk instead of the straw or glass tube.

Guidelines for the teaching and learning activities

1 Meaning of convection

Pupil's Book pages 49-50

Discuss the concept of convection currents with the pupils. Then set up the demonstration of convection currents in water using potassium permanganate. Ensure that all the pupils can see the demonstration as far as possible. It is best to use a large glass beaker if at all possible, and to place the permanganate crystals on the bottom of the glass, and to one side. Then apply the heat from a kerosene burner to this side only, and columns of pink liquid will move up the side of the beaker. The permanganate dissolves slowly in the water, and it is the pink dissolved permanganate that can be seen being carried upwards by the convection current in the water.

Discuss what is happening with the pupils, and ensure that they understand the concept that, because of the heat being applied to the water, a cycle of water movement, called a convection current, has been set up.

2 Ventilation in terms of convection currents

Pupil's Book page 51

Convection currents in air are an important means of ventilating the places where we live. The air we breathe out tends to be warmer than the outside air, so it will naturally rise, to be replaced by cooler fresher air.

3 Application of convection in everyday life

Pupil's Book pages 51-52

Take the pupils through the examples of everyday ventilation shown in the Pupil's Book, and then encourage them to suggest more examples in classroom discussion. Get them to talk about times when they have experienced very poor ventilation, especially if it has caused illness.

4 Sea and land breezes *Pupil's Book page 53*

If your school is near the sea, pupils may well be familiar with the phenomenon of land and sea breezes. They may know from experience that on most hot sunny days, the prevailing wind is one coming from the sea to the land – this is the sea breeze. And fishermen at sea will also have experienced the land breeze which blows in the night. If there is an opportunity, take the pupils out to a place where the sea breeze blows strongly so they can experience the power of this convection current.

5 Ventilation of rooms *Pupil's Book pages 53-54*

Ask pupils if they have ever felt sleepy when they are sitting in a warm humid room with the windows closed. How do they feel when the windows are opened? Ask pupils if they know what gas in coming in when the windows are opened. (oxygen)

6 Causes of poor ventilation in the home *Pupil's Book pages 54-55*

Have the pupils complete and extend the table shown in the activity. They should add in as many examples as they can think of where poor ventilation occurs, and then suggest what can be done about it.

Multi-ability learning – activities for the more able and the less able

1 Convection *Pupil's Book pages 49-50*

Let some of the more able pupils help with the demonstration of convection currents using potassium permanganate. They should be asked to make detailed observations of the convection currents, looking not only at the side of the glass beaker, but also at the top to see how the coloured water spreads across the beaker.

2 Application of convection in everyday life *Pupil's Book pages 51-52*

Ask less able pupils to make drawings of poorly ventilated rooms, and to explain why they are poorly ventilated.

3 Sea and land breezes *Pupil's Book page 53*

If you school is close to the sea, the more able pupils can be asked to demonstrate sea breezes by visiting the shore on a hot day, placing a small flag in the sand, and recording the direction of the wind as shown by the flag. Other pupils can help them in this investigation by preparing the flag and recording the behaviour of the flag.

5 Ventilation of rooms

Pupil's Book pages 53-54

Less able pupils can be asked to say more about why they like rooms to be well ventilated. They can prepare a class presentation, using pictures and other visual aids, to show the importance of good ventilation to good health.

Answers to end-of-unit questions

Objective questions

Pupil's Book pages 56-59

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

Essay questions

Pupil's Book page 59

1 Heat travels in liquids by *convection*.

2 The sea breeze blows during the *day*.

3 Windows with small openings prevent good *ventilation*.

4 A room is ventilated when the air inside is pure and *fresh*.

5 In factories, hot air is removed through the *chimneys*.

6 Convection occurs in liquids and *gases*.

Review questions for the pupils

These questions may be given to the pupils as an end-of-unit test, for homework or as a review of the topics in the unit.

1 What is a convection current?

2 Explain why heat is not transferred by convection currents in solids.

3 Describe the condition of the air in a room that is well ventilated.

4 List two health risks from living in rooms with poor ventilation.

5 Why is there a change from sea breezes in the daytime to land breezes at night?

6 Where would you expect to be able to feel a land breeze?

Answers to Review questions

1 Convection currents are currents in a liquid or a gas which are caused when part of the liquid or gas becomes heated and rises, allowing cooler liquid or gas to come in below.

2 Convection currents can only work in liquids or gases where the material is free to move around. This is not the case in solids.

3 Air in a well-ventilated room will be clean, dry, fresh and with plenty of oxygen.

4 Poor ventilation can lead to drowsiness and to respiratory infections (breathing problems).

5 In the day, the land gets hotter than the sea, causing a sea breeze to blow. In the night this changes, as the land cools more quickly than the sea, causing a land breeze to blow.

6 You would feel a land breeze when on a boat out at sea.

Diagnostic assessment

These diagnostic assessment exercises will assist you as the teacher to evaluate the impact of the teaching and learning activities in this unit and to assess the extent to which the unit objectives have been achieved.

1 Look back at the lessons on Ventilation. Which lessons went well? Which lessons did not go so well? Can you say why this was? Good ventilation is an important topic, but did the pupils find it interesting? Were they focused on it during the teaching? Did they see the relevance of land and sea breezes to good ventilation?

2 Did the practical demonstration of convection currents in water go well? Did pupils understand what was being shown to them? Are there any ways in which this practical demonstration can be improved in order to make it more convincing?

3 How successful were the pupils when they did the Review questions above? Was the class:

A All successful (all pupils scored 4 out of 6 or above)

B Mostly successful (most pupils scored 4 out of 6 or above)

C Some were successful (between 2 and the number in B of pupils scored 4 out of 6 or above/between quarter and half the class scored 4 out of 6 or above)

D Not really successful? (fewer than a quarter of the class scored 4 out of 6 or above)

4 Can pupils carry out these objectives? Again, rate your pupils as A (all), B (most), C (some) or D (few).

- Draw and label a diagram to show how ventilation makes a room safe for use.
- Draw and label a diagram to show how convection currents in the air at coastal regions cause sea breezes by day, and land breezes by night.

5 List two aspects of the teaching and learning activities that went well for this unit. Decide how you can build on this success for future teaching.

