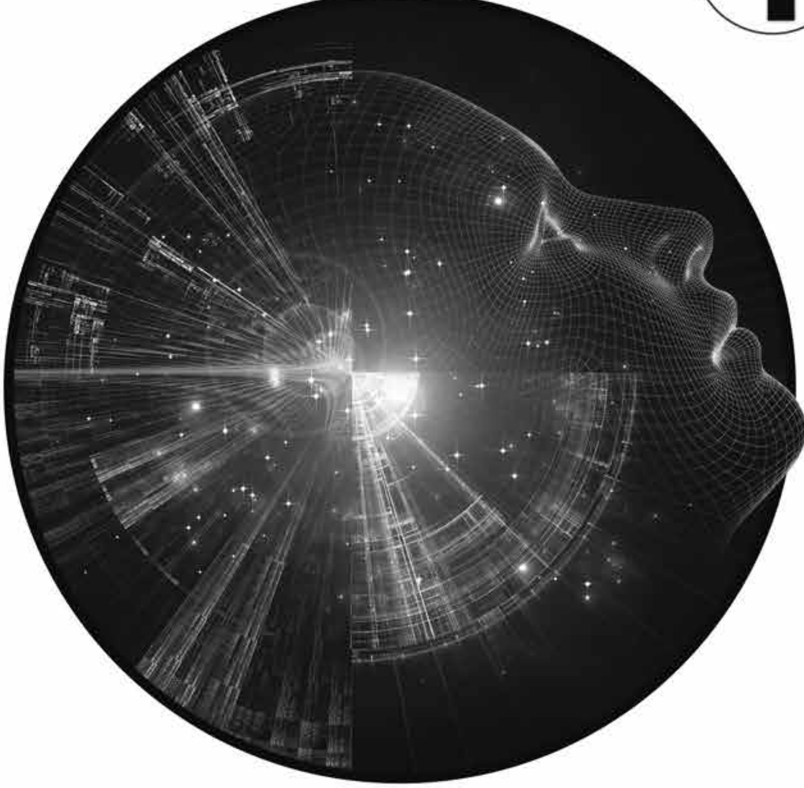
Complimentary Copy—Not For Sale

For secondary classes

SCIENCE Fact file 1

Teaching Guide



Wilhelmina Bernadette Petters Weem

OXFORD
UNIVERSITY PRESS

Contents

Introduction

As science teachers in the 21st century, we stand on the shoulders of many hundreds, if not thousands, of scientific giants who have gone before us. Never in human history has so much been understood about the scientific world. Yet, there still remains a lot that is unknown.

We should open up to students the many wonderful discoveries that have already been made, and stir in them a desire to continue to investigate and explore those areas of science that are still not fully understood.

When Newton, Faraday, or Pasteur, were looking at the world and seeking explanations, they did not have a book that contained all the answers; they used the knowledge they had to ask questions, to investigate, to try to discover what they did not know. They were active and life-long learners.

Far too often we permit our students to be passive learners by providing them with information and asking them to learn it. Education must be active! We must encourage our students to be inquisitive and searching, particularly in the field of science education, and empower them to be our partners in the process of acquiring knowledge.

Our hope is that this series of books and teaching guides will help in that endeavour.

Organization of the book

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

About the Teaching Guide

Science Fact file Teaching Guides 1, 2, and 3 have been written to promote and support effective science teaching. Suggestions for teaching procedures are provided for each unit, and answers for questions and solutions for exercises and problems are supplied.

Background information

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

Unit introduction

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

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

   At the start of a new unit, it is vital to find out what knowledge (and misconceptions!) students may already have. This can give rise to questions which will be answered during the unit. Ask questions such as: *Have you ever seen…..? What did it look like? Have you ever made a …? Have you heard about…? Have you ever watched someone …?* The purpose of these questions is to obtain some facts from the students' past experiences.

   While questioning, the teacher should bear in mind that the purpose is not to obtain correct answers; it is to find out what the students know and how they think. Another purpose is to get the students to ask their own questions. As the discussion progresses, the main points of the answers can be recorded on the board. Any questions that cannot be answered should be written on the board under the heading 'Questions we cannot answer'. The students can then read the text to check their responses and also find answers to their questions.

2. **Using pictures**

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

3. **Reading and discussion**

   Reading is a necessary and desirable activity for learning science, but too often it is the only activity. This is probably because reading is the method most familiar to teachers, who feel more at ease when using it.

   Groups can be formed in different ways, but this will affect how an activity is planned. If each group has a strong scientist, this person can take the lead and support the other group members. Alternatively, differentiated assignments and scaffolding can help strong and weaker groups to get the most out of the activity. Both approaches can and should be used, but both require the teacher to assign the groups. If students choose their groups, the teacher will not know in advance what the groups will be like, so he/she will not be able to design the activity accordingly.

4. **Experiments and observations**

   Though science concepts are best developed through first-hand experiences, sometimes, it is impossible to provide experiments that are simple enough for secondary level students, or they require laboratory facilities far beyond the resources of the average school. It is equally impossible to organize actual observations of all living things in their natural habitats. However with careful preparation, it should be possible to provide students with some opportunities to carry out relevant and meaningful practical work.

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

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

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

5. **Field trips**

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

How to use this Teaching guide

Please do not see this guide as the definitive or only way in which to present the material in the book. You, as a teacher, know your students best, so use this guide to help you plan lessons that they will find interesting and exciting.

Also remember that the text book contains only some of the information on a given topic. Do not be afraid to extend your students' learning experience by supplementing the work with other resources that you might have access to.

Each chapter of the guide corresponds to a chapter in the textbook.

Lesson Plans – For each unit there is a series of suggested lesson plans based on a 45 minute lesson. These can be used as a basis for planning your lessons based on the resources and time allocation in your school; the timings mentioned are purely as a suggestion. Do take the time to make the plans according to your requirements.

Worksheets – Photocopy-able masters are referred to in the lesson plans; use these to supplement and extend the work presented in the textbook. Conduct experiments that can be carried out throughout the unit, there are also suggestions for investigations that can be conducted. The idea of the investigations is not to 'give' the students the experimental procedure but to encourage them to use their existing knowledge and understanding to draw up a plan and then carry out and evaluate their own experimental procedure.

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

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

Chapter 1

Science skills

UNIT FLOW CHART

Science is everything about us

↓

Scientists observe and record results

↓

Scientists use instruments to make measurements

↓

Scientific information is recorded in the form of data

INTRODUCTION

The purpose of this chapter is to introduce students to science. Your task is to help them discover how interesting, and FUN, science is. This will not be achieved by only reading from a textbook and filling out worksheets, but by offering many different activities in the classroom and in the lab where students can experience science hands-on, and by relating science to everyday life. When most of your students enjoy science lessons, they will be more cooperative, which makes your role more rewarding too. So investing time in carefully planning what your students will be doing during each lesson will be worth your time.

After discussing what science is and what branches of science exist, we will look at how to take measurements and some strategies that can be used to improve accuracy. We will look at how to plan an investigation and show some ideas on how to handle data and present them in the form of graphs. Please continue to apply these ideas throughout the year, whenever your students are involved in an activity.

A word of caution about any experiment where students dissolve sugar:

Please be aware of two things.

First, some of the sugar solution will spill and leave an incredibly sticky mess which is difficult to clean up.

Second, if you are considering an investigation into how *much* sugar can be dissolved at various temperatures, rather than how *fast* it will dissolve, be aware that 1 litre of water at room temperature will dissolve 2 kg sugar, and that the solubility increases rapidly with temperature, reaching around 5 kg in 1 litre of water at 90°C. Using common ingredients to link science to students' life is usually a good idea, but think carefully before using sugar!

Lesson 1-1

Pages 2-4

OBJECTIVES

- To enable students to carry out a scientific investigation with due regard for health and safety

LEARNING OUTCOMES

The students should be able to

- differentiate between major fields of science.
- work safely with due regard for the potential dangers arising from their work.

START (20 min)

Ask students for words or sentences which they can associate with 'science' and write them on separate *post-it* notes. They can try to write a definition, but just words or ideas would be fine. Examples which may come up are 'experiments', 'chemicals', 'laboratory', etc. Group together similar concepts and see if any contradict each other. Discuss your findings, but avoid going into 'right' or 'wrong'. If students press you for answers, put it back to them by saying things like 'What do you think?' or 'We will answer this later in this chapter'. This activity will show you what they already know about science and may identify misconceptions. You can often start a new topic by doing an activity like this.

MAIN (20 min)

- Study pages 2-4.

  Definition of science: Science has many definitions, some of them very simple and some that are so complex that they are difficult to understand. Most definitions agree that science is a 'systematic study' and that the study aims to improve people's understanding of the world around them.

- Lab safety

  In order to be able to do hands-on experiments with your students, you need to be fairly confident that they will behave sensibly in the lab. It is impossible to cover all behaviours in a code of conduct for the lab, but the most obvious actions (which to do and which to avoid) can be written down.

- Please allow students to consider which behaviours would be wise and unwise in the lab and ask them to sign the document once it is finished. For suggestions on safe and unsafe behaviour, students can consider the drawing on page 4.
- Hand out worksheet 1-1. Use the 'think-pair-share' approach: ask students to write down what they think science is. They can then discuss their ideas with their neighbour and then with a group, and the groups can report to the entire class. It is almost certain that they do not know all these fields of science. Again, start with what you know and then see what is left. Discuss with others. If IT is allowed in the classroom, they can use the internet. It is also possible to complete this at home.

PLENARY (5 min)

Discuss this lesson with your students. Ask them what they learned and what they expect to learn in the future.

HOMEWORK

Complete the matching exercise on worksheet 1-1.

Lesson 1-2

Pages 5-7

OBJECTIVES

- To enable students to carry out a scientific investigation with due regard for health and safety

LEARNING OUTCOMES

The students should be able to

- take measurements accurately using appropriate apparatus.

START (15 min)

This is the lesson where good lab habits start. Ask students what kind of investigation they would do if they were given a fully-equipped lab. Someone is likely to suggest that they mix some chemicals together and see what happens. It is important to take the time to discuss this. Why is this not science and not safe? It is important that they understand that science experiments are planned and controlled and that the scientist has an expectation, grounded in knowledge, and that almost all experiments involve some type of measurement.

MAIN (25 min)

- Use pages 5-6 of the Student Book and worksheet 1-2 to familiarize students with the relevant equipment. Reading a graduated cylinder takes a bit of practice but it is also important to check if students are comfortable with all the other measurements described.
- The scientific method: The 'systematic' approach of science is called the 'scientific method'. In worksheet 1–2 students are asked to put the components in the correct order. Hint: one component has an arrow and one has a plus sign. These are kept in the students' diagram to help them get started.
- It is helpful if students realize that using a 100 cm^3 measuring cylinder to measure 5 ml is not going to be accurate. Please make sure they understand that beakers are NOT to be used for measuring volume.
- Please note that the Kelvin temperature scale has no 'degrees' symbol; so 273 K and not 273°K.

PLENARY (5 min)

Ask students to think how they would measure very large or very small things.

HOMEWORK

Read pages 5-6 and answer the Test yourself questions on page 7.

Lesson 1-3

Pages 7-9

OBJECTIVES

- To enable students to carry out a scientific investigation with due regard for health and safety

LEARNING OUTCOMES

The student should be able to

- carry out appropriate calculations.
- present the results of an investigation in an appropriate way.

In this lesson your students will work with data and data presentation (i.e. making graphs). If your students are already familiar with this and you have an IT teacher in school, you could choose to co-teach this with IT by using Excel spreadsheets. Check with your colleague if this works in your school.

START (10 min)

Follow up from last lesson's PLENARY. You could choose to turn the problem around initially and ask how they would find out the weight of a brick wall. (Weigh one brick and multiply it by the number of bricks. Be aware that this does not include the weight of the cement.). Or you could ask how to find out the weight of the cargo of soft drinks on a truck. (Weigh one bottle, multiply by the number of bottles; again, this does not include the weight of the crates.)

MAIN (25 min)

- Read page 7 of the Student Book and, if possible, perform this experiment. Grains of rice differ in size so you may get a different result from the book.
- Then get students to take their pulse. They are likely to need help finding the right spot on their wrist or neck. Once they all feel their pulse, you tell them to 'start'. After 20 or 30 seconds, tell them to 'stop' and ask them to write down their results and then convert them to a rate per minute.
- A bar chart can show how data change over time, while a pie chart, for example, does not show this. The exercise shows how data changes over one year and asks students to analyze the reasons for the changes. It is likely that students will need some guidance working through this problem.

PLENARY (10 min)

Ask students what kind of data they think they could collect to draw a bar chart.

HOMEWORK

Read pages 7-9. Answer the Test yourself questions on pages 8 and 9 of the Student Book.

Lesson 1-4

Page 10

OBJECTIVES

- To enable students to carry out a scientific investigation with due regard for health and safety

LEARNING OUTCOMES

The students should be able to

- carry out appropriate calculations.
- present the results of an investigation in an appropriate way.

If possible, co-teach this lesson with the IT department, using Excel. It is a great skill for students to have, but may take more than a lesson to learn.

START (10 min)

Students will be drawing line graphs. Please stress the need for accuracy (sharp pencil, ruler). Also discuss the different types of graphs and when to use them.

MAIN (25 min)

- Ask your students to read page 10 of the Student Book and take a close look at the line graph. How does a line graph differ from a bar chart? (A bar chart may have categories or intervals on the X axis; a line graph has numbers.)
- The first exercise on worksheet 1-4 about extending the spring provides the context and data for students to plot. It includes the steps needed to change a table into a graph, including the understanding of the dependent and independent variables. The grid next to the data table given in worksheet 1-4 is of suitable dimensions. Depending on your students' skills, you may want to give them some graph paper, so they need to decide the lengths of their axes.
- The second exercise about the temperature in cars also provides the context and data. Again, the grid next to the data table is the correct dimensions for plotting the graph. Please check that students go through the same process as for the previous exercise.
- In the third exercise, your students should convert the data about the sandwiches into a pie chart. The pie chart is already subdivided into the right number of sections so they only need to colour them. Again, you can ask them to draw a circle and do the task without these hints.

PLENARY (10 min)

Go over the types of graphs students have seen and when to use which graph. Sometimes, it is possible to plot more than one type of graph from a set of data. It is then important to consider what you want your graph to show best. The pie chart given in worksheet 1-4 shows which sandwiches the customers preferred at 9:00. If you collected the same data at noon and at 17:00, you might want to show how the preference changes in a day and use a bar chart.

HOMEWORK

Read page 10 of Student Book and answer the Test Yourself questions on page 10.

Lesson 1-5

Pages 11-13

OBJECTIVES

- To enable students to carry out a scientific investigation with due regard for health and safety

LEARNING OUTCOMES

The students should be able to

- present the results of an investigation in an appropriate way.

START (10 min)

It is important that students realize that critically reflecting on how your experiment went is important for you to learn and for others who may want to investigate something similar. There is always something to improve and/or to investigate further.

MAIN (25 min)

- Use worksheet 1-5 for a list of components of a full lab report. Ask students to consider the questions individually for a few minutes before they discuss them in small groups. Ask them to complete the first set of questions before starting on the second.

PLENARY (10 min)

Ask students what was the most difficult part of what they were asked to do and how they resolved any difficulties.

HOMEWORK

Workbook page 5, Question 9

1. What is science?

   Science is ____

   ____

2. You are most likely familiar with the three main fields of science: biology, chemistry, and physics. Write the correct field next to the correct description in the table below:

	the study of life and living things
	the study of matter and its properties
	the study of matter and energy and their interactions

3. Look at the Contents page of your Student Book to see the names of the chapters. Identify which chapters would be biology, chemistry, or physics. If you are not sure, have a look at the first page of the chapter to find more information. Write the branch of science beside the title of the chapter in the table below.

Chapter No.	**Title**	**Branch of science**
Chapter 1	Science skills	
Chapter 2	Life and living things	
Chapter 3	Acids and alkalis	
Chapter 4	Energy resources	
Chapter 5	Simple chemical reactions	
Chapter 6	Electrical circuits	
Chapter 7	The environment	
Chapter 8	Particles	
Chapter 9	Forces and their effects	
Chapter 10	Variation and classification	
Chapter 11	Solutions	
Chapter 12	The solar system	

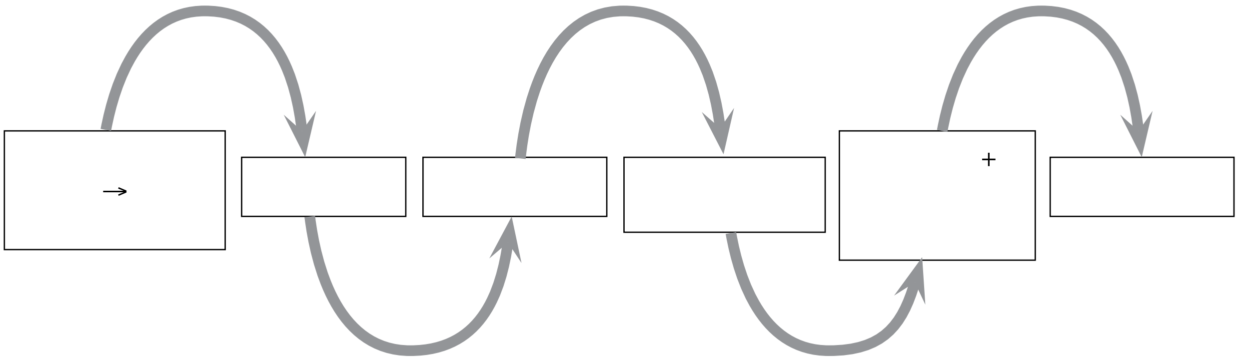
4. There are many fields of science within and between these main fields. Match the field to its description.

astronomy	the study of prehistoric life
biochemistry	the study of the oceans
botany	the science used to solve crimes
ecology	the scientific study of space
ethology	the study of organisms and their environment
forensics	the study of animal behaviour
genetics	the study of animals
meteorology	the study of chemical process in living things
oceanography	the study of hereditary traits
paleontology	the study of plants
pharmacology	the study of the atmosphere, including weather forecasting
zoology	the study of the effects of medicines

1. One of the most important characteristics of science is the use of the scientific method. It is a method of approaching problems that scientists have shown to be very effective. The scientific method has a number of steps which are taken in a certain order. Can you work out what the correct order is?