Section 3: Systems

The Solar System

Syllabus objectives covered in this unit

By the end of this unit the pupils will be able to:

3.1.1 Identify the components of the Solar System.

3.1.2 Describe the movement of the Moon around the Earth.

3.1.3 Identify the relative positions of the Sun, Moon and the Earth in the Solar System.

3.1.4 Distinguish between luminous and non-luminous bodies.

3.1.5 Explain the concept of satellite.

3.1.6 List some uses of artificial satellites.

Introduction and additional information

The Solar System is the system of planets, moons, asteroids, comets and other bodies which revolve around our Sun. Until 2006, it was considered that there were nine planets revolving around the Sun: Mercury, Venus, Earth, Mars, Jupiter and Saturn, which have been known since ancient times, Neptune and Uranus, which were discovered in the sixteenth and seventeenth centuries respectively, and Pluto, which was discovered in the twentieth century. However, Pluto has been considered an odd planet: it is the furthest away from the Sun, and one of the smallest. It has a moon, Chiron, which is nearly half its size, so it is more like a revolving double planet, and its orbit is not in the same plane as those of the other eight planets. For these and other reasons, the International Astronomical Union decided in 2006 to change the status of Pluto to that of a dwarf planet, along with a couple of the larger asteroids. At this level the pupils do not need to know the names of the other planets.

It is possible to see the nearer larger planets in the night sky when it is clear. They are often the brightest 'stars' that can be seen, and the planets are the ones which are not in the same place every night. They are the bright objects which move around the night skies, which is why people from ancient times have often viewed them as very special. Greek astronomers thought that they were gods moving around the Earth.

All the planets except for the innermost two, Mercury and Venus, have moons. Of these planets, Earth has the fewest, with just the Moon; Mars has two moons, and Jupiter has at least 53.

Key words introduced

Sun, Earth, Moon, satellite, planet, luminous, non-luminous, orbit, spin

Planning

In learning about the Solar System it is very helpful if the pupils are able to spend time observing the night sky. This can be difficult to arrange if the pupils are at home every night, but try to get them to take time in the evenings to observe the night sky, when it is not cloudy. They should try to do this away from areas where there is strong street lighting. Light pollution from cities makes it much harder for us to look at the stars and the planets, as our eyes take in less light when they are dazzled by other sources of light.

Resources and low cost or no cost materials required

- A football
- Eight smaller balls such as tennis balls or oranges
- Several smaller round stones
- Diary with phase of the Moon recorded in it
- Torch
- Models or pictures or wall charts to show the structure of the Solar System.
- If you have access to the internet, there are some excellent videos showing the phases of the Moon and the Moon's rotation around the Earth, and other aspects of the Solar System.

Guidelines for the teaching and learning activities

1 The Solar System *Pupil's Book page 61*

Examine the illustration in the Pupil's Book with the class. Pupils do not need to learn the names of all the planets at this level, but they must be able to point to the Sun and the Earth, (and the Moon orbiting the Earth, although it is not shown on the Pupil's Book diagram).

2 Components of the Solar System *Pupil's Book pages 61-62*

Take the pupils outside into the school yard to give plenty of space for Activity l, in which pupils model the Solar System. The football is to be held to represent the Sun in the centre, and another pupil at least 10 m away should hold the tennis ball to represent the Earth. Other pupils can represent the other planets - two which are near to the Sun, and five which are further away.

You can choose whether to give a smaller round stone, to represent a moon, to six of the eight pupils - all except the two innermost 'planets', or just to give a stone to the pupil with the tennis ball to represent the Earth.

When everyone is in position, get them to start orbiting by walking in a circle around the Sun. The pupil holding the Earth should also orbit his or her Moon (stone) around their tennis ball (Earth), as should all the other pupils with stones.

3 Luminous and non-luminous bodies *Pupil's Book pages 63-64*

It is important that pupils understand the concept of light-giving luminous bodies and non-luminous bodies. Go through as many examples as you can of things which are luminous that they will be familiar with, such as cooking fires, torches, kerosene lamps, car headlights and so on. The stars are also luminous bodies, but their light on Earth is not strong because they are very far away.

4 Movement of the Moon around the Earth *Pupil's Book pages 64-65*

The Moon is the Earth's only natural satellite. It orbits around the Earth about once every month, which is why it seems to go through different phases.

5 Why the Moon seems to have different shapes *Pupil's Book pages 65-70*

Set up the demonstration of the orbit of the Moon using pupils in the classroom (Activity 3). It is quite hard for pupils to understand why the Moon becomes a thin sliver at some times of the month. If it is possible to do this activity in a darkened room, and to use a torch to represent the light from the Sun, this will make it much more effective.

Take the pupils through Activity 4. It is an interesting fact that the Moon spins on its own axis at exactly the same rate that it orbits the Earth, the time for each being 28 days (one month). For this reason the Moon always presents exactly the same side to the Earth. This can also be demonstrated using two pupils: one represents the Earth and the other the Moon. As the Moon goes around the Earth, show the class that the Moon pupil is having to spin as well, in order to keep facing the Earth.

6 Satellites *Pupil's Book pages 70-71*

There are increasing numbers of artificial satellites orbiting the Earth, and more are being added every year. Take the pupils through the information which is provided in the Pupil's Book, and question them to find out if there are any enthusiasts in the class who have read more about satellites.

7 Uses of artificial satellites *Pupil's Book pages 71-73*

Activity 6: **Answers to questions**

1 Intelsat takes about a day to orbit the Earth.

2 GPS satellites are used by aircraft to find their position during a flight.

3 Meteosat satellites help with weather forecasting.

4 Artificial satellites can be used for communications, for exploring space, and to provide a base for humans to live and work in space.

Multi-ability learning – activities for the more able and the less able

1 The Solar System *Pupil's Book page 61*

2 Components of the Solar System *Pupil's Book pages 61-62*

More able pupils may already know more about the Solar System, and may know the names of some of the other planets. If so, they can talk to the class about these.

3 Luminous and non-luminous bodies *Pupil's Book pages 63-64*

Discuss with more able pupils that the Sun gives out both heat and light. To call a body luminous only implies that it gives out light. Fluorescent tubes are luminous when they are switched on, but they do not give out heat.

4 Movement of the Moon around the Earth *Pupil's Book pages 64-65*

Ask all the pupils if they know of any local folk stories about the Moon. What are the traditional beliefs about the Moon? Both more able and less able pupils will enjoy talking about their cultural heritage of beliefs about the way that the Moon behaves.

5 Why the Moon seems to have different shapes *Pupil's Book pages 65-70*

All pupils will have seen the different shapes of the Moon, but understanding why this happens Is quite a difficult idea to grasp. Try to do as many practical demonstrations as you can for the less able pupils.

You can ask more able pupils to look at the Moon in the evening and write down which phase they think it is in. (Check that the Moon is visible at a reasonably early time of night when you do this.) Discuss their observations in class.

6 Satellites

Pupil's Book pages 52-54

More able pupils can do further research on the artificial satellites which orbit the Earth.

Answers to end-of-unit questions

Objective questions

Pupil's Book pages 74-76

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

Essay questions

Pupil's Book page 77

1 The Sun, the Earth and the Moon are three components of the Solar System. (Pupils may give other planets.)

2 The Earth and the Moon are not luminous.

3 The Sun is the only luminous object in the Solar System.

4 When the Moon is bright, the light coming from it is light reflected from the Sun.

5 The Earth *orbits* the Sun, and the Moon *orbits* the Earth.

6 A satellite is an object which orbits another object, usually a planet.

7 Artificial satellites are used for weather forecasting, for television communication and for studying changes in the environment.

8 The International Space Station is used as a base for humans to live in space and carry out experiments.

Review questions for the pupils

These questions may be given to the pupils as an end-of-unit test, for homework or as a review of the topics in the unit.

1 Explain the meaning of the phrase 'the Solar System'.

2 What is the difference between a planet and a moon?

3 Which of these objects is luminous: the Moon, the Sun, a flashlight switched on, a cooking pot, a fire?

4 What is the name of the planet on which we live?

5 Name a satellite orbiting the Earth.

6 From what you know about the Solar System, would you expect a planet that is further away from the Sun to be hotter or colder than the Earth?

7 Explain why people on Earth have only seen one side of the Moon.

8 Forecasting weather is one use of satellites. Name two other uses.

9 What does orbit mean?

10 Why does the Moon seem to change shape each month?

Answers to Review questions

1 The Solar System is the system of the Sun, its planets, their moons, and other objects which all orbit our Sun.

2 Planets orbit the Sun, while a moon orbits a planet.

3 The Sun, a flashlight switched on and a fire are all luminous bodies that give out light.

4 The Earth.

5 There are many: the Hubble Space Telescope, the International Space Station, the Meteosats and so on. The Moon is also correct as it is a natural satellite.

6 A planet further away from the Sun would be colder.

7 Because the Moon spins as it orbits the Earth, so it always presents the same face to the Earth.

8 Environmental studies and communication. Any other valid answer Is correct.

9 Orbit means to go round and round another object.

10 As the Moon orbits the Earth different amounts of the surface lit up by the Sun are visible from the Earth.

Diagnostic assessment

These diagnostic assessment exercises will assist you as the teacher to evaluate the impact of the teaching and learning activities in this unit and to assess the extent to which the unit objectives have been achieved.

1 Review your teaching of the Solar System. This is a topic which some pupils find fascinating, but others find hard to understand. What was the response of your pupils? Are they excited by learning about the Earth in space? Which lessons went well? Can you say why this was?

2 Learning about the Earth in space does not offer many practical activities at this level. Did the simulations of the Solar System where pupils took the parts of the Sun and the planets work well? Do you think pupils had any better idea about how the Solar System works after having done this?

3 How successful were the pupils when they did the Review questions above? Was the class:

A All successful (all pupils scored 6 out of 10 or above)

B Mostly successful (most pupils scored 6 out of 10 or above)

C Some were successful (between 2 and the number in B of pupils scored 6 out of 10 or above/between quarter and half the class scored 6 out of 10 or above)

D Not really successful? (fewer than a quarter of the class scored 6 out of 10 or above)

4 Can pupils carry out these objectives? Again, rate your pupils as A (all), B (most), C (some) or D (few).

- What is the difference between a luminous object and a non-luminous one? List some objects that produce their own light.
- List some uses of artificial satellites.

5 List two aspects of the teaching and learning activities that went well for this unit. Decide how you can build on this success for future teaching.

Section 4: Energy

Sources of energy

Syllabus objectives covered in the unit

By the end of this unit the pupils will be able to:

4.1.1 Explain the term 'energy'.

4.1.2 Identify some sources of energy.

4.1.3 Demonstrate some uses of solar energy.

Introduction and additional information

Energy is a central and key concept in science, and especially in Physics. It is probably the most difficult concept which the pupils will meet in this Primary 4 year, as energy is not easily seen or touched, yet it is very obviously present in bodies that have energy. So although we often cannot see or feel the energy, we do know it is there. Sometimes we only know the energy was there when it is transformed into other types of energy. For example, looking at a lump of charcoal lying on the ground, it does not immediately look as if it has lots of energy, but we know that it does have energy, because as soon as it is lit it will give off heat and light energy. Similarly a lake of water behind a hydro-electric dam may look still and peaceful, but as soon as it is released to turn the turbines in the power station, it can produce huge amounts of electrical energy. So the water has potential energy due to its position, waiting to be released.

The activities in the unit introduce the pupils to energy in a variety of forms, particularly light energy, heat energy, sound energy and mechanical energy, and they introduce the idea that energy can be transformed from one form to another by devices such as electrical circuits, hydro-electric dams or charcoal burners.

Both energy and work are important scientific concepts. The words in English are also used in day-to-day language, and the meaning there is often more limited. Work, for example, does not just mean studying books, or sitting at a computer in an office. In science, work is done on an object when energy is transferred to that object.

Key words introduced

energy, heat energy, light energy, electrical energy, stored energy, sound energy, work, heater, source

Planning

Ensure that you have gathered together all the equipment that will be required for the activities in this unit. It is unlikely that there will be enough equipment for all the pupils to carry out all of the practical activities, but try to gather at least one set of equipment for each activity, and then appoint different groups to demonstrate the investigation to the rest of the class.

Resources and low cost or no cost materials required

To provide heat within a school classroom it is convenient to use small kerosene burners, and these are very safe to use. However, if these are not available it is quite satisfactory to use ordinary domestic charcoal burners to provide heat. If you do use charcoal burners, be aware of the safety issues. Ensure that the burner is removed to somewhere safe after use, and ensure that the pupils use it carefully.