The steps are:

- conclusion
- question
- experiment
- research
- hypothesis
- results + analysis
- observation



a. What do you need to do before you do an experiment?

____

____

____

b. When you are carrying out an experiment, what do you need to do?

____

____

c. When you are measuring something, it really helps if everyone uses the same units. If your height is 1.50 m and your friend is 4'11", who is taller? So scientists have agreed on a number of units which we all use. They are explained on pages 5–6 in your Student Book. Use this information to complete the table below.

What are you measuring?	Which instrument do you use?	What units could you use?
length		
volume		
mass		
temperature		
time		

d. Record the measurements of the objects below. Remember to include the correct units!

- How long is your pencil?

  ____

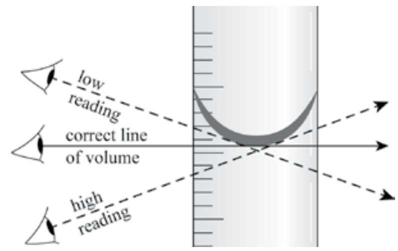
- What is the length and width of a paperclip?

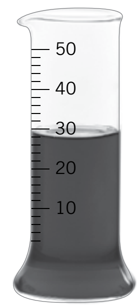
  ____

e. When you want to read the level of the liquid in a measuring cylinder, you need to remember two things.

First, the surface of the liquid is not flat: it is higher at the sides than in the middle. The cylinder is designed so that the lowest part of the surface (called the meniscus) shows the correct volume.

Second, make sure your eye is level with the surface of the liquid. The picture shows you what happens if you look down or up.





What is the volume of the liquid in this measuring cylinder?

__________ ml

f. Although there are many different ways of measuring an object's mass, many schools have scales that look like the one in the picture. How much does the envelope weigh?

__________ gms

g. Both analogue and digital stopwatches are used and they come in many shapes and colours. Digital stopwatches are more common in school labs.

What is the reading on the digital stopwatch?

__________ m __________ sec

1. Your heart rate is expressed in beats per minute. You can feel your heartbeat in the arteries of your wrist or near your neck. Use two fingers to locate the precise point on your wrist or neck. Do not use your thumb because the thumb itself has an artery and you may count both.

   When all students have found their pulse, the teacher will say 'start' and you will start counting your heartbeats—in total silence please. It is easier if you do NOT look at your classmates. When the teacher says 'stop', immediately record your results below.

   I counted ________________ heartbeats in ________________ seconds.

   Now you need to convert it so that you have a value for 1 minute (60 seconds).

   My cardiac frequency is ________________ beats per minute.

Data handling

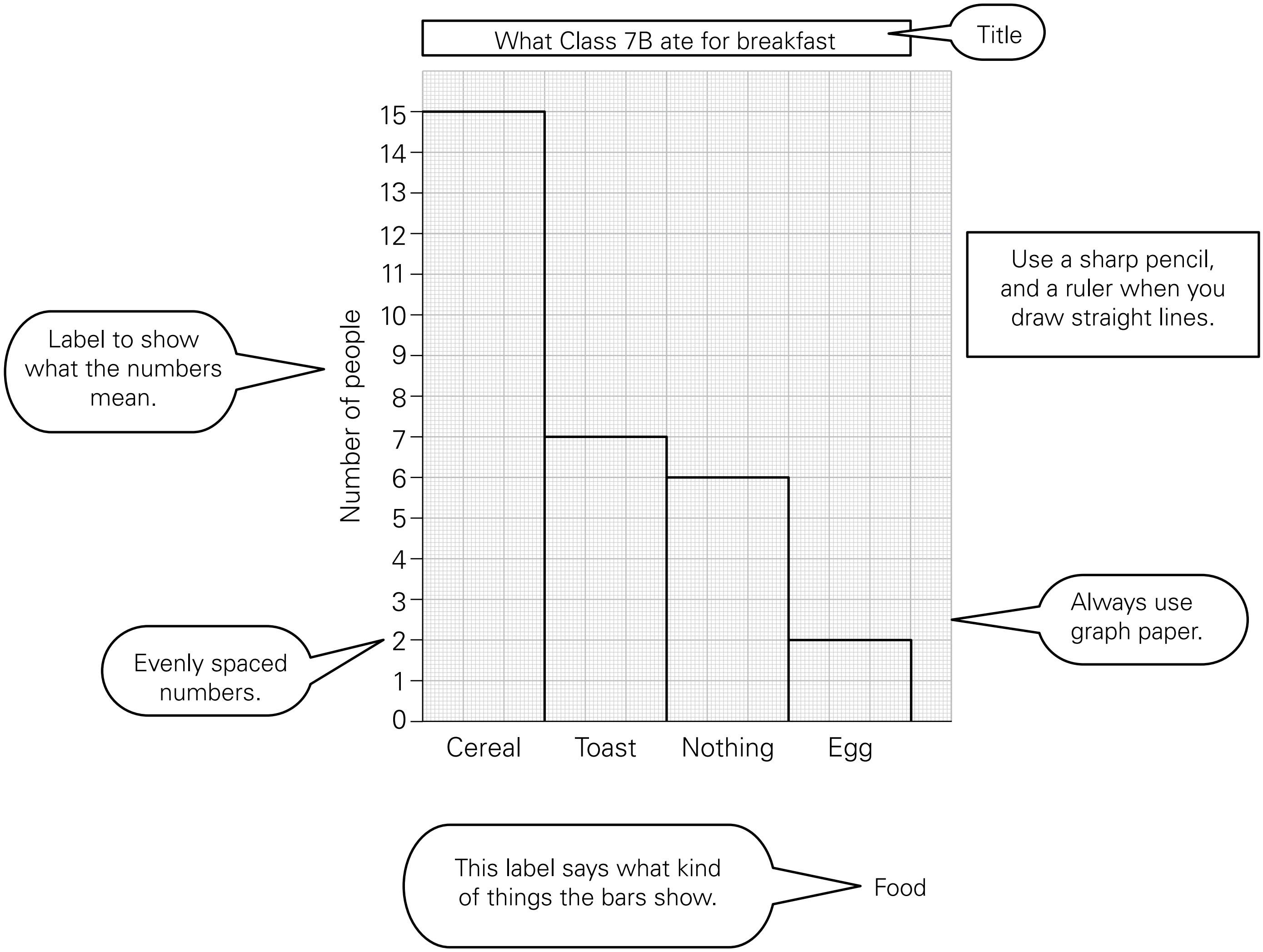
Once you have taken measurements in your experiment, you have collected data. Rather than describe it all in long sentences, you want to turn it into snappy data: tables and graphs.

Read page 9 in your Student Book and take a good look at the bar chart. Answer the questions on page 9.

2. You have done a survey to show what the people in your class had for breakfast, and these are your results:

Food	Number of people
cereal	15
toast	7
egg	2
nothing	6

Draw a bar chart like this one to show your results:



3. Draw bar charts to show the results of these surveys.

    a. Number of plants in a lawn

Plant	Number
daisy	10
buttercup	7
clover	20
thistle	2

b. Colour of cars on road.

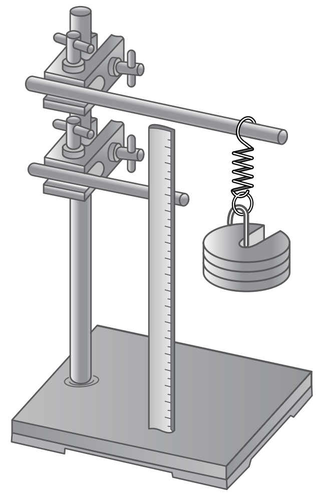
Colour	Number of cars
black	12
white	10
blue	8
red	1

4. Carry out your own survey to find out the following information and draw bar charts to show your results.
   A. How the pupils in your class travel to school.
   B. How many brothers and sisters pupils in your class have.

Method of transport	Number of people

Student	Number of siblings	
	Brothers	Sisters

Worksheet 1-4



1. Line graph

For a line graph, you simply plot all data points and connect the dots. A line graph can be used when all your data are numbers (and not months of the year or names of people). As you are drawing a line between your points, you need to be confident that if you had taken a measurement at that point, the results would have been on this line.

Sarah wanted to find out how much a spring would extend under different forces. She did this by attaching different weights to the spring, and recorded her data in the table.

You need to draw a line graph of these data by going through the following steps.

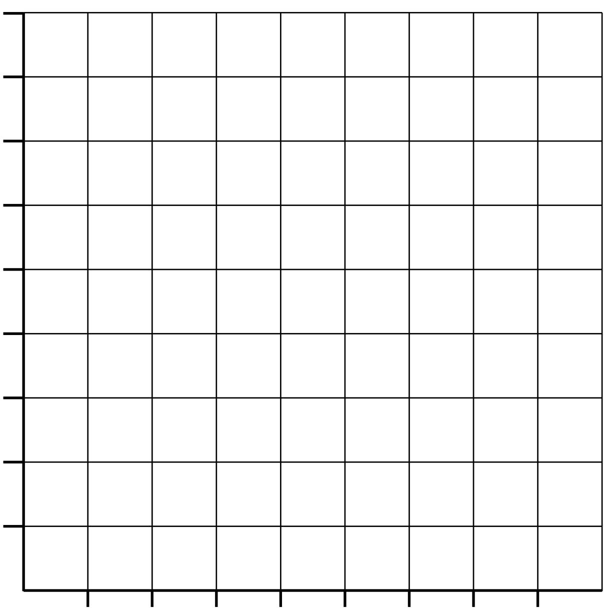
a. Drawing a graph

1. Decide which data go on which axis.

   Before starting her experiment, Sarah decided she was going to use the weights to give her forces of 0 N, 1 N, etc. So this variable was independent of Sarah's measurements—the independent variable. The independent variable always goes on the X-axis. (It is usually, but not always, written in the first column of a table.)

   That means that the length of the spring goes on the Y-axis. This is the variable Sarah measured and it depended on the force she put on the spring—the dependent variable.

2. A small graph is more difficult to plot and to read than a large one. But make sure the spaces between the numbers are correct. For example, if your values are 1, 2, 19, 20, the space between 2 and 19 cannot be the same distance as between 1 and 2; it needs to be proportional.
3. Label your axes. You need to tell people what they are looking at. Please include the units.
4. Use a sharp pencil to put a cross accurately for each set of data. If you make a mistake, erase it carefully. Only plot the point (0,0) if it really exists—in this graph, it does not.
5. Each graph should have a title which tells people what your graph shows. Look at the labels of your axes. Your experiment showed what the effect is of the changes of the independent variable (your X axis) on what you measured (your independent variable—the Y axis).



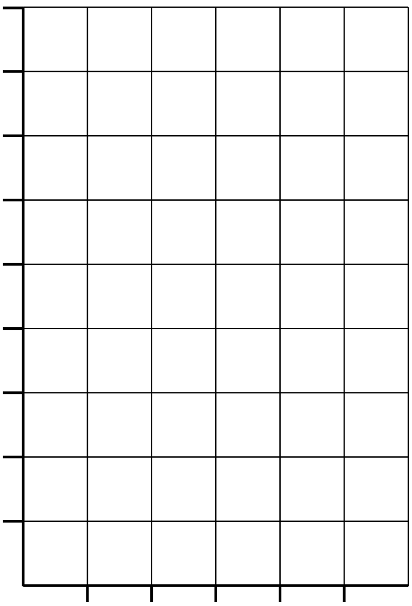
Force (N)	Length (cm)
0	5
1	10
2	15
3	21
4	26
5	32
6	36
7	41

b. Two sets of results

Sometimes you might want to put two sets of results on your graph so that you can compare them.

Knowing that white reflects more light than black, Mariam wanted to know if black cars become warmer in the Sun than white cars. She arranged for two cars to be parked next to each other in the parking lot and put a thermometer in each. She went to read the temperature every hour and collected the results shown in the table.

Plot a line graph, including the data for both cars. Please check all the steps decribed above to ensure you do not forget anything.



Time (hours)	Temperature (°C)	
	black car	white car
0	15	15
1	20	19
2	25	23
3	30	27
4	35	31
5	40	35

Ask your neighbour or lab partner to check if you have covered all the steps before asking your teacher.

2. Pie chart

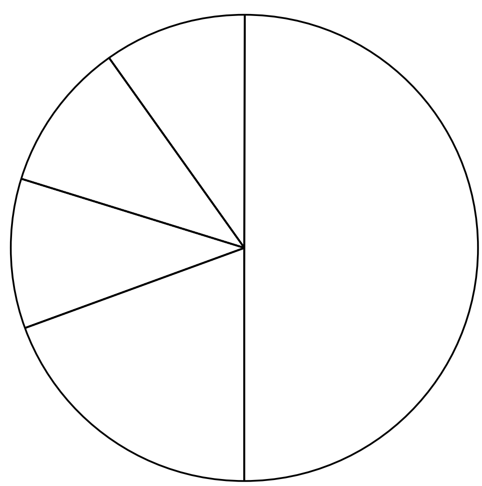
A sandwich shop wants to know if customers prefer different sandwiches at different times of the day, so they noted down the first 10 orders after 9:00 in the morning.

This is what they sold:

cheese, chicken, egg, fish, beef, chicken, chicken, cheese, chicken, egg, beef.

sandwich	tally	total number
chicken		
cheese		
egg		
beef		
fish		

Now you want to draw a graph from your data. Because you want to show that chicken sandwiches are the most popular at 9:00 in the morning, you choose a pie chart. It shows which part of the whole each section is. Use the table to show the results. Choose a different colour for each type of sandwich.



Earlier, we briefly mentioned the scientific method as the way scientists work. This means that you will also follow this method when you do an experiment. At first, your teacher will have done some of these steps for you already, but you will have to write it all up in a report.

A standard lab report has several sections you need to cover. You may do some very different investigations so it is a good idea to ask your teacher which parts need to be included in your report.

1. **Title**

   Your research question usually makes a good title. Make sure it is specific enough. For the experiment described on page 11 of your Student Book, the question 'Does sugar dissolve in water?' is not very good. A better title would be: 'Does sugar dissolve more quickly in hot water than in cold water?'

2. **Hypothesis**

   What do you think the answer to your question will be and why do you think this? You cannot make up just anything—you need to refer to something that you have read or learnt from a credible source.

3. **Materials and method**

   It is a good idea to list all the materials used first and then write down the steps of the experiment. The purpose is to allow someone else to repeat your experiment and get the same results. After you have done both, check if the use of all the materials you listed is described in your method and then check if all materials mentioned in your method are listed.

4. **Results**

   Write down your raw results—usually in a table. Then do the necessary calculations. You may have to calculate how much the spring stretched by subtracting the original length from the length you measured when a weight was attached, or you may need to calculate a percentage.

5. **Graphs**

   If you can plot graphs from your data, do so.

6. **Conclusion**

   Go back to your research question. Can you answer it? How does the answer compare to the hypothesis?

7. **Reflection**

   If you had to do this experiment again, what would you do differently?

A lab report needs to show you carried out your investigation well, but also that you understand your results and can analyze them. It even shows that you can reflect on your own work. All of this will take some time to write down, so do not expect to be able to write a full lab report in 15 minutes.

a. What could be a research question for the first experiment of worksheet 1-4?

b. What could be a hypothesis for this experiment?

c. What would be your conclusion from this experiment?

d. What could you do differently?

e. What could be a research question for the experiment about the black and white cars?

f. What could be a hypothesis for this experiment?

g. What would be your conclusion from this experiment?

h. What could you do differently?

Chapter

2 Life and living things

UNIT FLOW CHART

Characteristics of living things

↓

Living things are made up of cells

↓

Special cells perform special jobs

↓

Cells, tissues, and organs

↓

Organ systems of a human being

↓

Organ senses

INTRODUCTION

As with most of the material in science, students would have come across some of it in their daily lives. This is a link to strengthen. We all know it is easier to remember new information if we can link it to what we already know; therefore it is wise to make use of students' existing knowledge.

The time when schools existed in isolation, and 'real life' was carefully kept away from what was learnt at school, is long gone. 'No school is an island' so please link your teaching to the students' everyday experiences.

This chapter is about life. Students will be able to sort most things into 'living' and 'non-living' quite easily, but it might be harder to work out what is at the basis of their decisions. This could be an interesting discussion to start off the chapter.

There is no substitute for the hands-on work students do in the lab. They enjoy doing experiments and it will increase their interest in science, which usually makes them easier to teach. We teach the scientific method and this makes a lot more sense if students actually carry out experiments. Some of you will teach in schools with limited resources where you have no choice but to find alternatives to experiments, but many of the experiments or activities in this book can be done in classrooms or outside with very simple equipment.

Lesson 2-1

Pages 16-18

OBJECTIVES

- to show that all living things have similar characteristics and are made up of cells

LEARNING OUTCOMES

After this lesson, students should be able to:

- state that all living things share the same characteristics.
- name the 7 characteristics of life.
- outline each characteristic.
- give an example of each characteristic in plants and animals.

START (20 min)

The teacher should have a projector and screen. Students should have a (shared) pc/laptop/tablet/smart phone. If these resources are not available, printed slides can be used to start a discussion.

Go to the link https://share.nearpod.com/vsph/6G39955wpF . Go through the presentation and ask students to answer the questions.

Answers should be selected and shown by teacher.

Ask students their reasons for their choices but do NOT give a 'correct' answer. Encourage class discussion but do NOT come to a conclusion.

or

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

MAIN (15 min)

- Read pages 16-18 from the Student Book. Explain that a way of remembering the life processes is the acronym MRS GREN, **M**ovement, **R**elease **E**nergy, **S**ensitivity, **G**rowth, **R**eproduction, **E**xcretion, and **N**utrition.
- Hand out worksheet 2-1 to the students. Finish it for homework.

PLENARY (5 min)

Discuss why each of these characteristics is necessary. What would happen to a plant or animal that could not move, release energy, sense and respond to stimuli, grow, reproduce, excrete, or eat (nutrition)?

HOMEWORK

- Finish worksheet 2-1.
- Answer Test yourself questions on page 18 of the Student Book

Lesson 2-2

Pages 19

OBJECTIVES

- to explain how organisms are constructed from cells, tissues, and organ systems

LEARNING OUTCOMES

After this lesson, students should be able to:

- explain that all living things are made of cells.
- label the parts of the microscope.
- focus a microscope.

START (10 min)

- Display a picture of a cell or refer to the pictures on page 20 of the Student Book.
- Ask a student to write on the board: All living things are made of cells. Ask another student to write on the board: Most cells are smaller than 0.1 mm.
- Calculate the following with the students:

  If you were a cell, how big would one of your classmates be?

  Example:

  The student is 150 cm = 150000 mm. The (plant) cell is 0.1 mm.

  The student is 150000 / 0.1 = 1500000 times larger than the plant cell.

  If the cell were as large as the student, then his/her classmates would be 1500000 times larger than they are now. They would be 2225000 km tall. That is more than halfway to the Moon!

This shows how very small even the largest cells are.

MAIN (30 min)

- Read page 19.
- Take the students to the laboratory and show them a microscope and hand lens. Show them slides of different kinds of plant and animal cells and microscopic organisms like the amoeba and paramecium. Help the students to practice and acquire skill in using a microscope.
- If microscopes are not available, use the internet as an alternate option. Search for 'microscope animal cell' and show the students the differences between animal and plant cells.
- Hand out worksheet 2-2.

PLENARY (5 min)

Ask students which part of the microscope they think they will use most.

HOMEWORK

- Answer Test yourself questions on page 20 of Student Book.
- Complete tasks from Workbook page 11.

Lesson 2-3

Pages 20-21

OBJECTIVES

- to explain how organisms are constructed from cells, tissues, and organ systems

LEARNING OUTCOMES

After this lesson, students should be able to:

- draw a generalized plant cell and animal cell (cell membrane, nucleus, cytoplasm, cell wall, chloroplasts, vacuole).
- list the differences between plant and animal cells (as seen with the light microscope).

START (10 min)

- Remind students that all living things are made of cells.
- Remind students that we need a microscope to see cells.

MAIN (30 min)

- Give students microscopes and one or two prepared slides of plant and animal cells.
- Ask them to draw what they see on worksheet 2-3.
- Complete worksheet 2-3.

PLENARY (5 min)

Discuss the different structures found in plant and animal cells and the functions of each structure. This can be done in a plenary discussion or by asking students to answer questions on slips of paper/card.

HOMEWORK

- Answer questions on page 21.
- Complete tasks from Workbook page 8.

Lesson 2-4

Pages 21–23

OBJECTIVES

- to explain how organisms are constructed from cells, tissues, and organ systems

LEARNING OUTCOMES

After this lesson, students should be able to:

- describe the levels of organization (cells, tissues, organs, organ systems, organisms) and give examples of each.
- describe the relationship between the structure and function of nerve cells, epithelial cells, pollen grains, and red blood cells.

START (10 min)

Revision

Play the link below.

https://www.youtube.com/watch?v=-zafJKbMPA8

Discuss the information that is given and relate it to what was learnt in the previous lesson.

MAIN (25 min)

STRUCTURE AND FUNCTION

- Have a number of objects ready, for example, a fork, a spoon, a knife, a cup, and a plate. Ask students which item they would choose if they wished to drink tea. What about cutting a piece of bread? Obviously, students will drink tea from a cup and slice bread with a knife. Ask them why they made their choices. There will be different answers, but they will have in common a relationship between the structure of the item and the function for which they need it. Students are unlikely to actually say this, so the teacher may have to provide some guidance.
- Then ask students to give other examples where shape relates to function, and extend it to include the structure of the material. For example, we do not wear Styrofoam (a great insulator) to keep warm because it is not flexible. (It could be used to insulate houses but it is dangerous in case of fire.)
- Now ask students to write and/or draw a part of a living organism where the structure supports the function. Examples could include the gills of a fish (large surface for getting oxygen from the water), the splayed feet of camels (large surface area so they do not sink into the sand too far), the long snout and tongue of an ant eater (which allows them to get ants from deep inside their nests), etc.
- Transition to the different functions of cells and their different shapes. Refer to page 21 of the Student Book and worksheet 2-4.

LEVELS OF ORGANIZATION

Go over pages 22-23 and worksheet 2-4.

Discuss how different organs work together in an organ system.

If desired, connections between the systems can be considered. For example, the respiratory system gets oxygen into the organism but the circulatory system takes it to where it is needed, e.g. muscles.

PLENARY (10 min)

Check if students have understood the relationship between structure and function by referring to their writing/drawing. Ask students to explain where appropriate.

HOMEWORK

- Answer Test yourself questions on page 22 of Student Book.
- Complete tasks from Workbook pages 9 and 10.

Lesson 2-5

Pages 24-28

OBJECTIVES

- to extend students' knowledge of their sense organs

LEARNING OUTCOMES

After this lesson, students should be able to:

- identify the five sense organs.
- describe the structure of the eye, ear, and skin.
- explain how the eye, ear, skin, tongue, and nose detect changes in the environment.
- describe how these changes are interpreted by the brain.

START (10 min)

- Ask students to list the characteristics of life. Once all have been listed, focus on 'sensitivity'. In order to stay alive, it is important that an organism can respond appropriately to its environment.
- Ask students to list some examples, such as: running away from danger, smelling food, seeking a sheltered place and producing more body heat when it is cold, growing towards gravity (roots) or towards light (stems), etc.
- In order to respond to the environment, the organism must be aware of its environment, such as feeling the cold or smelling the food. For this, mammals, including humans, have sense organs.

MAIN (30 min)

- Ask some volunteers to sit with their eyes closed. Ask them to identify the stimuli (given below) to which they are exposed, but avoid giving answers unless asked. Ask students to whisper their answers to a classmate who will write them down.
    - Hold something with a strong smell near them, e.g. perfume on a tissue or a strong smelling fruit like a peeled banana.

- Ask them to hold their nose and give them a small amount of cinnamon to taste (no more than ¼ teaspoon to avoid choking). Then, still holding their nose, give them a sip of juice or sweet tea.
- Create a sound, e.g. tapping a glass, playing a note on a recorder, or using a ring tone from a mobile phone. Ask them to indicate where the sound came from.
- Rub an ice cube over the back of their hands. Touch either one hand or both, with either one or two fingers.
- Ask students to open their eyes and look at a picture, e.g. a red square or a tree.

Discuss the students' answers. Most likely, the following answers will be given:

- They correctly identified the smell of the perfume or banana.
- They most likely did NOT taste the cinnamon (it has a smell but no taste!) but did taste the sweet drink.
- They were able to identify both the sound and the direction from which it came.
- They felt the cold ice cube and should be able to tell you how many touches they felt.
- They saw the picture and could describe it.

- Based on this activity, ask students to list the human sense organs (eyes, ears, tongue, nose, and skin). This can be done on a poster with appropriate drawings.
- Divide the class into 5 groups. Teachers are advised to select these groups themselves. They may put the strong students together and give them a more difficult task while the teacher spends most of his/her time helping a group which needs more support. Alternatively, stronger students can be divided between the groups so they can help the others in the group. Do not let students choose groups: teachers cannot predict the groups and that is not helpful when you are preparing the lesson.
- Give each group one sense organ to investigate. Ask them to prepare a poster and a 2-3 min presentation and a handout with the key points for their classmates. The Student Book (page 24–28) is a good starting point but more details are required, including structure, function, and how the information is processed by the brain for appropriate action.

PLENARY (5 min)

Each group briefly shares its planning on what type of information they will present and how they plan to find it. This can be directed by the teacher (e.g. you must include at least one website and one library resource) as appropriate.

Inform the students that they either have to prepare this at home for the next lesson, or that they have the next lesson to prepare, and they will present in lesson 6.

HOMEWORK

Research the allocated sense organ.

Lesson 2-6

OBJECTIVES

- to extend students' knowledge of their sense organs

LEARNING OUTCOMES

After this lesson, students should be able to:

- describe the structure of the eye, ear, and skin.
- explain how the eye, ear, skin, tongue, and nose detect changes in the environment.
- describe how these changes are interpreted by the brain

START (5 min)

Decide on the order of the presentations mentioned in lesson 2–5.

MAIN (30 min)

Presentations

PLENARY(10 min)

Ask students to identify the best part of preparing their presentation.

Ask students to identify the best part of each presentation. Please try to avoid negative feedback from anyone. Giving negative feedback is not the aim of this peer appraisal and should never be done in public.

1. Read pages 17 and 18 of your Student Book . How many characteristics of life are given?

   Can you match the words below to the characteristics given in your textbook? Write each word in the correct place.

excretion	growth	movement	nutrition	release energy	reproduction	sensitivity

	characteristic of life	**animals**	**plants**
		running away from danger	growing towards light
		food	flowers closing at night
		smelling or hearing danger	sense light (and growing towards it)
		from an egg into a chicken	from a seed into a tree
		babies, young	flowers are pollinated and produce seeds
		urinating, breathing out carbon dioxide	plants excrete oxygen
		eating	plants make their own food by photosynthesis

2. Write the first letter of each characteristic in the small column. When you read the letters down, what is the name of the woman?

   ____

3. Which characteristics from Question 1 do you see in each picture? Name as many as you can.

____
____
____
____
____
____

Sun

1. All living things are made up of cells. Almost all cells are very small and cannot be seen by just looking at them. We use a microscope to see cells.

   In order to work well with a microscope, it is helpful to know what the parts are and their functions.

   Use the words from the word bank to complete the sentences below. Some words are used more than once. Read page 19 of your Student Book if you need some hints.

coarse focusing knob	fine focusing knob	stage
diaphragm	mirror	stage clips
eyepiece lens	objective lens	turret

   a. You look through the ________________________.

   b. The ________________________ quickly changes the distance between the objective lens and the stage.

   c. Light microscopes often have more than one ________________________ which provide different magnifications.

   d. The microscope slide is placed on the ________________________.

   e. The ________________________ directs light through the slide.

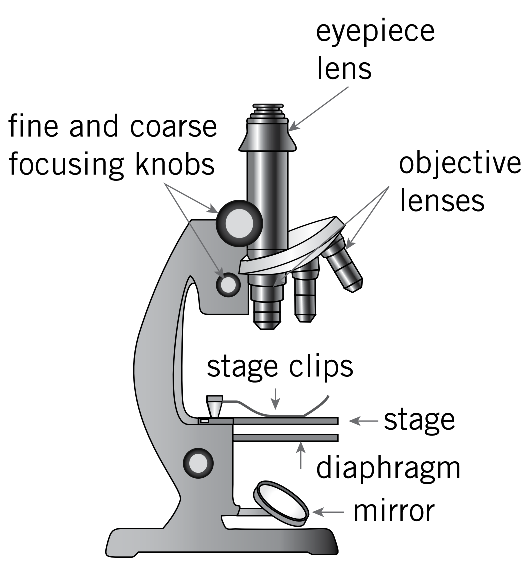
   f. Objective lenses can be rotated into place. They are attached to the ________________________ or nose piece.

   g. The ________________________ changes the distance between the objective lens and the stage slightly to enable you to focus exactly.

   h. The microscope slide is held in place by the ________________________.

   i. The ________________________ can be adjusted to allow the correct amount of light to pass through the hole.

   j. The total magnification is calculated by multiplying the magnification of the ________________________ and the ________________________.



All living things are made up of cells. We need a microscope to see cells.

1. Looking at cells.

Plant and animal cells carry out similar tasks but each type of cell also has unique functions. Therefore, some of the structures of plant and animal cells are the same, but others are different.

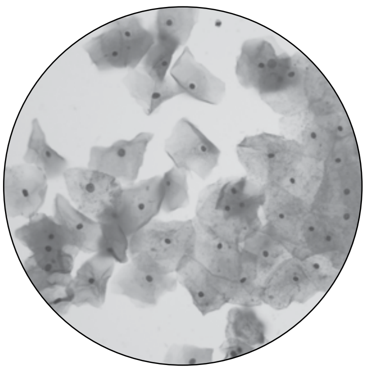
Using your microscope, look at a slide of some animal cells.

a. Describe what you see.

____

____

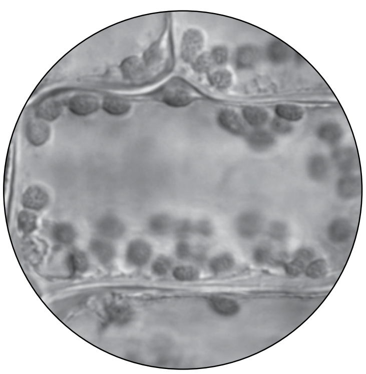
b. It is possible that your animal cells look something like the picture below. Draw what you see under your microscope.



Name of the slide: ____________

Magnification: ____________

Now look at your plant cell. Does it look something like the micrograph below? Draw your plant cells.



Name of the slide: ____________

Magnification: ____________

c. What colour are the little round structures you see in the plant cell? ____________________

Use page 20 of your Student Book to label the structures you drew in your animal and plant cells.

2. Comparing plant and animal cells.

Looking at page 20 of your Student Book, which structures do you see in the diagram of the animal cell and also in that of the plant cell?

a. ____________________

b. ____________________

c. ____________________

There are some structures which are found only in plant cells. Which are they?

d. ____________________

e. ____________________

f. ____________________

3. Complete the table below. Use the information from page 20 of your Student Book.

	name of the structure	**what it looks like**	**what it does**
all cells		dense, round structure	It is the control centre of the cell.
		fluid substance	Everything floats in this.
		thin layer around the skin	It controls what enters and leaves the cell.
plant cells		thicker layer around the cell	It helps the plant cell keep its shape.
		green sphere, most plant cells have many of them	This is where the plant uses light energy to make its food.
		very large structure in the middle, filled with cell sap	Together with the cell wall, the vacuole helps the plant cell to keep its shape.

All living things are made of cells but organisms are not just a lot of cells sticking together. Organisms have many different types of cells, doing different jobs, and they are highly organized.

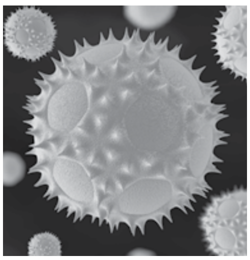
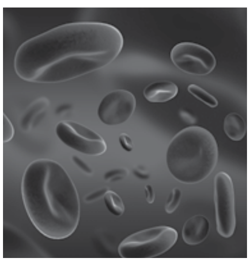
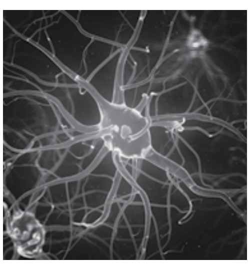
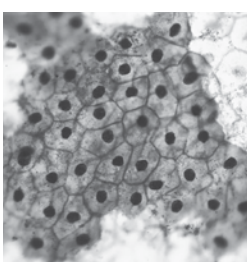
1. Specialised cells

If cells have a special function, they may need to have a special shape in order to do their work well. This relationship between structure and function is a key concept in biology that you will see often.

Below are pictures of four types of cells:

nerve cells, epithelial cells, pollen grains, and red blood cells.

Fill in the empty sections of the table. Use page 21 of your Student Book.

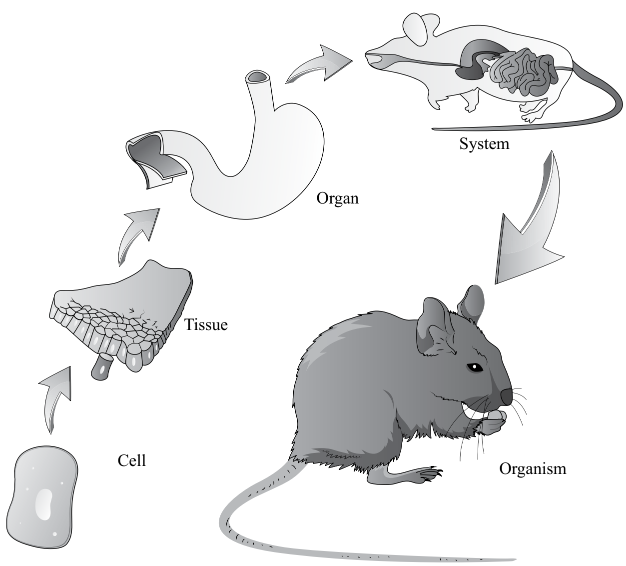
picture	name of cell	function	structural adaptations
		reproductive cells	
			round with a dent in the middle so that it has a large surface area which makes it faster to absorb or give off oxygen
			
		cover surfaces	packed close together without any spaces between the cells so that everything entering or leaving the body is controlled by having to go through the cells

2. Levels of organisation

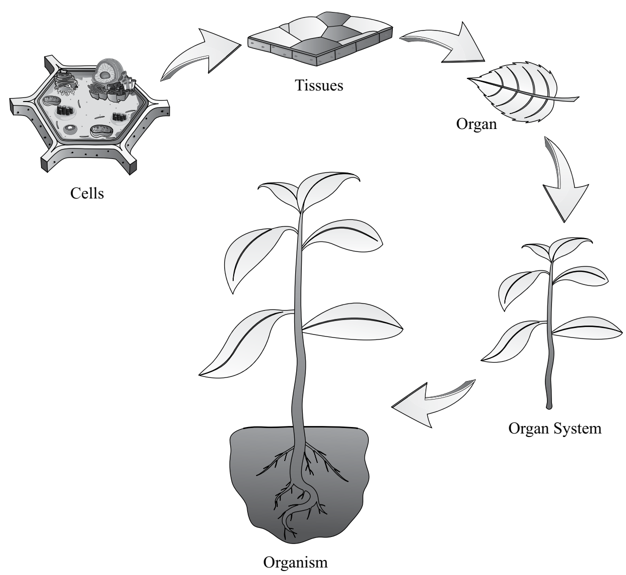
Read page 22 of your Student Book.