- Activities 1 and 2 – an electric heater, if available, or a domestic charcoal burner and matches, a beaker.
- Activities 3 and 4 – glass hand lens, clamp to hold the lens if possible, sheet of paper, blackened old Milo tins or cleaned food tins.

Guidelines for the teaching and learning activities

1 Energy

Pupil's Book pages 78-80

This opening section is based on classroom discussion, and the objective is for pupils to begin to develop their concept of energy. Begin by discussing what they understand by the term now. Ask what they mean if they say someone 'has energy'. What do the adverts mean that say that some drinks will give you energy? Ask pupils to contrast those people who have energy with those who do not. What differences can they see? The important issue for pupils to grasp is that people and things which have energy are able to do work of various kinds.

2 Sources of energy

Pupil's Book ages 80-83

Activities 1 and 2 are alternatives: it is not necessary to do both. If an electric water heater is available in class, this is a very convenient way to demonstrate the changing of electrical energy into heat energy. If no electric heater is available, then use a charcoal burner as suggested in Activity 2. *Safety:* Make sure the charcoal burner is removed to safety after use.

3 The Sun is a source of energy

Pupil's Book pages 83-86

Energy always comes from somewhere. The Sun is the most important source of energy on the Earth, and Activity 3 is a useful reminder that the Sun gives us not only light energy to enable us to see by day, but also heat energy, sufficient to dry clothes, warm our bodies and, in this activity, to burn a piece of paper. The hand lens acts to focus the Sun's energy onto a smaller point, which can be enough to ignite the paper.

It is also possible to show the heat energy from the Sun by heating water. Activity 4 shows pupils that it is possible to make water very hot – even to boil it – using the heat from the Sun. Ask the pupils to record what they have observed in this activity.

For Activity 5, hold a classroom discussion based on the illustration on page 85 to bring out as many different sources of energy as possible. Make sure the pupils complete their table as fully as possible.

4 Electricity is important to us

Pupil's Book pages 87-88

Electricity is a very convenient form of energy because it can so easily be transformed into other types of energy. Hold a classroom discussion with the pupils to discuss the uses of electricity. Ask groups of pupils to role play how they use electricity in the home, and then to show what it is like when the electricity is cut off. The pupils should all know how worried they become when the electricity is cut off, and be aware that food in a fridge will spoil if electricity is cut off for long periods.

Multi-ability learning – activities for the more able and the less able

1 Energy

Pupil's Book page 78-80

More able pupils may be set a home and school activity to make a collection of references to 'energy' in newspapers or on television. They could make a collection of cuttings to show the way that the word is used in common everyday language.

3 The Sun is a source of energy

Pupil's Book pages 80-83

Ask more able pupils to suggest ways in which they can assess the strength of the Sun's heat radiation on different days. They can use their darkened Milo tins to measure the temperature increase in a given time, or the time taken for the temperature to rise a certain amount. As an additional investigation, you may wish more able pupils to compare the temperature rise for shiny and blackened tins of the same size and shape, containing the same amount of water.

Use the illustrations in the Pupil's Book as a starting point for a class discussion on sources of energy. For less able pupils, work with them through Activity 5 to ensure that they have

completed at least the first seven rows of the table, and that this is clearly written in their notebooks. Ask them to think about where energy comes from in their homes and to add these sources to their list. It will be helpful to them to refer back to their own home environments.

Answers to end-of-unit questions

Objective questions

Pupil's Book pages 88-91

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

Essay questions

Pupil's Book page 91

1 Car batteries contain stored chemical energy which can be released as electrical energy.

2 Charcoal gives heat and light; firewood gives heat and light; liquefied gas gives heat; electricity can be used to give heat, light, sound and mechanical energy.

3 If we leave objects out in the sunshine, they become warmer. Dark objects heat up more quickly.

4 Electricity is used for lighting, for keeping a fridge cool, and for powering a radio. (Other answers are possible.)

5 When the electricity is cut off, people will have no light at night, and the food stored in their fridge may begin to spoil.

Review questions for the pupils

These questions may be given to the pupils as an end-of-unit test, for homework or as a review of the topics in the unit.

1 What is energy?

2 List three different forms of energy, and describe objects that have each of these forms of energy.

3 What device can be used to transform electrical energy into sound energy?

4 What device can be used to transform light energy into heat energy?

5 Which is the most important source of energy on the Earth?

6 List three other sources of energy, and say what each is used for.

7 Give two advantages and two disadvantages of electrical energy.

8 What forms of energy can be obtained by burning wood?

9 Where did the energy that can be obtained from wood come from originally?

10 What forms of energy can be obtained from a dry cell?

Answers to Review questions

1 Energy is the ability to do work.

2 There are many examples that the pupils could give. A shining light bulb has light energy, a lit fire has heat energy, a car battery has stored chemical energy that turns to electrical energy.

3 A radio or a music system transforms electrical energy into sound energy.

4 Solar panels absorb sunlight energy and convert it into heat energy.

5 The Sun.

6 Fuel oil is used for transport, charcoal is used for cooking, kerosene is used for lighting.

7 Electrical energy is easy to transform into other types of energy and it is clean. However, it can be dangerous, and it requires cables to make it available to everyone.

8 Heat and light.

9 The energy in wood was stored there by the tree which grew the wood. The tree got its energy from the Sun originally.

10 Electrical energy is obtained from a dry cell, but this can be easily changed into heat energy, light energy, sound energy and so on.

Diagnostic assessment

These diagnostic assessment exercises will assist you as the teacher to evaluate the impact of the teaching and learning activities in this unit and to assess the extent to which the unit objectives have been achieved.

1 Review the teaching and learning activities on Sources of energy. Were there some lessons which were not successful? Which lessons went well? Can you say why this was? Were you able to arrange all the practical activities so that all of the pupils were able to develop their practical and experimental skills?

2 Were you able to supply sufficient equipment for all of the practical activities? This unit encourages a lot of practical work, so that pupils can get a better concept of energy and the idea of energy transformations, but is it difficult to organize a lot of practical activities in your school? Is there anything you can do to improve this?