Fill in the empty sections in the table.

name of the structure	description	example plant	example animal
	basic unit of life	root cell	skin cell
tissue		vascular tissue	
organ		leaf	
organ system		branch	
organism		palm tree	



Structure of an organism (Animal)



Structure of an organism (Plant)

Chapter 3

Energy resources

UNIT FLOW CHART

What are energy resources?

↓

How do fuels release energy?

↓

What are fossil fuels?

↓

The harmful effects of burning fossil fuels

↓

Conservation of energy

↓

Renewable energy resources

↓

Energy from living things and how do living things use energy

INTRODUCTION

Every day, we use a lot of energy in many different ways. This includes the energy we use to walk up the stairs, energy used to move the car, and the energy needed to run the refrigerator. Coal, oil, and gas are fossil fuels that we get from the soil and use to produce electricity, drive cars, and cook our food. These fossil fuels were made over millions of years ago under special conditions, and there are only limited amounts of them left. They also pollute our environment. We need to find other sources of energy to stop the pollution, but also before the fossil fuels run out.

Food contains the energy our bodies need to keep functioning. Some foods contain more energy than others. How can you test the amount of energy in different foods?

Lesson 3-1

Pages 32-35

OBJECTIVES

- To extend knowledge about energy resources for living things

LEARNING OUTCOMES

After this lesson, students should be able to:

- name some common fuels.
- explain that fuels release energy when they burn.
- describe how fossil fuels are formed.

START (15 min)

Ask students to list things that require energy. They can write them on post-it notes (one idea per post-it) and put them on the board or on a large poster on the wall. Expected answers could include: driving a car, playing soccer, and cooking food.

Once the post-its are in place, the students could group similar ideas together, e.g., driving a car and flying an aeroplane could be put together, as could playing soccer and going upstairs. Groups could include: transport, activities of living things, appliances using electricity.

Then, ask students for the source of energy in each group. Using the examples from above, this could include: transport (using fossil fuel), activities of living things (muscle power with energy from food), electric power (cooking on electricity, running the air conditioning, or an electric heater). Add these sources of energy to the grouped post-its. You may wish to leave these ideas on display so that you can refer to them in later lessons.

MAIN (15 min)

- Read pages 32-35.

  Ask students to create a visual, e.g. a flow chart, which shows the sequence of events in the formation of coal and oil/gas. Encourage them to draw as well as write.
- Discuss the similarities between these processes:
  - o They both started from living things.
  - o The living things died.
  - o Then they were covered by layers of mud which became rock.
  - o There was a lot of pressure and a high temperature.
  - o The formation took a long time.

PLENARY (15 min)

Going back to the beginning of the process, you can consider from where the living things (plants and animals) received their energy. Animals eat plants, and plants make their own food with the help of sunlight. So, ultimately, the energy in fossil fuels came from the Sun.

HOMEWORK

Test yourself questions on page 33 and page 35 of the Student Book.

Lesson 3-2

Pages 40-42

OBJECTIVES

- To extend knowledge about energy resources for living things

LEARNING OUTCOMES

After this lesson, students should be able to:

- describe how renewable energy sources can be used to generate electricity and provide heating.

START (10 min)

- Go over the homework (questions on pages 33 and 35). Reinforce the concept that ultimately, the energy in fossil fuels comes from the Sun.
- What about the energy of the other groups? The donkey pulling the cart, eats grass for energy. The grass gets energy from the Sun. All energy in muscle power initially comes from the Sun.
- What about electricity?

MAIN (20 min)

- Electricity can be made in different ways. One of them is to run generators on fossil fuel. Read pages 40–42 and ask students to list the renewable ways to make electricity. Can they point out similarities between some of these ways?

- In principle, electricity can be made via movement: wind or water (or burning fossil fuel) can drive/ rotate a generator, or the Sun's energy is used in solar panels (or heat collectors) and solar voltaic cells.
- Clearly, the energy in electricity from solar panels or solar voltaic cells comes from the Sun. We already saw that the energy in fossil fuels also comes from the Sun (although a long time ago).
- Moreover, the other sources of renewable energy also come (indirectly) from the Sun:
  - o When the Sun warms up the Earth, the air above the Earth becomes lighter and rises. This creates an area of low pressure. If this is not happening some distance away, the air there remains in place at a higher pressure. Air from the area of higher pressure will travel parallel to the surface of the Earth to the area of lower pressure, and we call this wind. So even wind energy comes from the Sun warming one place more than another.
  - o Since the Sun evaporates water which falls as rain on the mountains and runs down in a river, even the electric energy from a hydroelectricity plant comes from the Sun.
- Due to the gravitational forces of the Moon, the water in the seas and oceans is not always in the same place. This is called tidal movement and can be used to generate electricity. Details can be found on http://www.alternative-energy-tutorials.com/tidal-energy/tidal-barrage.html Tidal power is mostly caused by the gravitational field of the Moon.
- Geothermal energy comes from the Earth.
- Ask students to read pages 43 and 44 and to list sources of energy. (They may wish to revisit pages 34–35 and 40–43 to answer.)

Sources of energy include: fossil fuels (oil, gas, coal), wind, hydroelectric energy, solar energy, tidal and wave energy, geothermal energy, biomass.

- Discuss the concept of renewable vs non-renewable energy and classify the sources of energy in either group.

PLENARY(10 min)

- 'When will fossil fuels run out?' Ask students to search the internet for this information for homework and compare it with the information provided on page 37 of the Student Book. Ask them to consider why the answers are not all the same.

HOMEWORK

Test yourself questions on page 43 of Student Book.

Lesson 3-3

Pages 38-39

OBJECTIVES

- To emphasize the importance of fuel conservation and the need to develop new sources of energy

LEARNING OUTCOMES

After this lesson, students should be able to:

- explain why conservation of fuels is important.
- suggest some ways of conserving energy.
- describe and explain global warming and list some of its implications.

START (10 min)

Go over the homework from previous lesson. Establish a range of answers (from the earliest to the latest time the fuel is expected to run out). Let the students calculate how old they will be if the fuel runs out (soonest expected time), and how they will manage without these fuels.

MAIN (30 min)

If we have a finite amount of fossil fuel, what can we do to make it last longer? Ask students to explore various ways of saving energy. They should read pages 38 and 39 but also consider other ideas, especially those relevant to their area. For example, insulating houses will keep the heat inside in winter but outside in summer. They could also consider planting trees (which absorb carbon dioxide anyway) in such a way that their house is in the shade.

Ask students what could they contribute? For example, walk short distances, take public transport, or car pool; switch off lights, heating, and air conditioning; recycle paper; avoid wasting food, etc. How and why do these things reduce energy use?

Students can create a communication to parents which will list some of the ways in which the students can help to save energy. It could take many forms, however, a leaflet, newspaper, or letter could be taken home and parents may be requested to provide positive feedback when their child saves energy.

PLENARY (5 min)

In order to conserve energy, we will have to change our habits. This is not easy. Ask students to think about how they and their family could use less energy and write one action on a post-it. If they did this, would it really make a difference? (If we all do it, then yes, it will make a difference. Also, even a small difference is a difference.)

HOMEWORK

Do the Test yourself questions on page 39 of the Student Book.

Lesson 3-4

Pages 36-37

OBJECTIVES

- To consider the impact on the environment of burning fossil fuels
- To emphasize the importance of fuel conservation and the need to develop new sources of energy

LEARNING OUTCOMES

After this lesson, students should be able to:

- describe and explain global warming and list some of its implications.

START (10 min)

Hand out worksheet 3-1 and explain it to the students so that they understand what needs to be done.

MAIN (25 min)

Students should carry out the instructions. If you wish, you can have the timer and call out each time they need to take a reading. This will reduce the students' independent inquiry, but increase classroom control.

PLENARY (10 min)

Make sure students tidy up. Reflect on the results and how well the experiment went. Students can discuss the following: If I repeated this experiment, I would do the following differently: ….. They will, of course, have to give reasons for why they would do something differently.

HOMEWORK

Complete the graph and conclusions given in worksheet 3–1.

or

Workbook, Question no. 5, Page 15-16.

Lesson 3-5

Pages 37

OBJECTIVES

- To consider the impact on the environment of burning fossil fuels
- To emphasize the importance of fuel conservation and the need to develop new sources of energy

LEARNING OUTCOMES

After this lesson, students should be able to:

- describe and explain global warming and list some of its implications.

START (10 min)

Revise issues raised last lesson about fossil fuels running out and the need to conserve energy. Then bring up the fact that, even with very good conservation, fossil fuels will run out some day and we either change our lifestyle and do without a lot of things (like transport and refrigerators) or we need to find other ways of producing energy.

MAIN (30 min)

- Going back to the very beginning of the chapter, page 33 shows that burning fossil fuels will produce carbon dioxide. Carbon dioxide traps heat near the edge of the atmosphere of the Earth, making it a comfortable temperature for us. Carbon dioxide does this very effectively. Only 0.04 % of the gases in the atmosphere are particles of carbon dioxide, but they cause the Earth to be about 30 - 35°C warmer than it would be without any carbon dioxide.

- If possible, play the video 'Climate 101' on http://video.nationalgeographic.com/video/101-videos/climate-101-causes-and-effects and discuss the information presented.
- Hand out the worksheet for lesson 3-5 and support the students working individually or in small groups.

If necessary, ask students to finish the worksheet for homework.

Lesson 3-6

Pages 43-45

OBJECTIVES

- To extend knowledge about energy resources for living things

LEARNING OUTCOMES

After this lesson, students should be able to:

- evaluate an experiment designed to measure the amount of energy stored in a sample of food.

START (10 min)

- Read the experiment described on pages 44-45 of Student Book.
- Watch the experiment done on http://www.schooltube.com/video/d7e883fc8c07081250c8/Calorimetry-Measuring-Energy-in-a-Peanut

MAIN (20 min)

Use worksheet 3-6 to help students critically evaluate an experiment.

PLENARY(15 min)

Discuss with the students how the aim of an experiment affects the design. The experiment on page 44 is effective in comparing the amounts of energy in different foods. Peanuts will have the most energy and dried bread the least when they are tested under the same conditions. It is less suited to calculating the value of energy in the food because some variables are not controlled.

HOMEWORK

Do the Test yourself questions on page 45 of the Student Book.

Experiment

What does a greenhouse do?

Greenhouses come in all shapes and sizes, but why do people use them?

If you know someone who has a greenhouse, you can ask them, but you can also do an experiment.

Materials:

You need the following:

- two thermometers
- a large glass jar (which can hold the thermometer)
- a stopwatch or timer

Method:

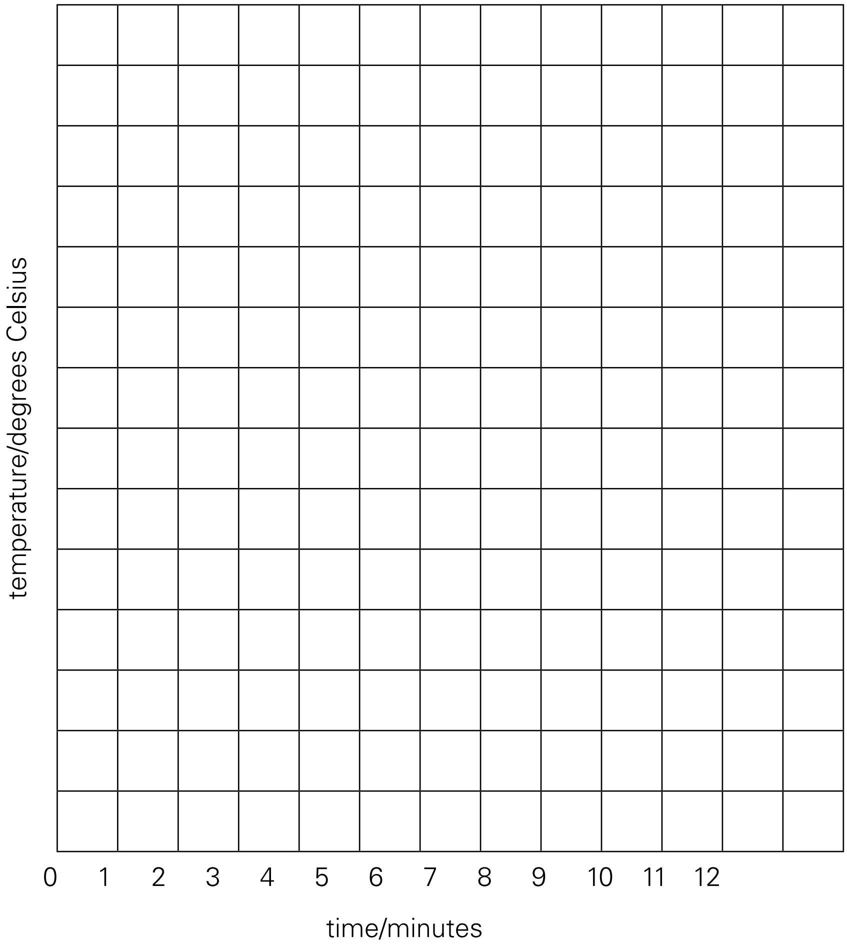
1. Find a place in the Sun where you can place the glass jar and a thermometer. You must be able to read the thermometer easily.
2. Place thermometer A on the table in direct sunlight. Place thermometer B in the jar, close the jar, and place it next to thermometer A. (Make sure it does not block the sunlight to thermometer A.)
3. Immediately read both thermometers, record your findings in the table, and start the stopwatch.
4. Every minute, read both thermometers and record your results in the table.

Results:

Time	Thermometer A (degrees Celsius) on the table	Thermometer B (degrees Celsius) in the jar
0		
1 min		
2 min		
3 min		
4 min		
5 min		
6 min		
7 min		
8 min		
9 min		
10 min		

Use your results to draw a graph. The time (in minutes) goes on the X-axis and the temperature recorded goes on the Y-axis. Use two different colours for the two thermometers (or pen and pencil).

Title: The effect of a glass jar on temperature.



Conclusion:

Describe what happened to the temperature as measured by thermometer A.

____

Describe what happened to the temperature as measured by thermometer B.

____

Which changed faster? ______________________________

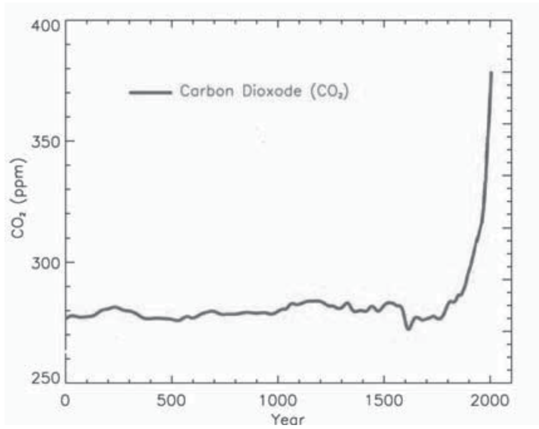
Conclusion.

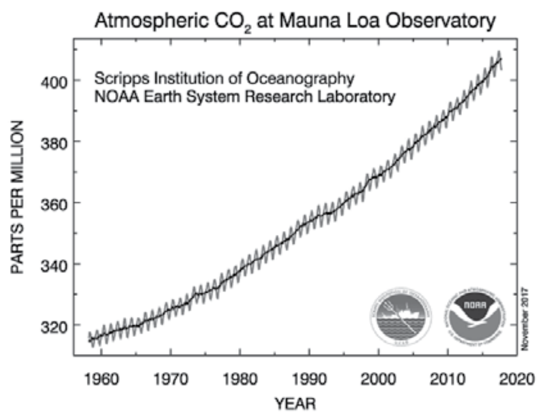
Describe how the glass jar affected the temperature change.

____

____

1. Study both graphs below. They show levels of carbon dioxide in the Earth's atmosphere.





a. What was the level of carbon dioxide in the atmosphere in the year 1000? ____________

b. What was the level of carbon dioxide in the atmosphere in the year 1900? ____________

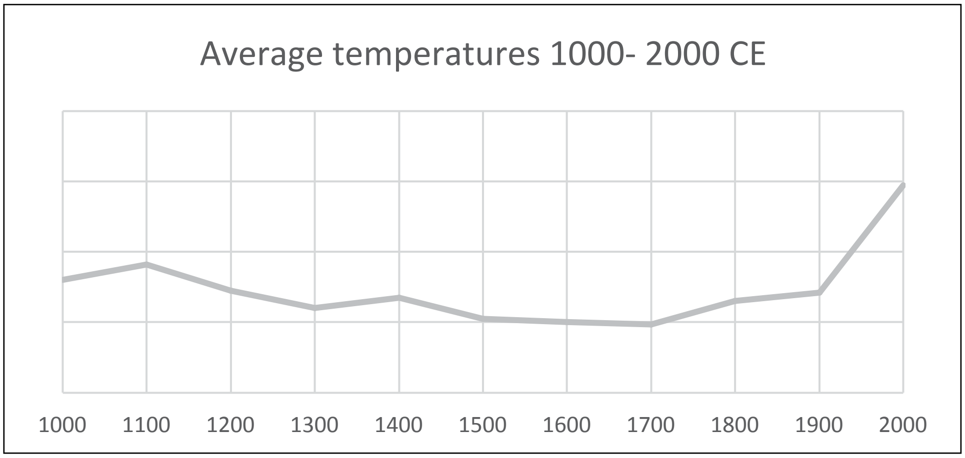
c. How much did the level of carbon dioxide change between 1000 and 1900? ____________

d. What was the level of carbon dioxide in the atmosphere in the year 1900? ____________

e. What was the level of carbon dioxide in the atmosphere in the year 2000? ____________

f. How much did the level of carbon dioxide change between 1900 and 2000? ____________

The graph below gives the average temperatures in the Northern Hemisphere.



g. Compare the changing pattern of the levels of carbon dioxide and the changing temperature between the year 1000 and now. What do you notice?

____

____

h. Write one or two paragraphs about the relationship between carbon dioxide in the atmosphere and the temperature on Earth. Use information from previous lessons and/or the graphs to support your arguments.

____

____

____

____

____

____

____

____

____

____

Read the experiment described on pages 44-45 of Student Book.