3 How successful were pupils when they did the Review questions above? Was the class:

A All successful (all pupils scored 6 out of 10 or above)

B Mostly successful (most pupils scored 6 out of 10 or above)

C Some were successful (between 2 and the number in B of pupils scored 6 out of 10 or above/between quarter and half the class scored 6 out of 10 or above)

D Not really successful? (fewer than a quarter of the class scored 6 out of 10 or above)

4 Can the pupils carry out these objectives? Again, rate your pupils as A (all), B (most), C (some) or D (few).

- List at least eight sources of energy.
- Give reasons why people get worried when there is no electricity.

5 List two aspects of the teaching and learning activities that went well for this unit. Decide how you can build on this success for future teaching.

Basic electronics

Syllabus objectives covered in this unit

By the end of this unit the pupils will be able to:

4.2.1 Describe the behaviour of a p-n junction diode in an electronic circuit.

Introduction and additional information

Electronic devices have improved their performances as a result of the use of semiconductor materials. Since the 1960's, there have been huge improvements in the functioning of electronic products. The N-type semiconductors which have electrons as majority charge carriers, and the P-type semiconductors which have holes as majority charges carriers, function with small amount of potential difference (p.d.).

When a P-semiconductor is joined to an N-semiconductor, a P-N junction is formed. In alternating current (a.c.) circuits, P-N junction diodes have the property of allowing current to flow in one direction only. In an electronic circuit in which a.c. is flowing, there may be the need for current to flow in only one direction, so junction diodes placed in a circuit can 'chop off' one direction. Thus the to and fro directions of the a.c. is changed into one direction.

Key words Introduced

conductor, insulator, semiconductor, diode, p-semiconductor, n-semiconductor, p-n junction diode, light-emitting diode (LED)

Planning

Gather together all the electrical equipment that you will need for the activities in this unit. Try out the activities before working through them with the class. Ensure that you have enough dry cells or batteries to maintain the voltage needed in the circuit.

Resources and low or no cost materials required

Four dry cells, variable resistor switches, semiconductor diodes, low voltage bulbs, plenty of connecting wires, light-emitting diodes, d.c. power source (enough dry cells to give 3V)

Guidelines for the teaching and learning activities

1 Semiconductors *Pupil's Book pages 92–94*

Take the pupils through the text and illustrations in this section and ensure that they understand the concepts of conductors, insulators and semiconductors. Show them the components that you will be using in the activities in the next sections, so that they are familiar with what they look like.

Discuss with the pupils the importance of semiconductors in the electronics business and the importance of electronics in modern living.

2 P-N junction diode in an electronic circuit *Pupil's Book pages 94–97*

Having seen the components, the activities in this section allow pupils to see the effects of putting a diode into a simple light circuit. Pupils have made and used simple circuits with light bulbs previously, and they should be able to see that when a diode is added into the circuit it allows current to flow in the normal way when it is connected in one direction, but stops the current from flowing when connected in the reverse direction.

Check that pupils understand what all the symbols in the electric circuit diagrams mean. You could draw them on the board and get pupils to copy them into their notebooks. Remind them which is the positive and which the negative terminal of a battery in the symbol.

You may have to do these activities as demonstrations if there is insufficient equipment for each group of pupils. If done as a demonstration, make sure the pupils help with setting up the circuits and recording the outcomes. Ensure that all pupils are able to see what is going on.

Check that all pupils understand that when a diode is connected in a forward biased direction, then the p-region (positive) is connected to the positive terminal of the battery and the n-region (negative) is connected to the negative terminal of the battery, and current will flow through the diode. When the diode is connected in reverse bias, then the negative end of the p-n junction is connected to the positive terminal of the battery and the positive end of the p-n junction is connected to the negative terminal of the battery, and current will not flow through it.

You may wish to explain to pupils that these diodes can be used to change an a.c. electricity supply, such as mains electricity, into a d.c. supply.

Multi-ability learning: activities for the more able and the less able

1 Semiconductors *Pupil's Book pages 92–94*

Ask the less able pupils to draw up a list of devices which use electronic components in order to see how widely they are used. Ask the more able pupils to describe what their home would be like if no electronic devices were available.

2 P-N junction diode in an electronic circuit *Pupil's Book pages 94–97*

More able pupils can be given the opportunity to experiment with the components in the circuit. For example, the light bulb can be placed at different positions in the circuit relative to the diode and relative to the cell. Ask pupils to report back to the class on the results of this investigation.

Answers to end-of-unit questions

Objective questions *Pupil's Book pages 97-99*

1 C **2** B **3** D **4** A **5** D **6** B **7** A **8** B

Essay questions *Pupil's Book page 100*

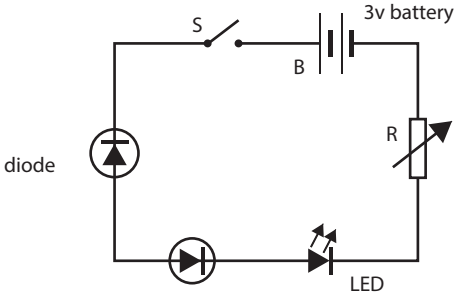
1 Semiconductors.

2 P-semiconductors and n-semiconductors.

3 A p-n junction diode is formed.

4 A p-n junction diode allows the current in a circuit to flow in only one direction.

5



d.c. circuit with a forward-biased diode and a reverse-biased diode

No current would flow in this circuit as the forward current would be cut by the reverse bias diode. The LED would not light.

6 a When the diode in a circuit is forward biased, the current flows through the circuit.

b When the diode in a circuit is reversed biased, the current will not flow through it.

Review questions for the pupils

1 What is the name given to materials that do not conduct electricity well?

2 Describe the conducting abilities of semiconductors.

3 How is a p-n junction diode made?

4 What is the meaning of the term p-n?

5 Explain the effect of putting a p-n junction diode in a d.c. circuit.

Answers to Review questions

1 Insulators.

2 Semiconductors conduct electricity weakly: not as strongly as conductors and not as badly as insulators.

3 It is made by joining a p-semiconductor with an n-semiconductor.

4 P-N indicates that the diode is made by joining a p-semiconductor with an n-semiconductor.

5 A diode in a d.c. circuit allows the current to flow in one direction only.

Diagnostic assessment

These diagnostic assessment exercises will assist you as the teacher to evaluate the impact of the teaching and learning activities in this unit and to assess the extent to which the unit objectives have been achieved.

1 Look back over the work on diodes in a circuit. Were there any lessons which the pupils particularly enjoyed? What was it that was successful about these lessons? Were the pupils able to understand the notion of a.c. even though this topic is not properly introduced?

2 Was there enough equipment for the practical activities? Did you manage to get the correct electronic components? Was there any difficulty in using the a.c. power source? Were the pupils able to see clearly when the activities were demonstrated?

3 How successful were the pupils when they did the Review questions above? Was the class:

A All successful (all pupils scored 4 out of 7 or above)

B Mostly successful (most pupils scored 4 out of 7 or above)

C Some were successful (between 2 and the number in B of pupils scored 4 out of 7 or above/between quarter and half the class scored 4 out of 7 or above)

D Not really successful? (fewer than a quarter of the class scored 4 out of 7 or above)

4 Can the pupils carry out this objective:

- Explain the function of the diode in an a.c. electric circuit?

Rate your results as A (all pupils), B (most pupils), C (some pupils) or D (only a few pupils).

5 What were the difficulties with teaching this topic? Examine these difficulties and devise strategies that you can use in future to overcome them.

Section 5: Interactions of Matter

Forces

Syllabus objectives covered in this unit

By the end of this unit the pupils will be able to:

5.1.1 Explain the term 'force'.

5.1.2 Describe different types of force.

5.1.3 Describe the effects of force on objects.

Introduction and additional information

Force, like work and energy, is a scientific term which is also in common use in everyday language. In science the definition of a force is much more precise, and it relates to the effects of a force. A force can move a body, can change the motion of a body or can stop a body. In addition forces can change the shape of bodies which do not move.

Mechanical forces are usually divided into pushing forces or pulling forces, and we use the terms push and pull in this unit to avoid using a more difficult word like 'mechanical'. Mechanical forces are most easily understood: if we push a cart loaded with farm produce, it moves. If a cow pulls a cart, it moves. Mechanical forces such as pushes and pulls act through contact with massive bodies. But there are other forces – which pupils often find very surprising – that act at a distance. A force can be exerted without there being any contact. Gravity is the most obvious example, but it is hard to demonstrate gravity because we are all so used to its presence. The activity using two magnets in this unit shows magnetic forces acting at a distance, and pupils often find this very intriguing.

Key words introduced

force, push, pull, friction, gravity, gravitational, elastic, compression

Planning

Make sure that all the equipment required for this unit is available. Items to demonstrate special kinds of force, such as compression forces, will be valuable. Make a collection of these before beginning the unit.

Resources and low cost or no cost materials required

- Activities 2 and 3 - wooden or cardboard boxes (large and small), clean sand or books for weighting the boxes, piece of rope or strong cord, spring balance.
- Activity 5 - elastic bands, spiral springs e.g. old bed springs if they can be found, nails, hammer, a piece of wood. (The nails can be hammered into the wood before the lesson, so it is not necessary to bring the hammer to the lesson. If you have several pieces of wood, you can attach a nail to each, so several groups can carry out the activity at the same time.)
- Activity 6 - two bar magnets (it may be necessary to borrow these from a nearby secondary school; fridge magnets can be used if bar magnets are not available).
- Activity 8 - moulding clay, old food tins or milk tins.

Guidelines for the teaching and learning activities

1 What is a force? *Pupil's Book pages 102 -103*

Begin by discussing what pupils understand by the word 'force' in everyday life. The everyday meaning is similar: to force something means to make something happen, and in science a force is something which makes things happen to a body - making it move, change direction, stop or change shape.

The activity is an observational activity, to encourage the pupils to look carefully at the illustrations, and to make sure that they understand what is going on.

2 Types of forces *Pupil's Book pages 103-112*

The common types of force are listed and illustrated. At this stage do not dwell on the less obvious types of force, such as compression forces. The activities which follow look at frictional forces, elastic forces and magnetic forces, so there is no need to spend too much time on the others.

When investigating friction, it should be possible for pupils to understand that the heavier an object is, the greater the friction that is created. If there is a greater frictional force, then a stronger pulling force is needed to move the box. In the next activity, pupils repeat this investigation but using smaller boxes, and using a spring balance to apply the force. It is then possible to measure the applied force, by observing the reading on the spring balance.

Make sure that pupils understand the importance of frictional forces in our daily lives. Without being able to grip and hold things, and without things being stopped from moving if no further force is applied, our lives would be very different and very difficult.

Take the pupils through the activities to demonstrate elastic and magnetic forces. As discussed, showing magnetic forces in particular is of great interest to pupils, as this is a clear example of forces acting at a distance. Make sure that as many pupils as possible feel for themselves the magnetic forces of repulsion and attraction. Ask pupils if they can think of any examples where magnetic forces are used in the home or in industry. (Some cupboards use magnets to hold their doors closed. Magnets can be used to pick up items that have spilled, for example pins or iron nails. Very large magnets are used for lifting vehicles in scrap yards.)

3 Effects of force on objects

Pupil's Book pages 112-115

Using a rolling ball provides a simple means to demonstrate that a force can change the direction in which an object is moving. It also allows a qualitative understanding that the greater the force, the greater the speed with which the object moves. Pupils can relate this to games with a bat and ball, or to kicking a ball, where a force changes the direction and speed of motion.

Pupils can have fun demonstrating that forces can also change the shape of a lump of clay, or an old food tin. This activity may be fun, but ensure that the pupils record that forces can also change the shape of bodies. Get them to provide other examples of situations where a force is applied in order to change the shape of a body. (You may wish to remind the pupils of work done in Unit 3 on metals, where they watched a blacksmith hammering metal into shape.)

Multi-ability learning – activities for the more able and the less able

1 Types of force

Pupil's Book pages 103-112

There are opportunities for more able pupils to do further investigations into the nature of frictional forces. For example, what will be the direction of the frictional force acting between two bodies? They can use an old car tyre or a bicycle tyre rim, and roll the tyre or bicycle rim and find out the direction of the tyre or rim at the point of contact with the floor. They can spin the wheel and feel the force of the friction.