Watch the experiment done on http://www.schooltube.com/video/d7e883fc8c07081250c8/Calorimetry-Measuring-Energy-in-a-Peanut

In an experiment, variables are the factors which change, or can change. In science experiments, we recognize three kinds of variables:

- independent variables
- dependent variables
- controlled variables

It is important to understand these variables very well because they will impact on your experiment.

▲ Energy from burning sugar

Independent variables are factors which you decide to change. If you wanted to know how adding salt to water changes its boiling point, you would boil water with different amounts of salt, so the amount of salt is your independent variable.

Dependent variables are the factors you measure. They change, depending on your independent variable. So in your experiment on the effect of salt on the boiling point of water, the measured boiling point would be your dependent variable. If you change the independent variable (adding more or less salt), the dependent variable (the boiling point) will change.

Controlled variables are important to keep constant. For example, you want to know how adding salt changes the amount of time you need for your water to reach its boiling point. You can take 100 ml of water with a little salt, heat it and measure how long it takes to boil. Then you take 200 ml of water, add a lot of salt, heat it and measure the time until boiling. These times are likely to be different but what caused the difference? Was it the amount of salt or the amount of water? So you are only allowed to change one variable, you measure another variable, and everything else needs to remain the same. If you do this, you are conducting a fair test.

a. In the experiment described on page 44, what are you measuring? ____________________

b. In the experiment described on page 44, what are you changing? ____________________

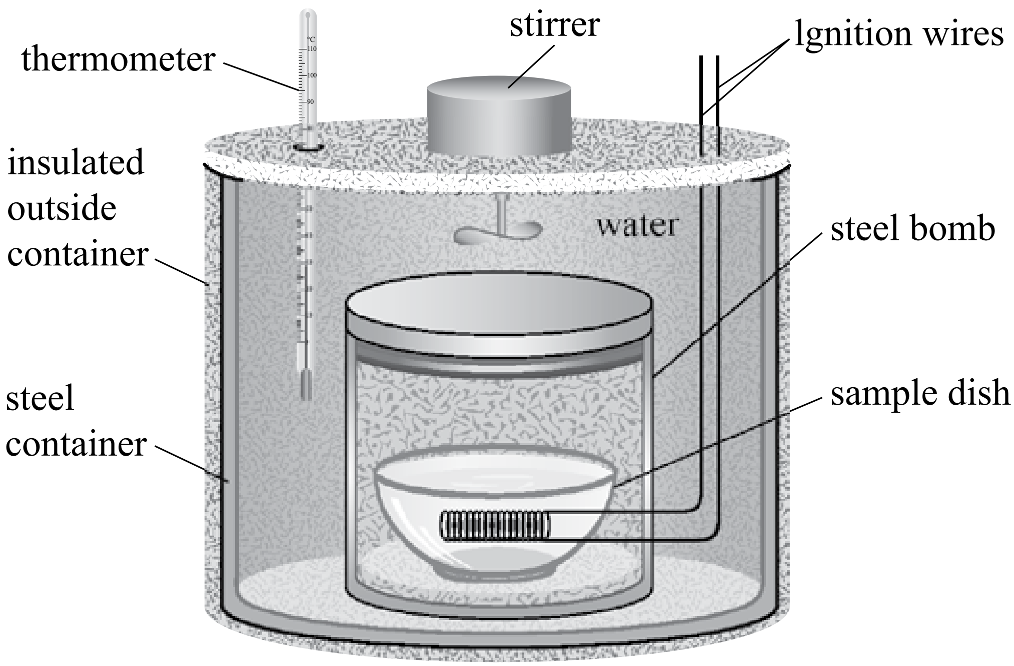
c. In the experiment described on page 44, what must stay the same? ____________________

d. So in this experiment, you have identified the following variables:

independent variable	
dependent variable	
controlled variables	

The principle of this experiment is that food is burnt, releasing energy as heat. This heat warms up the water and if we know how much the temperature of the water has increased, we can calculate the energy (heat) that was needed to cause this change. We then say that this energy was released by the food.

When companies determine the energy in their food, they use a device called a calorimeter. The temperature of the water is recorded. A known mass of food is placed in the sample dish and ignited by running an electric current through the ignition wires. The food burns, giving off heat which warms up the water. To ensure it is warmed evenly, the water can be stirred. Once the food stops burning, the final temperature is recorded.



e. If you were to hold your hand near the burning food in the experiment as described on page 44, what would you feel?

____

f. What would you expect to feel if you held your hand near the calorimeter? ______________

g. Which method do you think would give a more accurate result? ______________

h. If you wanted to do the experiment and had no calorimeter, how could you modify the set up as given on page 44 to get more accurate results?

____

____

i. If you used 1 g of food and looked in the dish after the food stopped burning, you would see some of it left. Not all the food had completely burned (into carbon dioxide and water). This means that the energy you measured was given off by less than the 1 g of food that you started with. What could you do to get a more accurate result?

____

Chapter 4 Electrical Circuits

UNIT FLOW CHART

Electricity is closely related to our daily lives
↓
Some materials allow electrons to pass through easily, some do not.
↓
Types of electrical circuits
↓
Electricity in the home
↓
Resistance wires and fuses.

INTRODUCTION

In Chapter 3, you were introduced to electricity as one of the many types of energy. In our daily lives, electricity is very useful, mainly because it can easily be converted into other types of energy. Electricity has its own characteristics and, also like the other types of energy, it is potentially dangerous.

One of the most powerful examples of electricity is lightning which kills 20–40 people in the USA every year. And although the electricity from the mains at home carries a lot less energy than lightning, it is still dangerous if not used properly. In India, almost 10000 people died of electric shock in 2014. In the UK, on average, 4 people die per day as a result of a fire which started due to a problem with electricity (e.g. a short circuit).

This chapter will cover the basics of electricity from a science perspective. If possible, experiment building different types of circuits, including different numbers of light bulbs, resistors and other components, and measure the voltage and current in the various set-ups.

Strongly recommended: please watch before starting to teach this unit.

Many misconceptions students may have about electricity are indicated in the video found at https://www.stem.org.uk/elibrary/resource/30937. Some general principles of good science teaching are included. The teacher, can simulate the way electricity moves using a rope (from minute 6 of the video). Teachers may wish to watch this video with their students, but it might be more suitable to teach the concepts in a similar manner.

Lesson 4-1

Pages 50-51

OBJECTIVES

- To extend knowledge about electrical circuits and use the concepts of electric current and energy transfer to explain how electrical devices work.

LEARNING OUTCOMES

After this lesson, students should be able to:

- list some modern electrical devices and state the energy changes that take place in them.
- explain the difference between an electrical conductor and an electrical insulator, and list some examples of each.

START (10 min)

Ask students to complete the following sentences:

Without electricity, I would have to ….

Without electricity, I would not be able to …

Example answer: Without electricity, we would have to cook using a fire, and would not be able to keep food fresh in the refrigerator or freezer. In winter, we would go to sleep early (without light and heat) and in summer we would have to live without fans.

BACKGROUND INFORMATION

We can run water and gas through pipes and transport coal in bags. In order to find out how to move electricity, we first need to know what it is.

We established that electricity is a form of energy in previous chapter. All matter is made of atoms, and inside atoms are electrons. These tiny particles carry a negative charge. Normally, they stay with their atom and move back and forth a little. However, if there is a positive charge somewhere, electrons may move in that direction. This movement is flowing electricity.

Although electrons are attracted to a positive charge and will move in that direction, they maintain their position relative to each other, rather than all rushing to the positive charge.

If you were to model this with students, it will be like a proper dinner queue. Students remain in line and take a step towards the food (the positive charge). What it is NOT is a rush of students (electrons), all trying to get to dessert (the positive charge)!

So in order to move electrons (and have a current of electricity), we need a material which contains electrons that can move. Some materials have this and are called conductors; others do not, and are called insulators.

MAIN (25 min)

Please try to have students build circuits as shown in the experiment described in worksheet 4-1. If this is really not possible, use the online simulation available at http://coolsciencelab.com/conductors_and_insulators.htm.

Worksheet 4-1: Students carry out the experiment to classify materials as conductors or insulators.

If the necessary resources are not available, have a look at this site to improvise:

https://www.education.com/science-fair/article/parallel/

PLENARY (10 min)

Ask students to read page 50 and discuss the conversions from electric energy to other forms that they encountered in this lesson.

HOMEWORK

Test yourself questions 1-3 on page 52 of Student Book.

Lesson 4-2

Pages 52-53

OBJECTIVES

- To extend knowledge about electrical circuits and use the concepts of electric current and energy transfer to explain how electrical devices work.

LEARNING OUTCOMES

After this lesson, students should be able to:

- draw circuit diagrams to represent simple electrical circuits, using appropriate symbols.

START (10 min)

Read pages 52 and 53. Discuss the concept of circuit diagrams.

MAIN (20 min)

Hand out Worksheet 4-2 and provide support to students. Ensure that students use rulers since circuit diagrams require straight lines.

If resources are available, the students can also build the circuits.

Students can build simulated circuits on

http://thefusebox.northernpowergrid.com/page/circuitbuilder.cfm (level 1)

This could be an extension activity to be done at school or at home.

PLENARY (15 min)

High voltage cables transport electricity over long distances. The voltage involved can be 200 000 Volts or more. Birds sometimes sit on these cables and are not harmed.

The reason is in the amount of electricity which actually goes through the body. The birds sit on the wire, holding the wire with their feet/claws. Their feet are close together, so the moving electrons, which are the electricity, have a 'choice': they can travel through a small length of highly conductive metal wire, or they can 'choose' to go all the way round through the bird's body (which is not as good a conductor as the metal wire). As the resistance to go through the bird is much higher, (almost) all the electricity will flow through the wire, and the bird is safe—as long as it does not touch another wire or the supporting pole. If the bird puts its feet far apart, the resistance through its body will not change, but the length of wire (the alternative route for the electricity) will be longer, and hence the resistance higher. So a bird with its feet far apart will experience more electricity than a similar bird with its feet close together.

HOMEWORK

Test yourself question no. 4 on page 52 and the questions on page 54 of Student Book.

Lesson 4-3

Pages 57-59

OBJECTIVES

- To extend knowledge about electrical circuits and use the concepts of electric current and energy transfer to explain how electrical devices work

LEARNING OUTCOMES

After this lesson, students should be able to:

- draw circuit diagrams to represent simple electrical circuits, using appropriate symbols.
- describe a parallel circuit used in the home.

START (10 min)

Use https://www.ck12.org/book/CK-12-Physical-Science-Concepts-For-Middle-School/section/5.72/ to share the explanation about series and parallel circuits.

MAIN (25 min)

- Hand out worksheet 4-3.
- Support students in building series and parallel circuits, comparing the brightness of the bulbs.

PLENARY (10 min)

It is great fun to have fairy lights for decoration when you are celebrating something.

These days, fortunately, they are produced as parallel circuits, but many years ago, they were made as series circuits.

Ask students why it is much better to have the bulbs connected in parallel.

When they are connected in series, none of the lights will work if one bulb is loose or broken. You cannot tell which one is the problem, so you have to check them all.

HOMEWORK

Test yourself questions on page 58 of Student Book.

Lesson 4-4

Pages 54-56

OBJECTIVES

- To demonstrate the use of an ammeter to measure the current flowing in an electrical circuit
- To demonstrate the use of a voltmeter to measure voltage in an electrical circuit

LEARNING OUTCOMES

After this lesson, students should be able to:

- draw circuit diagrams to represent simple electrical circuits, using appropriate symbols.
- measure the current and voltage in an electrical circuit.

START (10 min)

Read pages 54, 55, and 56 and discuss. Ask questions to ensure students understand.

Reinforce the concept that an ammeter measures current (how many electrons run through it), and a voltmeter measures voltage (how much "push", or energy, each electron has). The current is constant throughout the circuit (or you would have electrons collecting in one part of it) so it does not matter where in the circuit the ammeter is placed. The voltmeter is connected in parallel to a component (e.g. light bulb, resistor, or cell) and the voltage produced by the source (cell or battery) must be the same as the sum of the voltages measured for each component.

As before, make sure every circuit has a switch (so it is not left 'on') and make sure that every circuit with an ammeter also has another component (in addition to the switch) such as a bulb or motor. Since the ammeter has very little resistance, a circuit without an additional component would essentially short-circuit, which is both dangerous (fire) and/or damages the ammeter.

MAIN (20 min)

- Hand out worksheet 4-4. If possible, students should build the circuits and measure current and voltage at various points and in various set ups.
- If practical activity is not possible, complete worksheet 4-4 as a theoretical exercise.

PLENARY (10 min)

Ask students to apply their learning to how they understand appliances with batteries, e.g. a torch.

HOMEWORK

Test yourself questions on page 57 and page 60 of Student Book.

Lesson 4-5

Pages 62

OBJECTIVES

- To extend knowledge about electrical circuits and use the concepts of electric current and energy transfer to explain how electrical devices work.

LEARNING OUTCOMES

After this lesson, students should be able to:

- explain electrical resistance and describe how a resistance wire can be used as a fuse.

START (10 min)

Recall that in lesson 1, the bulb did not glow equally brightly with all conductors and remember that we mentioned 'resistance' when discussing the birds on the high voltage cable.

Read page 62.

Similar information can also be found at

https://www.ck12.org/book/CK-12-Physical-Science-Concepts-For-Middle-School/section/5.68/

MAIN (25 min)

Go over worksheet 4-5

PLENARY (10 min)

Consider the advantages that electricity has brought us but also consider the dangers.

HOMEWORK

Test yourself questions on page 63 of Student Book.

Lesson 4-6

Pages 60-61

OBJECTIVES

- To consider the hazards of electricity

LEARNING OUTCOMES

After this lesson, students should be able to:

- explain the importance of fuses as safety devices.

START (10 min)

Any house will have a number of sockets and lights. How are these connected?

Your students probably do not know the answer to this so discuss both options (series and parallel).

Series: if one socket did not have a (working) appliance plugged in, none of them would work. Also, all lights would have to be on all the time for any of them to work.

As this is not practical, the answer is that the sockets and points for lights are connected in parallel. But they are not all on one large parallel circuit; rather they are connected in sections called ring mains.

Read page 60 (last paragraph) and page 61 of Student Book.

MAIN (25 min)

Go over worksheet 4-6

In some countries, plugs have a fuse. Open a plug to show students. Look at the current allowed through the fuse and discuss what would happen if it were overloaded.

Some electrical appliances have their own fuse. Ask an electrician to come and show this and discuss electrical safety from a very practical perspective. You could also ask a fireman to talk about electrical fires.

PLENARY (10 min)

Discuss the concepts relating to fuses and several main ring circuits in a house and ensure that this is understood by students. Make sure to relate it to their situations at home and/or a house they may build.

HOMEWORK

Test yourself questions on page 62 of Student Book.

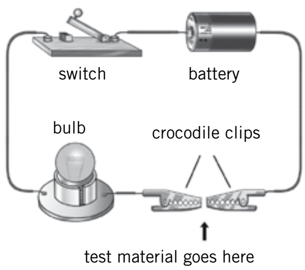
Experiment:

1. Which materials conduct electricity (conductors) and which do not (insulators)?

PLEASE NOTE – safety instructions

- Only use the equipment provided as directed by the teacher.
- When you have set up the equipment, ask the teacher to check it before starting the experiments.
- NEVER use power from the mains (unless you have a transformer provided by the teacher).
- Include a switch in every circuit so it is only completed when you push the switch.

Method



1. Set up a circuit as shown on page 51 of your student book.
2. Ask the teacher to check your circuit.
3. Place the first of the materials provided between the crocodile clips.
4. Push the switch.

If the light goes on, electricity is flowing through your circuit, so the material you tested is a conductor. If not, the material is an insulator.

Your materials could include some of the following:
a piece of aluminium foil
a drinking straw
a metal bottle cap
a plastic bottle cap
a fresh twig from a bush or tree
a wooden cube
an eraser
a pencil lead
a paper clip
(many others are also possible)

Results

In the table below, record your findings

Material	**conductor or insulator**

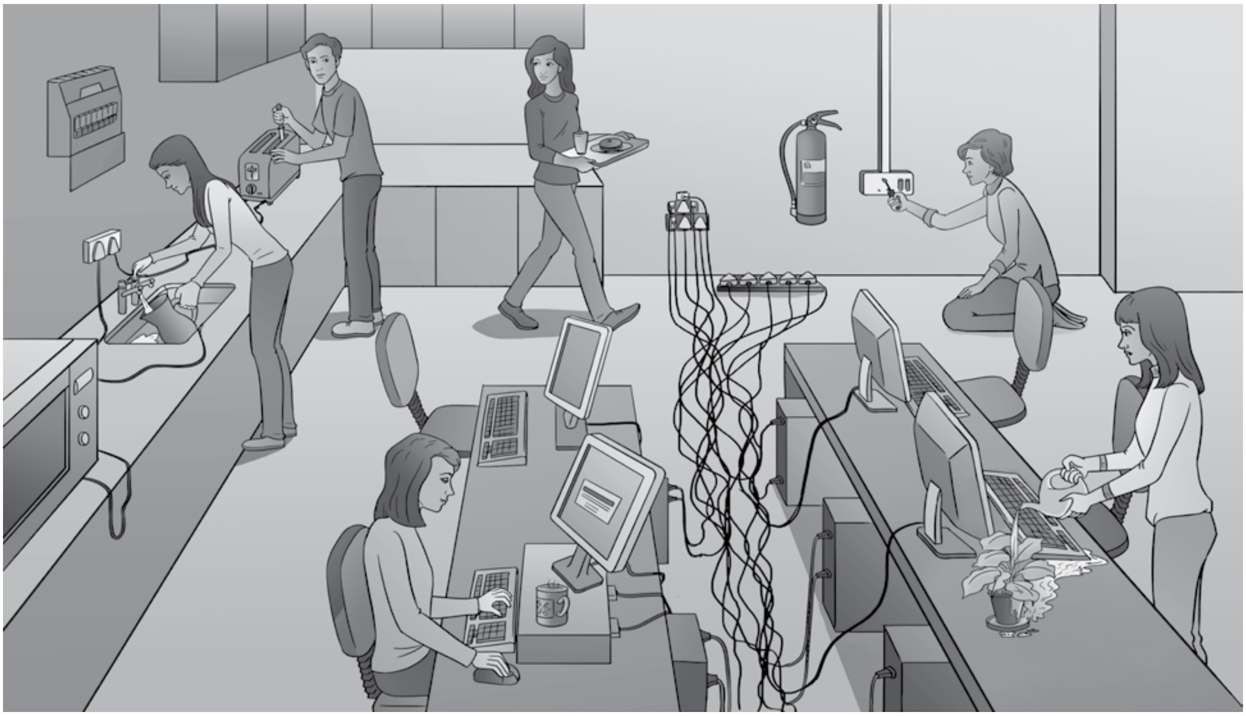
OXFORD UNIVERSITY PRESS

2. Air is not a good conductor of electricity. If you hold the plug of a lamp near the socket, the light will not go on, meaning the electricity does not "jump" through the air.

   However, you also know that lightning goes through air (and can be dangerous). So remember that when you have high voltage power lines, do not get close to them because the high voltage electricity has enough energy to 'jump' through the air, and this can be extremely dangerous.

   Electricity is very useful but it also has its dangers. Discuss some safe and unsafe practices with your group.

   Have a look at the picture below.

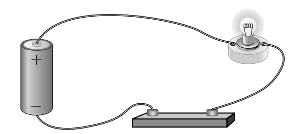


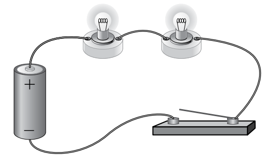
   Write the number 1 over the first hazard you see in the picture and describe it below. Continue until you have found all of them.

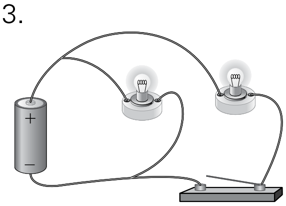
1.
2.
3.
4.
5.
6.
7.
8.

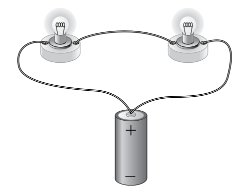
1. For each diagram given on the right side, put a red circle around every bulb which does not light and explain the reason below.

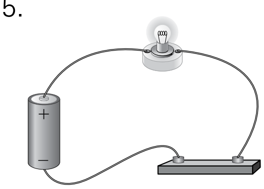
	Explain why the bulb(s) will not light.
1.	
2.	
3.	
4.	
5.	
6.	

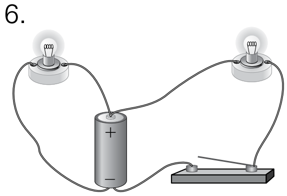
1.


2.


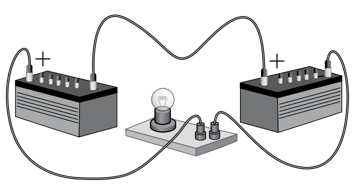
3.


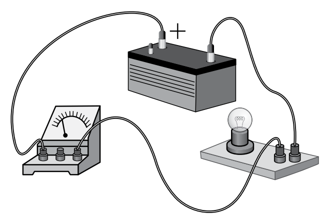
4.


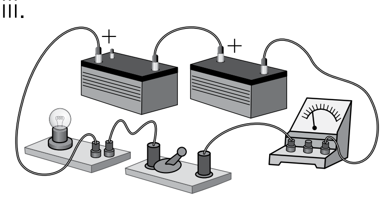
5.


6.


2. Draw each of these electrical circuits as a circuit diagram. Use the symbols provided on page 53.

i.


ii.


iii.


3. Draw circuit diagrams of the following situations. Please use a ruler so you draw straight lines.

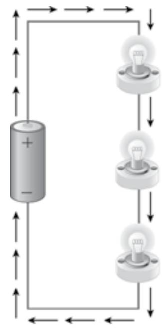
a battery connected to a bulb	a battery connected to a motor and a switch	two batteries connected to a buzzer and a bell

OXFORD UNIVERSITY PRESS

Worksheet 4-3

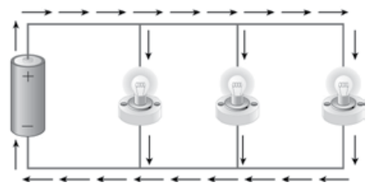
1. Label the drawings with "series circuit" or "parallel circuit".

a.



_______________ circuit

b.



_______________ circuit

2. Consider the following experiment:

Create a circuit with one cell or battery, a switch, and a lamp. Close the circuit and look at how bright the bulb is.

Using the same circuit, add one lamp in series. The lamp must be the same as the one already used. Close the circuit.

a. Are the bulbs burning equally brightly? _______________

b. Are they as bright as when there was only one bulb? _______________

c. If you loosen one bulb, does the other still light up? _______________

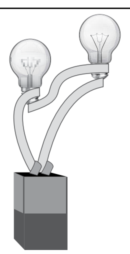
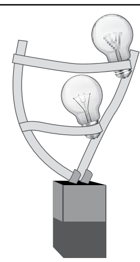
Slightly change your circuit so that the bulbs are now in parallel.

d. Are the bulbs burning equally brightly? _______________

e. Are they as bright as when there was only one bulb? _______________

f. If you loosen one bulb, does the other still light up? _______________

3. Draw the following as circuit diagrams:

 Series Circuit		 Parallel Circuit	

Assuming all bulbs are the same, will they all burn equally brightly? Explain your answer.

____

____

Worksheet 4-4

A mnemonic is a way to remember something in an easy way. This can be done by using the first letters and making a sentence (which is easier to remember).

You need to remember that

Voltmeters are connected in Parallel, Ammeters are connected in Series.

If this is difficult, it may help to remember that

"volt and ammeters are Very Particular About Some things".

Complete the table below. You can use pages 54, 55, and 56 from your Student Book.

	Ammeter	**Voltmeter**
What does it measure?		
Which units does it use?		
How is it placed in the circuit?		
Does it matter where it is placed?		

2. In the previous worksheet, you saw that three bulbs in series do not burn as brightly as three similar bulbs connected in parallel.

   What happens to the current and the voltage in circuits with bulbs in series or in parallel?

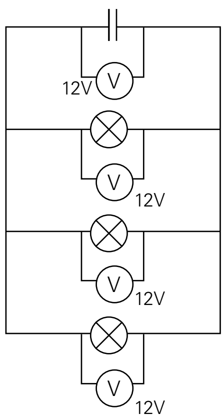
   Below you can see four circuit diagrams.

   Write the correct answer by each circuit diagram:

   How are the bulbs connected? Series / Parallel

   What is being measured? Current / Voltage

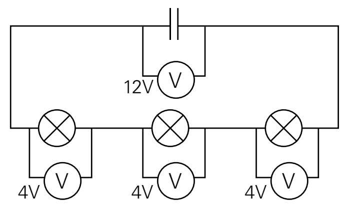
a.



Series / Parallel

Current / Voltage

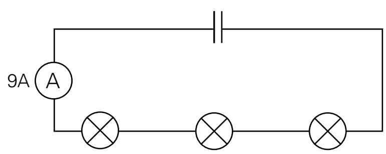
b.



Series / Parallel

Current / Voltage

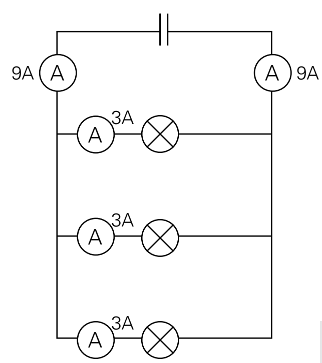
c.



Series / Parallel

Current / Voltage

d.



Series / Parallel

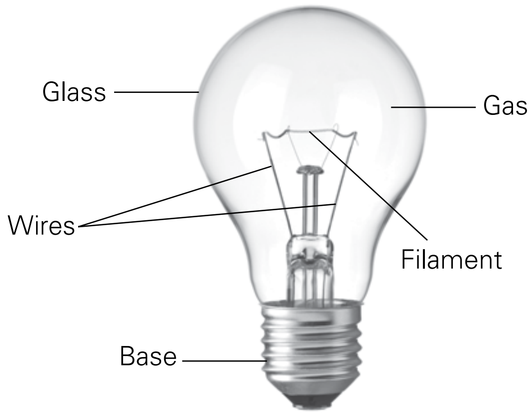
Current / Voltage

3. Complete these sentences.
   a. When the bulbs are connected in series, the current will be ____________________
   b. When the bulbs are connected in series, the voltage will be ____________________
   c. When the bulbs are connected in parallel, the current will be ____________________
   d. When the bulbs are connected in parallel, the voltage will be ____________________

1. During the experiment in the first lesson of this unit, you may have noticed that not all conductors allowed the light bulb to light up equally brightly. This is because the division of conductors and insulators is not black and white. Many materials will conduct some electricity. How much they conduct depends on the amount of resistance they have. The higher the resistance to electricity, the less electricity will flow through it—remember the example of the birds on the high voltage wire.

   Even the best conductor has some resistance. This means that it will heat up when a current goes through it. Depending on how much the resistance is and how much the current is, this may or may not be a problem.

   In a light bulb, the filament has quite a high resistance. A current running through this filament will make it so hot that it will start to glow. A special gas in the light bulb will stop the filament from catching fire, but after some time, the filament will be destroyed and we need a new light bulb.



   Name some household appliances which also make use of the concept that high resistance causes a wire to become very hot.

   ____

   ____

   ____

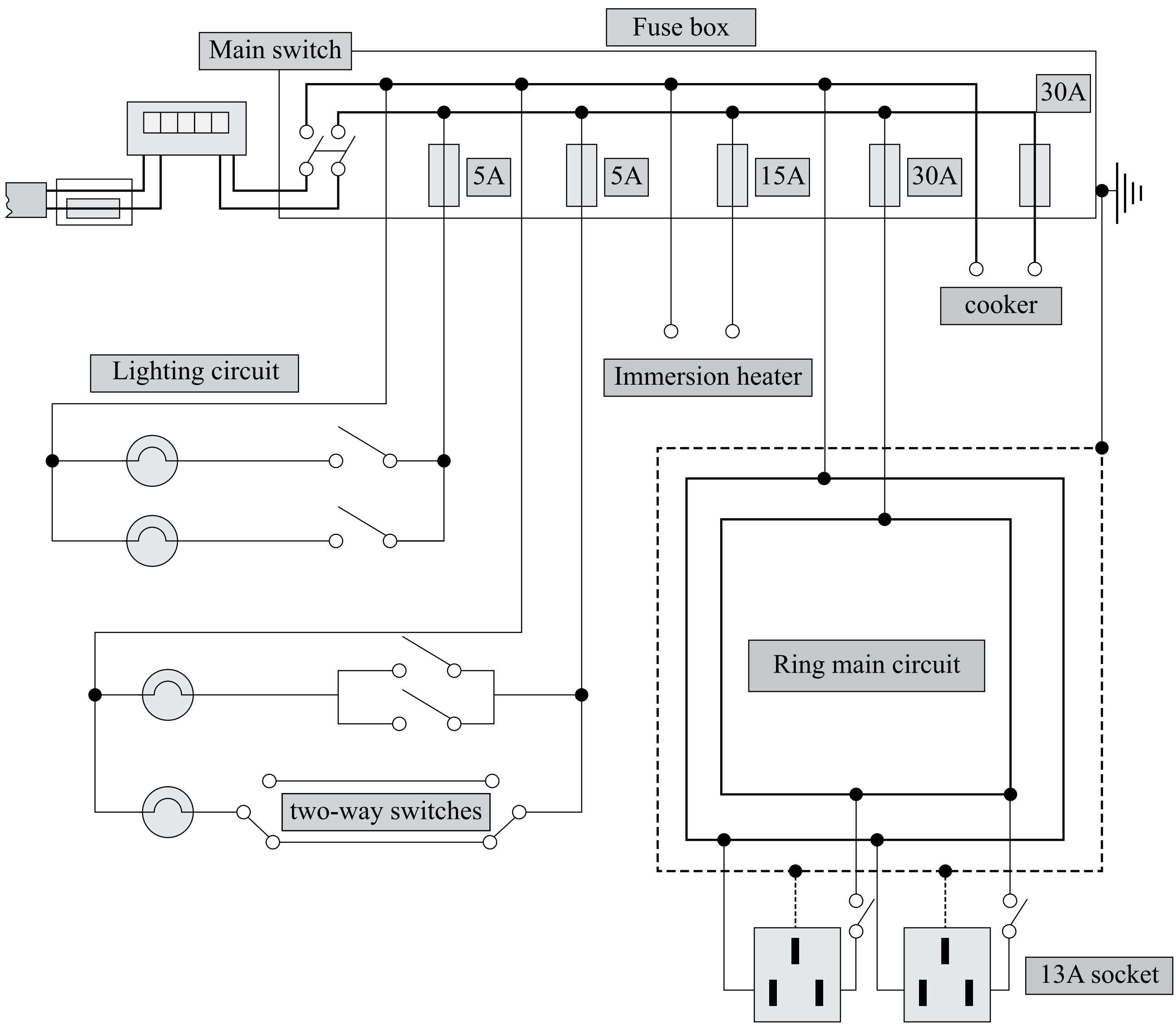
   However, if an old appliance breaks, it may ‘short circuit’. That means that the current will no longer go through the appliance, with its resistance, but, instead take a short cut. Without resistance, a lot more current will go through, and that could be dangerous.

   In order to prevent this large surge of current, we can use a fuse. A fuse is a piece of wire with a specific resistance. When too much current runs through this wire, it will melt and break the circuit. This means we have to replace the fuse but have avoided the large and dangerous surge of current.

   In some countries, each plug of an appliance will have its own fuse.

1. The cables used in a house are made in such a way that they do not heat up much when a normal current goes through them. However, an old appliance, for example, could break and cause a short circuit. The electricity would not flow through the appliance (with a certain amount of resistance) but would take a 'short-cut' without any resistance. This short circuit would lead to a lot of current going through the cables and could make them heat up so much they could start a fire.

   To prevent this type of situation, the cables in your house are connected to the electricity supply via a fuse. As there are several separate circuits in your house, each has its own fuse. All fuses are put together in the fuse box. A diagram of a possible design of the electric circuits in a house is shown below.



You can see that different parts of the house have their own circuit.

1. Give examples of anything in your house which uses electricity? Do not include anything on batteries.

____

____

2. Consider that anything which heats up or cools down will take much more energy than e.g. lamps. Where in your house would you use fuses that allow a lot of current before they melt and where could you put fuses which do not allow so much electricity?

____

____

____

____

When a fuse 'blows', i.e. too much current has gone through it and the special cable has melted, it needs to be replaced. As different areas have fuses allowing different amounts of current, this means that people have to have a range of spare fuses. So now, many places have devices called 'circuit breakers'. When too much current flows through them, a switch flips itself and the circuit is cut. When the faulty device which caused the overload is unplugged, the circuit breaker switch can simply be flipped back again.

Chapter 5 Plants and photosynthesis

UNIT FLOW CHART

The chemistry of photosynthesis
↓
The starch test
↓
Testing the equation
↓
What happens to the glucose?
↓
Plants need water
↓
Plants need minerals

INTRODUCTION

Plants are vital to life on Earth. They use the Sun's energy to produce their own food, but they are also the food of animals. In addition, plants produce the oxygen we need and take in carbon dioxide. So in this chapter, students should learn that it is vital to maintain an extensive and healthy plant population on Earth. They also learn about the mechanics of photosynthesis and how this information can be verified. Many students consider plants to be boring. Learning about the importance of plants and being introduced to the chemical processes in plants may improve their interest and appreciation.

EXPERIMENTS

A lot of information can be found (for free) on the SAPS website. Please see http://www.saps.org.uk/secondary/teaching-resources/134-photosynthesis-a-survival-guide-teaching-resources .

Experiments involving photosynthesis can be difficult. SAPS suggests using algal balls which work well but require a fair amount of preparation. Please check out http://www.saps.org.uk/secondary/teaching-resources/235-student-sheet-23-photosynthesis-using-algae-wrapped-in-jelly-balls to decide if this is a good option for you. If you decide to use them, please do a test run a few weeks before to ensure it all works. It takes 3 weeks to grow the algae from the original culture, so effective time management is required.

If you can not make algal balls, you could use leaf discs. Take a normal leaf (not too floppy and the waxy cuticle not too thick; avoid "hairy" leaves; spinach works well) and use a hole punch to cut out disks. If you do a video search using the terms 'photosynthesis leaf disc' you should see several demonstrations of how to do this and ideas on how to use them.

Lesson 5-1

Page 68

OBJECTIVES

- To discuss the importance of photosynthesis to humans and other animals
- To show that carbon dioxide for photosynthesis comes from the air, and that the water is taken in by the plant's roots

LEARNING OUTCOMES

After this lesson, students should be able to:

- explain how photosynthesis is the source of biomass.
- write the word equation for photosynthesis.

START (15 min)

Ask students to name some species and to list what they need to live. Examples could include a cat, a palm tree, a fish, a rose, etc.

The list of things they need to live could include food, water, air, a place to live, etc.

Focus on the issue of food. What kind of food do they need? The animals need to eat (mice, other smaller fish, or plants) but what do plants eat? A student may come up with 'plants make their own food' which would be great, but you can ask what they need to make this food. It would be nice if a student knew that plants need sunlight, but do they need anything else? Can water be considered 'food' for plants?

The question on what plants 'eat' was exactly what Jean Baptiste van Helmont studied in the first half of the 17^{th} century. Worksheet 5-1 gives a summary of this part of his work.

MAIN (15 min)

- Hand out worksheet 5-1 and read the information with the students. Ask students to work on the questions independently for 5-10 minutes and then ask them to discuss their answers in small groups of 3-4 students.
- Carry out the experiment with the glass jars and the candles as described in worksheet 5-1. If it is not possible to do the experiment, something similar can be viewed on the internet, via https://www.youtube.com/watch?v=fcXL28NMPYQ

Note: in this section, we are stressing the importance of experiments in science. It would be best if the experiments were indeed carried out by students rather than shown as a demonstration or on screen.