2 Effects of a force

Pupil's Book pages 112-115

Less able pupils should be asked to describe the effects of a force in their own words. Pupils often have a clear understanding of the nature of force, but some pupils are not comfortable with using scientific English to describe this. If less able pupils struggle to understand how friction helps us to hold things, then ask them to imagine trying to pick up an item that is covered in oil or grease. It is much harder to grip a greasy item, as the grease makes the item very slippery. Grease reduces the friction between items, but we need this friction to help us to grip items. Some pupils may already know that oil or grease is used to reduce friction between moving parts, such as between metal parts in a car engine.

Answers to end-of-unit questions

Objective questions

Pupil's Book pages 116-118

1 C **2** A **3** C **4** B **5** C **6** B **7** A **8** A

Essay questions

Pupil's Book pages 118-119

1 Friction is essential for the process of walking, for the process of holding something in our hands, and for stopping a bicycle when it is moving.

2 A cow pulling a cart exerts a pull force.

A girl throwing a ball exerts a push force.

A fisherman paddling a canoe exerts a push force.

Pupils may give other examples, so check the answers they have given.

3 The greater the force applied by the boy, the greater will be the movement – the speed – of the ball.

4 Magnetic forces act at a distance.

5 Gravity and magnetic forces act at a distance.

6 To make something move, we have to apply a *force* to it. The greater the force, the *faster* the object will move. Friction is a *force* which tends to *prevent* movement between objects. Sometimes friction is *helpful*, such as when brakes help a car to *stop*. At other times friction is *unhelpful*, such as when digging the ground.

Review questions for the pupils

These questions may be given to the pupils as an end-of-unit test, for homework or as a review of the topics in the unit.

1 What is a force?

2 List five different types of force.

3 Explain the difference between forces which can act at a distance, and those which cannot. Give an example of each type of force.

4 What is friction?

5 How can friction between a moving body and the ground be reduced?

6 Give three examples where friction is useful.

7 Give two examples of a pulling force.

8 If you are using a pushing force to move a broken-down car, what happens to the car when a friend joins you and the pushing force is doubled?

9 Give two examples where a force changes the shape of an object.

10 Give two examples where a force changes the way an object is moving.

11 A girl rolls an orange along the ground. After a few seconds, the orange stops rolling. Explain what forces are acting on the orange.

Answers to Review questions

1 A force is something an object can apply to another object which will make it move, stop it moving, change the way that it is moving or change its shape.

2 Frictional force, pull force, push force, magnetic force, gravitational force. (Also elastic force, compression force)

3 Most forces can only be applied when bodies are in contact, such as push or pull forces. Some forces, such as magnetic or gravitational forces, can act at a distance, without being in contact.

4 Friction is a force which tends to oppose motion.

5 Friction can be reduced by lightening the load of an object, or by lubrication.

6 Friction is useful in walking, in climbing and in holding things in our hands.

7 A cow uses a pulling force on a cart. A person can exert a pulling force on a goat on a lead.

8 If the pushing force on the car is doubled, the car should move at double the speed.

9 Treading on a lump of clay; flattening a food tin with a stone.

10 Brakes can apply a friction force to stop a car moving. You can kick or hit a moving ball to change its direction.

11 When the girl rolls the orange, she is applying a push force. Once the orange is rolling, the force of friction is acting on it. This slows and eventually stops the orange.

Diagnostic assessment

These diagnostic assessment exercises will assist you as the teacher to evaluate the impact of the teaching and learning activities in this unit and to assess the extent to which the unit objectives have been achieved.

1 Review the teaching and learning activities on Forces. Which lessons went well? Which lessons were not so good? Can you explain why this was? Were you able to arrange all the practical activities satisfactorily? Could the pupils develop their practical and experimental skills?

2 Were you able to supply sufficient equipment for all of the practical activities? This unit, as well as the previous one on energy, encourages a lot of practical work. Does

this present problems? Can you develop teaching methods which will get around the practical problems?

3 How successful were the pupils when they did the Review questions above? Was the class:

A All successful (all pupils scored 6 out of 11 or above)

B Mostly successful (most pupils scored 6 out of 11 or above)

C Some were successful (between 2 and the number in B of pupils scored 6 out of 11 or above/between quarter and half the class scored 6 out of 11 or above)

D Not really successful? (fewer than a quarter of the class scored 6 out of 11 or above)

4 Can pupils carry out these objectives? Again, rate your pupils as A (all), B (most), C (some) or D (few).

- State two uses of friction in everyday life.
- Explain why a kicked ball moves and then eventually comes to a stop.

5 Were there some areas of teaching about Forces that gave difficulties, where the pupils' learning was not as good as you hoped? How can you work around these problems for future teaching?

Care of the skin

Syllabus objectives covered in this unit

By the end of this unit the pupils will be able to:

5.2.1 List some diseases of the skin.

5.2.2 Describe preventive measures for some common skin diseases. describe the behaviour of p-n junction diode in an electronic circuit

4.1.2 describe preventive measures for some common skin diseases

Introduction and additional information

Pupils have studied the skin in earlier years of primary school, but this unit opens with a brief review of the structure of the skin. The skin has many functions, but in summary its purpose is to keep our insides in and the outside out. Skin diseases occur when this function breaks down, in particular when disease-causing agents (germs) are able to get into the skin and develop and grow there.

It is clear that we can assist the skin's function of keeping the outside out by washing it regularly, attending to wounds and tears in the skin, and keeping germs away from the skin as far as possible.

For some diseases, such as eczema, the causes are not fully understood. Eczema is likely to be due to an allergic response of some type by the body, and this tendency to allergy is probably inherited from parents. However, it is also clear that exposure to allergens (substances in the environment that cause allergic reactions) will also stimulate the occurrence of eczema, so its effect can be minimized by avoiding contact with known allergens. For most eczema sufferers, the problem is that the allergens causing the problems are not known, and are difficult to identify, so they do not know when they are exposing themselves to allergens and when not.

Leprosy is a bacterial infection which has long been known, and which tends to carry great social stigma. There is no reason why it should carry any more stigma than any other skin disease, and it can now be treated with a multidrug programme of antibiotics. Leprosy does not cause the fingers and toes to fall off, as is popularly believed, but because of damage to the nerves of the

skin, patients very often damage their fingers and toes, and do not treat this damage, as they do not feel it. This results in progressive damage and deterioration of the fingers and toes.

The term 'germ' is introduced here. This is not strictly a scientific term, but it is one that is used in everyday language. Germs are any small organisms that can cause disease, and they include viruses, bacteria, fungi and protozoa (malaria is caused by a protozoan parasite).

Key words introduced

skin, germs, microbes, disease, vitamin, mite, bacteria, virus, fungus, personal hygiene

Planning

It is a good idea to invite a health worker to come into the class to talk about skin diseases. This could either be a nurse from the Community Health Centre, or a doctor from a local hospital. Setting this up will take some planning and advance work, and you will have to agree a suitable date for the health worker to come into the class. Ensure that the pupils are properly prepared for this visit, and that you have done some preliminary work with them on skin diseases, so that they can ask useful questions of the health worker, and get the most value out of the visit.

Resources and low cost or no cost materials required

Wall charts, photographs and illustrations of skin diseases are useful.

Guidelines for the teaching and learning activities

1 The skin *Pupil's Book pages 120-121*

This section is a review of work done previously. It is useful for pupils to know that the skin contains two layers – an outer layer (epidermis) and an inner layer (dermis).

2 Some diseases of the skin *Pupil's Book pages 121-123*

You may want to begin by asking pupils to brainstorm any diseases of the skin that they may have heard of. Then go through the table of information in this section with the pupils. If you have been able to find any additional resources, such as wall charts and pictures of various types of disease, show these to the pupils as well at this stage.

This is the best time for the visit of the health worker to the class, so that he or she can provide pupils with additional information about skin diseases.

3 Treatment and prevention of skin diseases *Pupil's Book pages 123-124*

Go through the table of information shown in the Pupil's Book and discuss the treatment methods with the pupils. Ask if any of them know people who have suffered from these skin diseases, and ask how they were treated.

4 Personal hygiene *Pupil's Book pages 124-125*

Prevention of skin disease is mainly through good personal hygiene. The activity in this section is intended to make pupils aware of good personal hygiene practices, and also to get them to discuss and share their experiences.

Multi-ability learning – activities for the more able and the less able

2 Some diseases of the skin *Pupil's Book pages 121-123*

3 Treatment and prevention of skin diseases *Pupil's Book pages 123-124*

All pupils will know of relatives or friends who have had skin diseases. Ensure that the less able pupils are invited to contribute to this discussion as much as the more able. More able pupils can be asked to research further information on skin diseases from the school library or from the internet.

It would be useful to ask more able pupils to investigate traditional beliefs surrounding some of these skin diseases, and to report back to the class as a whole. Traditional beliefs often do not include the concept of germs causing infection, and therefore personal hygiene to prevent germs is not always seen as a remedy. Ask the researchers to find out what remedies have been used in traditional cultures and to report back on whether they are effective or not.

4 Personal hygiene *Pupil's Book pages 124-125*

It is suggested in the Pupil's Book that it is not a good idea to use skin lighteners, as this damages the skin. Pupils who are interested might like to investigate this further, in order to find out why skin lighteners damage skin, and just how dangerous they are.

Answers to end-of-unit questions

Objective questions **Pupil's Book pages 26-127**

1 C **2** B **3** D **4** D **5** C **6** B

Essay questions *Pupil's Book page 128*

1 The skin is important in preventing germs from getting into our body, and in preventing body fluids, such as the blood, from getting out.

2 Eczema is probably caused by something that creates an allergic response. Scabies is caused by a skin mite.

3 Beriberi is caused by a poor diet.

4 Personal hygiene is the process of keeping the body clean and healthy. Amongst the habits which create good personal hygiene are:

- Regular bathing
- Washing of hands after urinating and using the toilet
- Washing of hands before taking food
- Washing the hair frequently
- Wearing clean clothes
- Wearing socks and shoes
- Not using foreign chemicals on the skin.

Review questions for the pupils

These questions may be given to the pupils as an end-of-unit test, for homework or as a review of the topics in the unit.

1 What causes infectious skin diseases?

2 What are the signs of eczema?

3 What are the signs of measles?

4 How can we prevent beriberi?

5 Why is beriberi not an infectious skin disease?

6 How can we prevent measles?

7 List four habits of good personal hygiene.

8 Why is personal hygiene important in preventing skin diseases?

Answers to Review questions

1 Infectious skin diseases are caused by germs, which may be bacteria, fungi, moulds or viruses.

2 Redness and patches on the skin which are itchy and tend to become raw and broken.

3 A red rash all over the body.

4 We can prevent beriberi by eating a diet which includes plenty of vitamin B1, such as unpolished rice and fresh vegetables.

5 Beriberi is not infectious, because it is not caused by germs: it is caused by poor diet.

6 Measles can be prevented by good personal hygiene, not coming into contact with measles patients, and by vaccination against measles.

7 Pupils should give any four good hygiene habits from:

- Washing of hands after urinating and using the toilet
- Washing of hands before taking food
- Washing the hair frequently
- Wearing clean clothes
- Wearing socks and shoes
- Not using foreign chemicals on the skin.

8 Good personal hygiene prevents germs and disease causing agents from staying on the skin, and so prevents the skin from becoming infected.

Diagnostic assessment

These diagnostic assessment exercises will assist you as the teacher to evaluate the impact of the teaching and learning activities in this unit and to assess the extent to which the unit objectives have been achieved.

1 Review these lessons on Care of the skin. Which lessons went well? Which lessons were not so good? Can you explain why this was? Was this a topic which the pupils enjoyed learning about? Were any of the pupils squeamish, and unhappy about discussing skin diseases? Did you make any special provision for such pupils?

2 Were you able to have a health worker visit the school to talk to the pupils? Did this go well? Did the pupils prepare well for the visit? Did they get a lot of benefit from this visit?

3 How successful were the pupils when they did the Review questions above? Was the class:

A All successful (all pupils scored 5 out of 8 or above)

B Mostly successful (most pupils scored 5 out of 8 or above)

C Some were successful (between 2 and the number in B of pupils scored 5 out of 8 or above/between quarter and half the class scored 5 out of 8 or above)

D Not really successful? (fewer than a quarter of the class scored 5 out of 8 or above)m

4 Can pupils carry out these objectives? Again, rate your pupils as A (all), B (most), C (some) or D (few).

- Name the causes of scabies and eczema.
- Describe how to prevent eczema and scabies.

5 List two aspects of the teaching and learning activities that went well for this unit. Decide how you can build on this success for future teaching.