PLENARY (15 min)

Using images of an aquarium and an ecosphere, consider the similarities and difference between both the set-ups.

Both have water, plants, and fish. The aquarium has a filter, a thermometer, and an air pump. The fish are fed and most of their waste is removed by the filtering system. Air is bubbled through the water all the time and various values are measured and, if necessary, adjusted.

In the ecosphere, the plants are supposed to absorb the carbon dioxide produced by the animals and to give off the oxygen that the animals need. The plants are also the food for the animals and use the animals' waste to grow. Nothing is added or removed and everything is recycled. Although it is possible to maintain a successful ecosphere for decades, it is very difficult to find the correct amount of, e.g., light and temperature so that the entire system remains balanced.

Lesson 5-2

Page 69

OBJECTIVES

- To show that chlorophyll enables a plant to utilize light in photosynthesis

LEARNING OUTCOMES

After this lesson, students should be able to:

- identify carbon dioxide and water as the raw materials, and light as the energy source, for photosynthesis.
- write the word equation for photosynthesis.

START (5 min)

Ask students to write the word equation for photosynthesis on the board. Discuss that the first product of photosynthesis is glucose.

MAIN (35 min)

Hand out worksheet 5-2.

Students can carry out all these experiments (with the exception of the test for the need for carbon dioxide—it is better if students do not handle soda lime).

This would be the best approach and the teacher should plan at least one additional lesson for students to carry out the experiments.

PLENARY (5 min)

Return to the equation on the board and ask students to name and summarize the test needed to show that each of the components is made or needed.

HOMEWORK

Test yourself questions on page 72 of Student Book.

Lesson 5-3

Pages 70-72

OBJECTIVES

- To show that chlorophyll enables a plant to utilize light in photosynthesis

LEARNING OUTCOMES

After this lesson, students should be able to:

- describe how leaves are adapted for photosynthesis and how roots are adapted to take in water.

START (5 min)

Write the word equation for photosynthesis on the board. Ensure that 'light' is written above the arrow.

Ask students why only plants photosynthesize. During the discussion the following should come up:

- Plants are green.
- The green colour is caused by the presence of chlorophyll or chloroplasts (which contain chlorophyll).
- Chlorophyll is needed for photosynthesis.

MAIN (35 min)

Hand out worksheet 5-3.

If you are planning for students to do the experiment (recommended), you need to get plants with variegated leaves, i.e. leaves that have yellow/white/light pink parts of the leaf. You will need to try out which works best, but thin leaves with thin cuticles tend to work best.

Ask students to complete the worksheet.

PLENARY (5 min)

Food is produced in leaves and transported to the other parts of the plant. Roots take up water and minerals which are transported to other parts of the plant. What is one very important function of the stem? What would you predict about the structure of the stem, knowing this function?

What other organs might plants have? What are their functions?

A main function of the stem is to facilitate fast transport. The stem therefore contains a number of separate tubes through which water and minerals move from the roots to e.g., leaves, and sugars are moved from the leaves to e.g., roots and flowers.

Other organs are flowers (for reproduction) and seeds (for growing new plants). The seeds may have fruits (to help seed dispersal).

Lesson 5-4

Pages 74-75

OBJECTIVES

- To discuss the importance of photosynthesis to humans and other animals

LEARNING OUTCOMES

After this lesson, students should be able to:

- explain the importance of minerals to plants.

START (15 min)

Discuss the following ideas with students.

There are ways of growing plants without soil. The roots of the plants can be immersed in a nutrient solution or their roots can be sprayed with a nutrient solution.

REFERENCE WEBSITES

https://www.citycrop.io/tag/hydroponics/

http://www.homehydrosystems.com/hydroponic-systems/aeroponics_systems.html

Controlling disease and pests is much easier without soil. Also, the concentration of minerals provided to the plants can be regulated very precisely. The correct amount of minerals available to plants is very important. When you grow plants outside (e.g. like a farmer will grow a crop of potatoes, carrots, or tomatoes), the soil will provide the minerals. Although farmers provide additional minerals to their crops, this is only one of the factors affecting the crop. Others would be the temperature and amount of water. Also, the soil will be like a reservoir of minerals, so a little more or less of something is less important.

However, if you grow plants inside, on a large commercial scale, you want to make sure all factors are at their best (including water, temperature, and often carbon dioxide) so it is also really important to have the perfect amount of each mineral. This can be controlled better when growing plants without soil.

MAIN (15 min)

Hand out worksheet 5-4 to students.

PLENARY (15 min)

Plants need minerals and absorb them via their roots. They become part of the plant, so when an animal eats plants, they also eat these minerals.

Animals (including people) also need minerals. Students may know some of them and their roles in the animal's (or human's) body.

Examples could include:

i. calcium and phosphorus from milk or cheese for strong bones and teeth.
ii. iron from spinach or beef to make red blood cells which carry oxygen from lungs to tissues.
iii. potassium from dairy products and dark green leafy vegetables which will help nerves and muscles function.
iv. magnesium from spinach and bran cereals for muscles and nerves and also to build strong bones and teeth.

Lesson 5-5

Page 73

OBJECTIVES

- To discuss the importance of photosynthesis to humans and other animals

LEARNING OUTCOMES

After this lesson, students should be able to:

- list some of the ways that plants use glucose.

START (15 min)

Discuss the following ideas with students.

The first product of photosynthesis is glucose, which is a sugar. Plants convert glucose to other molecules for different reasons. Where do we still find glucose or other sugars in plants? What could be the reason for them being there?

Sugars are found in nectar and fruits. Nectar is produced to attract bees which then pollinate the plant, and sweet fruits are eaten by animals which then disperse the seeds, usually in their droppings.

So the plant keeps sugars for others, in order to get them to do something (pollinate or disperse seeds). For its own use, plants will convert glucose to other molecules which are structural (cellulose) or functional (proteins, especially enzymes). For storage, sugars are converted to starch.

MAIN (15 min)

Hand out worksheet 5-5 to students.

Support students working through the worksheet. It might be useful if they first attempt to work out the answers individually and then discuss them in small groups. Finally, the entire class could collaborate to make a presentation or poster on how important and useful plants are to us.

PLENARY (15 min)

If we were to travel to Mars and live there, what role would plants play in our colony. What plants would we choose and for what reasons?

Go back to the list of uses we have for plants and consider what we would and would not do on Mars. For example, we probably would drive electric cars, powered by solar energy, so we would not have to worry about biofuels (although we would need to find a use for our organic waste). The discussion is the interesting part here—there are no right and wrong answers.

1. Read the information below and answer the questions.

   Jean Baptiste van Helmont was a Flemish scientist. He lived from 1580 to1644 and is considered to have been a major contributor to the founding of modern science.

   http://homeoint.org/photo/uv/vanhelmont.htm

   The Ancient Greeks would note their observations about the world around them and discuss theoretical explanations, but they were less likely to set up experiments to test their ideas.

   Van Helmont carried out an experiment and described the results which were published only after his death. The description was brief and is found (translated) below.

   I took an earthen pot and in it placed 200 pounds of earth which had been dried out in an oven. This I moistened with rain water, and in it planted a shoot of willow which weighed five pounds. When five years had passed the tree which grew from it weighed 169 pounds and about three ounces. The earthen pot was wetted whenever it was necessary with rain or distilled water only. It was very large, and was sunk in the ground, and had a tin plated iron lid with many holes punched in it, which covered the edge of the pot to keep air-borne dust from mixing with the earth. I did not keep track of the weight of the leaves which fell in each of the four autumns. Finally, I dried out the earth in the pot once more, and found the same 200 pounds, less about 2 ounces. Thus, 164 pounds of wood, bark, and roots had arisen from water alone."[1]

   [1] Helmont, J.B. van. (1662). Oriatrike or Physick Refined. London: Lodowick Loyd. (translated by John Chandler).

   a. Van Helmont was one of the people who changed science by taking a different approach. What did he do that was different?

   ____

   b. If you had done this experiment, what title would you have put above your lab report? In other words, what would have been your research question?

   ____

   c. What was Van Helmont's conclusion?

   ____

   d. One ounce is 28.35 g. One pound is 454 g.

   How much had the mass of the tree increased (in kg)?

   ____

   e. How much mass had been lost from the soil (in g)?

   ____

   ____

f. Do you think Van Helmont proved that the wood, bark, and roots had NOT come only from the minerals in the soil? Explain your answer.

____

g. Do you think Van Helmont proved that the wood, bark, and roots had arisen from water alone? Explain your answer.

____

2. We know that plants make their own food by photosynthesis. This fact, and how plants actually do this, took a lot of time and the input of many scientists to unravel.

   Van Helmont made a very important start when he proved that the increase in the tree's biomass could not possibly come only from the minerals in the soil. A second important discovery was made by Joseph Priestly (1733 – 1804) when he placed a lighted candle under a glass jar.

Experiment

Read the experiment below.

Method:

1. Take at least three small candles, A, B, and C.
2. Place each on a plate and light them.
3. Take a large glass or glass jar in one hand and a smaller one in the other. Place the large jar over candle A, the small glass over candle B, and leave candle C uncovered.

a. What is the dependent variable (what you measure)?

____

b. What is the independent variable (what you decided to change)?

____

c. What do you expect the results to be? Explain your reasons.

Hypothesis: ____

____

____

If you wish, you can repeat the experiment.

d. What do you observe? Give the reason(s) why this may be happening.

Results: ____

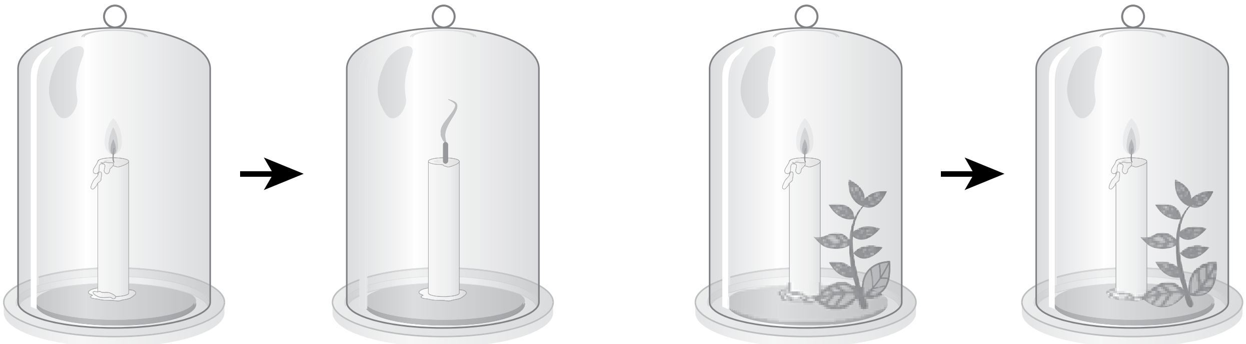
____

____

e. What is the function of candle C?

____

3. Joseph Priestly did this experiment in 1774 and found that the burning candle went out when under a glass jar. When he tried to relight the candle some days later, it would not light. However, if he added a small plant to the container, he could relight the candle after a few days.



https://www.education.com/activity/article/candle-snuffing-contest/

Priestly concluded that the candle 'spoiled' or 'injured' the air and that the plant 'refreshed' or 'restored' it.

Further discoveries by other scientists included the findings that the plant will only 'restore' the air when it is in sunlight and soon afterwards; it was found that plants absorb carbon dioxide; and finally, that the increase in a plant's biomass had to be caused by the uptake of both carbon dioxide and water.

So, you now know how plants make their own food and create biomass and you can complete the chemical word equation. Put the words in the right places to complete the equation for photosynthesis.

biomass	carbon dioxide	oxygen	water

______________ + ______________ → ______________ + ______________

Read page 69 of your Student Book to check your answer.

In the previous lesson, you came across the importance of experiments to test your scientific hypotheses. It is important to test if our word equation for photosynthesis is indeed correct. From Van Helmont, Priestly, and others, we found that

carbon dioxide + water → biomass + oxygen.

Research has shown that the first biological molecule made in photosynthesis is glucose. All biomass is made from glucose.

So we can rewrite the equation as it is given on page 69.

$$\text{carbon dioxide + water} \xrightarrow{\textit{light}} \text{glucose + oxygen.}$$

In order to test if this reaction takes place, we can, theoretically, test for four things. We can test if the amounts of carbon dioxide or water become less (because they are used up), or we can test if glucose or oxygen is present because they are produced.

Different experiments given in the workbook can be conducted in Labs to test the following:

1. Experiment A: Testing whether starch is produced during photosynthesis. Plants almost immediately change glucose into starch, so we can test for the presence of starch.

   Experiment given in workbook page 30, Question no.5 i

2. Experiment B: Testing if oxygen is produced.

   Experiment given in workbook page 31, Question no. 6

   or

   Method B2 : Using leaf discs.

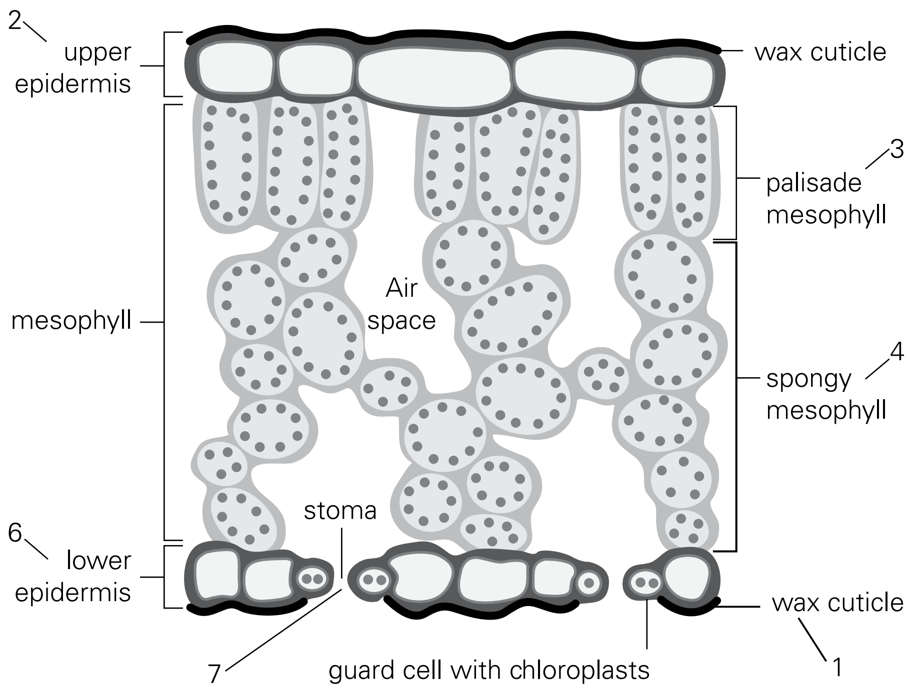
   Instructions for making the solution of bicarbonate solution (baking soda).

   i. Each student will need about 300 ml.

   ii. For 1 litre solution (1 dm^3) you will need to dissolve 17 g of baking soda into 1 litre of water. Add 1 drop of detergent to make it easier for the solution to be drawn into the leaf. The detergent should not be enough to cause bubbles.

   iii. Set up your experiment in the following way or study this information carefully.

      1. Get 1–2 dark green leaves from your teacher. They may be spinach or other leaves.
      2. Use a hole punch or a large strong straw to punch out 20 leaf discs. Avoid veins and irregular areas.
      3. Remove the plunger from a 5 cm^3 or a 10 cm^3 syringe and gently place the discs inside. Put the plunger back in place.
      4. Add 5–10 ml of bicarbonate solution to your syringe and remove the air.
      5. Put your thumb on the syringe and pull out the plunger to create a low pressure. This takes the air out of the leaf and you may see bubbles on the outside of the leaf.
      6. Repeat several times until (almost) all your discs are sinking. Tap the syringe in between to move the discs.
      7. Put your syringe on the plunger (with the opening pointing up) in good light (sunlight or a lamp)
      8. In about 10–20 minutes, the leaf discs should rise.



Answer these questions. Use the diagram to help you.

a. When you put the discs in the syringe and added the solution (before creating the low pressure), your discs floated. Looking at the diagram, what element of the leaf made these discs float?

____

b. Thinking about what is needed for photosynthesis, can you deduce the reason for using a solution with bicarbonate rather than water in this experiment?

____

c. What happened in the leaf discs during the 10–20 minutes before they started to rise?

____

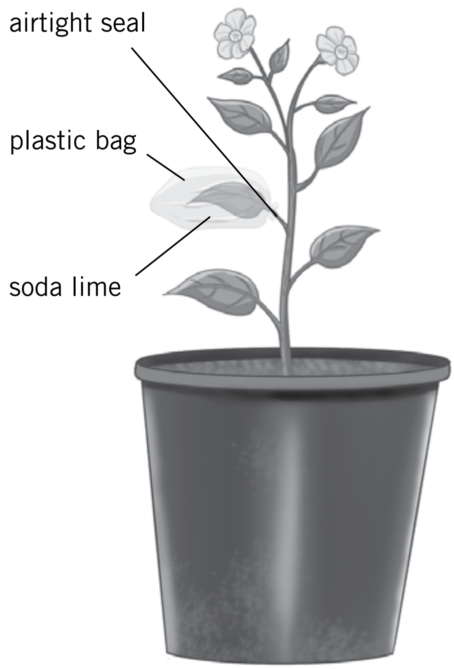
d. If the leaf discs had been kept in the dark, would the same have happened?

____

e. What gas caused the leaf discs to rise?

____

3. Experiment C: Testing whether carbon dioxide is needed for photosynthesis



A plant is put in a dark cupboard for 2-3 days. During this time, it will not photosynthesize and will use up all the starch from its leave. One leaf is taken off the plant (keeping it in the dark) and immediately tested for starch.

What will the starch test show?

____

A plastic bag with some soda lime is put over one of the leaves and the plant is put in the light. After 4-24 hours, the covered leaf and another leaf are tested for starch.

What will the covered leaf show? ______________________________

What will the other leaf show? ______________________________

Why were two other leaves tested (one after the plant had been in the dark and the other after it had been returned to the light)?

____

____

4. Testing whether light is needed for photosynthesis

Experiment given in workbook p 30, Question no.5 ii

1. If you were to take a glass of fizzy water (water with carbon dioxide), put it in the Sun for some time, and then test it for starch, would you expect to find starch present? Explain your answer

2. So what do we need to add to the equation that, so far, we have not included? Write the missing word in the box.

$$\text{carbon dioxide} + \text{water} \xrightarrow{\textit{light}} \text{glucose} + \text{oxygen.}$$

Which experiment will prove that we not only need a plant, but also chloroplasts, for photosynthesis to occur?

Variegated leaf

Testing whether chlorophyll is needed for photosynthesis

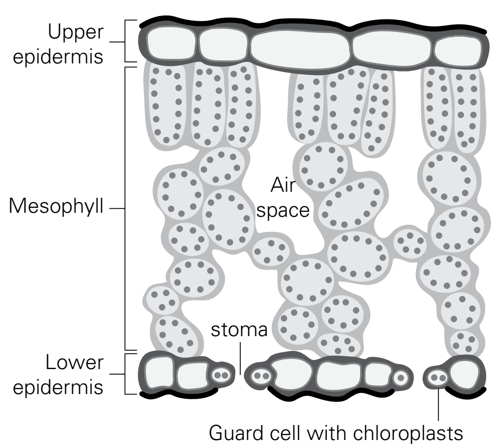
A plant with variegated leaves is put in a dark cupboard for 2-3 days. During this time, it will not photosynthesize and will use up all the starch from its leave. One leaf is taken off the plant (keeping it in the dark) and immediately tested it for starch.

3. What will the starch test show?

4. The plant is put in the light. After 4-24 hours, a leaf is tested for starch.

   What will the leaf show? Explain your observations

Look at the diagram of the leaf below and compare it with the diagram on page 69.



In the diagram above, colour the chloroplasts (which contain chlorophyll) green.

5. Where do you find these chloroplasts? Give the name of the layer of cells.

____

6. You also find chloroplasts in the guard cells which open and close the stomata (leaf pores). In which layer do you find the stomata?

   (The singular is "stoma" while the plural is "stomata". So, one stoma, two stomata.)

____

7. The upper skin (or upper epidermis) is transparent. Why is this important?

____

8. The structure of the leaf is adapted to best suit its function.

   Write the correct structural adaptation of the leaf with the given function needed for photosynthesis.

chlorophyll	large surface area	network of veins	stomata	thin

	allows carbon dioxide to diffuse into the leaf
	absorbs sunlight energy needed for photosynthesis
	The absorbed carbon dioxide only has to travel a short distance to reach the chloroplasts.
	to absorb more light at the same time
	to bring water and minerals to the leaf and to take away the glucose produced

The leaf has a network of veins to bring in water and minerals, but where do these come from? Just as the leaf is specially adapted for photosynthesis, the structure of the roots is very well suited to taking up water and minerals.

Plants have different-looking roots. Some plants have very deep roots, others have many shallow roots, and others have roots that are also used for storing food (like carrots).

However, all roots anchor the plant in the soil and take up water and minerals. Read pages 73,74, and 75, and write the correct structural adaptation to the function of the root.

large vacuole	living cells	network of veins	root hairs

	increase the surface area so more water can be absorbed
	to absorb and hold as much water as possible
	take up oxygen from the air spaces in the soil and can release energy which they use to take up some minerals from the soil
	to take water and minerals to other parts of the plant and to bring food

1. List the four main ways that plants use glucose, and briefly explain the main point of each. Read page 73 for information.

use of glucose	main point

2. Animals, including humans, use plants for food. Even when we eat meat, the chicken we are eating was eating grain from plants as it was growing. All food originally comes from plants.

However, humans make use of plants in many other ways. Can you think of at least 5 other ways?

1.	
2.	
3.	
4.	
5.	

Chapter 6

Particles

UNIT FLOW CHART

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

↓

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

↓

Evidence for the existence and behavior of particles.

↓

Expansion and contraction

INTRODUCTION

This chapter deals with the nature of all the materials we see around us every day. They are so common and so much a part of our lives that we take them for granted. Of course ice melts into water and boils into steam. Of course we do not build bridges from orange juice (or other liquids). What we try to do in this chapter is to take the 'of course' knowledge and look at the reasons for it. Why is orange juice not the best building material?

As before, some experiments have been included in this chapter. It would be great if students could do them (hands-on) so that they learn the skills needed in the lab. At least as important is the fact that most students prefer doing an experiment to watching a demonstration or video. Our future generations need scientists, and it is our responsibility to create the interest among our students.

Too often, students perceive what they learn at school as being separate from 'real life', so this unit (as all others) aims to include as many examples from 'everyday life' as possible.

Lesson 6-1

Page 80

OBJECTIVES

- To show how the particle model can be used to explain the differences between solids, liquids, and gases

LEARNING OUTCOMES

After this lesson, students should be able to:

- classify materials as solid, liquid, or gas.
- describe materials as being made of particles.
- describe the movement and arrangement of particles in a solid, a liquid, and a gas.

START (5 min)

Show students an ice cube, a glass of water, and a boiling kettle with steam coming out. Ask them what the differences are between the ice cube, the water, and the steam. Students should recognize that they are all water, but in different states (solid, liquid, and gas).

MAIN (15 min)

Hand out worksheet 6-1 to students.

As mentioned in the worksheet give students a stone, different size cups or beakers, a way to measure 100 ml of water, and a balloon. Ensure each student records his/her answers.

PLENARY (15 min)

Discuss the answers and the reasons for the answers given by the students.

HOMEWORK

Complete the second half of the worksheet (fill in the blanks).

Lesson 6-2

Pages 80-81

OBJECTIVES

- To show how the particle model can be used to explain the differences between solids, liquids, and gases

LEARNING OUTCOMES

After this lesson, students should be able to:

- describe the movement and arrangement of particles in a solid, a liquid, and a gas.

START (10 min)

Read pages 80 and 81

MAIN (15 min)

Hand out worksheet 6-2 to the students.

Do the activity from Worksheet 6-2.

PLENARY (15 min)

Go over the questions in worksheet 6-2 and relate the information to both the activity and their drawings of the particles in different states (gas, liquid, solid).

HOMEWORK

Workbook page no. 37

Lesson 6-3

Pages 82-84

OBJECTIVES

- To show how the particle model can be used to explain the differences between solids, liquids, and gases

LEARNING OUTCOMES

After this lesson, students should be able to:

- describe the movement and arrangement of particles in a solid, a liquid, and a gas.

START (10 min)

Read pages 82 – 84 of Student Book.

MAIN (25 min)

Hand out worksheet 6-3. Carry out the experiment mentioned in the worksheet. As always, it is preferable if students do this experiment themselves. If this is not possible, the next best option is for a few students to demonstrate it at the teacher's desk while the others watch. (But please do not choose the same students every time you use this approach.)

PLENARY (10 min)

Compare the speed of diffusion in air and in liquid. Relate this to the speed of the particles.

Lesson 6-4

Page 86

OBJECTIVES

- To show how the particle model can be used to explain the differences between solids, liquids, and gases

LEARNING OUTCOMES

After this lesson, students should be able to:

- use the particle model to explain pressure in gases.

START (15 min)

Do the experiment as described in worksheet 6-4 as a starter. Be aware that students will want to see this more than once, so have several cans prepared—preferably with water in them and (almost) boiling to speed up the process.

http://www.wikihow.com/Crush-a-Can-with-Air-Pressure

This site contains some suggestions to help students, but also a video at the end if the experiment cannot be done in class. Although it is the same experiment, it is spectacular when done in class, but a lot less interesting on the video.

MAIN (20 min)

Read page 86 of Student book.

Answer the questions on worksheet 6-4 and Test yourself questions on page 86.

PLENARY (10 min)

Discuss the following observations with students.

Changes in air pressure can be felt in your ears. Even though the cabin of an aircraft is pressurised, the pressure is lower than it was before take-off and you can feel this in your ears. Yawning or swallowing will equalize the pressure on either side of your ear drums and you will no longer notice the reduced pressure.

If students have taken a closed bag of crisps with them on an aeroplane, they may have noticed it seemed to contain more air after takeoff. This again is caused by a drop in air pressure outside the bag, so that the difference in pressure makes the bag seem bigger (although, unfortunately, not with more crisps but with more air!).

The reverse happens if you put the screw cap back on your partly-finished water bottle during the flight and only opened it after landing. Chances are you found your bottle had collapsed a little.

Lesson 6-5

Page 85

OBJECTIVES

- To show how the particle model can be used to explain the expansion and contraction of solids, liquids, and gases, and pressure in gases

LEARNING OUTCOMES

After this lesson, students should be able to:

- use the particle model to explain the expansion and contraction of solids, liquids, and gases.

START (20 min)

Demonstration:

Put a glass bottle in a bowl of ice. Leave it for 5-10 minutes. Put a balloon over the bottle opening and transfer the bottle into a bowl of warm water. The balloon should inflate. Placing it back into the bowl of ice should shrink the balloon again.

https://www.teachengineering.org/activities/view/cub_air_lesson04_activity4

Ask students what causes the balloon to inflate and shrink. Do not confirm or deny any answers.

If you have the metal ball and ring or the metal bar as described on page 85 of the student book, please demonstrate it. If not, you can search the internet for a video, using search tems like: ‘Expansion and contraction ball and ring experiment’, or something similar.

MAIN (15 min)

Hand out worksheet 6-5 and ask students to read the information, together with page 85 in the Student Book, and answer the questions. Go over their answers.

PLENARY (5 min)

Introduce the idea that if something becomes larger with the same number of particles, the particles are further apart (with more empty space between them). This means the density becomes less. This concept is used in hot air balloons.

HOMEWORK

Test yourself questions on page 85

REVISION

Test yourself questions on page 84

Worksheet 6-1

1. **Experiment:** The properties of different states of matter.

Form groups with your class-fellows and perform the following three experiments. Follow the directions and record what you observe. Discuss your conclusions in your groups and then each of you record your conclusions below.

a. A stone

Action	Observation	Concluding statement about solids
Try to press and squeeze the stone. What happens to its shape and volume?	Shape	
	Volume	
Put the stone in different-shaped containers. Does the shape or the volume of the stone change?	Shape	
	Volume	

b. Water

Action	Observation	Concluding statement about liquids
Measure 100 ml of water into different-shaped containers. Observe what happens to the volume and shape of the water when you place the water in different-shaped containers.	Shape	
	Volume	

c. A balloon

Action	Observation	Concluding statement about gases
Blow up the balloon. Does its shape and volume change?	Shape	
	Volume	

d. A sponge

Action	Observation	Concluding statement about the sponge – why did it behave differently from the stone?
Squeeze the sponge. Does its shape and volume change?	Shape	
	Volume	

2. Fill in the gaps in the sentences below, using words from the box. You may need to use some words more than once.

dense	fill	lower	squashed
density	fixed	properties	volume
easy	flow	rise	

a. All solids have some things in common. These are called the ____________ of solids.

b. Solids have a ____________ volume.

c. They cannot be ____________.

d. They also have a ____________ shape which cannot be changed, making them ideal materials to use to build large structures such as bridges.

e. They do not ____________ and so they cannot be poured.

f. Solids also have a high ____________, which means that their mass is higher than the same ____________ of other materials.

g. Like solids, liquids cannot be ____________.

h. They have a ____________ which is fixed.

i. However, they are different from solids because they can ____________ quite easily and have no ____________ shape.

This means that they always take the shape of their container.

j. Although liquids are ____________, they usually have a ____________ density than solids.

k. Gases are quite ____________ to squash and so they have no fixed ____________.

l. They also have no ____________ shape.

m. They will spread out and ____________ any shaped container.

n. Gases are less ____________ than liquids (which is why bubbles ____________ in a fizzy drink).

Worksheet 6-2

1. **Activity**

   Ten students should line up and close their eyes. It would be best to be away from windows, fans, and/or air conditioners.

   The teacher will spray some perfume onto a tissue and place it at the end of the line. Each student should raise her/his hand when she/he smells the perfume. Students not in the line should record the time between spraying the perfume and each student raising her/his hand.

   Write down in the table below how long it took for each student to smell the perfume. Write the time in seconds.

student	time (in seconds)	student	time (in seconds)
1.		6.	
2.		7.	
3.		8.	
4.		9.	
5.		10.	

   a. Which students smelled the perfume first?

   ____

   b. Were they close to the tissue or far away?

   ____

   c. How can all students smell the perfume after some time if they are not near the tissue?

   ____

2. Remember what you know about the particles in different states.

   Draw the arrangements of the particles in a solid, a liquid, and a gas in the boxes below.

   Refer to page 82 of your Student Book.

solid	liquid	gas

3. Answer the questions below.

Are there big spaces between the particles in a solid?	yes/no
Are there big spaces between the particles in a liquid?	yes/no
Are there big spaces between the particles in a gas?	yes/no
When you compress a substance, do the particles get smaller?	yes/no
When you compress a substance, do the spaces between the particles get smaller?	yes/no

1. **Experiment:**

   Diffusion of food colourant in hot and cold water.

   Method:

   i. Collect two glasses.

   Fill one with hot water, and the other with cold water.

   ii. Leave the water to stand for a minute or two so that it has stopped moving.

   iii. CAREFULLY put one drop of food colourant in the water. Make sure you do NOT stir the water.

   iv. Leave the glasses of water absolutely still.

   v. Draw a diagram (A) of each glass to show what it was like just after you put the coloured substance in the glass.

   vi. Look at the glasses again after 5 minutes. How far has the colour spread through the water? Draw another set of diagrams (B) to show what has happened.

   vii. Draw a third set of diagrams (C) to show what has happened after 15 minutes.

Hot	Cold	Hot	Cold	Hot	Cold
(A) after putting in colour		(B) after 5 min		(C) after 15 min	

Considering your results/conclusions

Complete these sentences.

a. The longer you leave the water, the more the colour ____________________.

b. The hotter the water, the ____________________ the colour spreads out.

c. This is because in hot water the particles are moving ____________________ than in cold water.

d. How long did it take before the last student smelled the scent? ____________________

e. What was the distance between this student and the scented tissue? ____________________

f. If you compare this with the distance the colour diffused in water in 5 or 15 minutes, what can you conclude about the speed of diffusion in a gas compared to the speed of diffusion in a liquid?

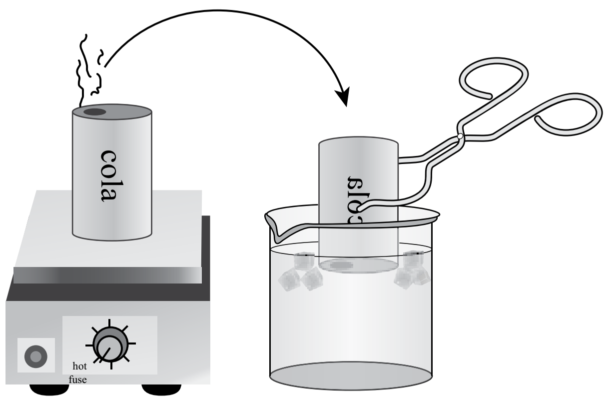
____

1. Demonstration - Gas pressure.

Your teacher will show you the following experiment.

A large bowl of very cold water (containing ice cubes) has been prepared and is placed on a table.

Nearby, your teacher will put a small amount of water into an empty can. The can is put on a hot plate until water vapour starts to come out. The teacher will take the can, using tongs, and put it in the large bowl of cold water.



a. What did you see?

____

b. Some force was needed to make this happen. Which direction did this force come from?

____

c. What was in the space that provided this force?

____

d. What force was it?

____

e. Why did the can collapse after being put in cold water and not before?

____

____

When air pressure is the same on all sides, we do not notice it. But when the pressure is higher on one side than on the other (for example, more air pressure outside the can than inside), we suddenly realize that air pressure is a big force.

How does thermal expansion affect our lives?

As you saw in the lesson and read on page 85 of the Student Book, materials expand when heated. Gases expand most, but liquids and solids also expand. This can be inconvenient as you can see in the picture below.

a. What do you think happened?

____

____

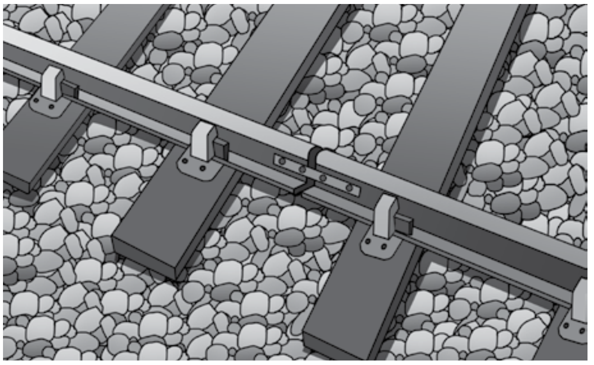
____

b. Why do you think this may have happened?

____

____

____



c. To prevent this problem, people constructing railway tracks ensure they leave small gaps between each section of the metal track.

How does that prevent the problem?

____

____

____

People also make use of the fact that solids, liquids, and gases expand on heating.

d. Inside the thermometer there is mercury, the only metal which is liquid at room temperature. Explain what happens when the thermometer is placed in the tube with hot water.

____

____

1. **Student activity - Oil and temperature**

Oil molecules are relatively large and sometimes do not move past each other easily. This makes the oil thick and viscous.

Ali, Sarah, and Essa each did an experiment to find out if oil became runnier when it was heated.

These are their results:

Temperature (°C)	Time for oil to run through funnel (in seconds)			average time (seconds)
	Ali's results	Sarah's results	Essa's results	
22	138	124	132	
30	55	52	57	
40	35	33	36	
50	25	24	27	
60	22	23	21	
70	20	19	20	
80	19	19	18	

a. An experiment is always done to answer a question. This question is called the 'research question'. What could the research question have been for this experiment?

___

b. Remember that the dependent variable is the thing you measure, and the independent variable is the thing you change. What were these variables for this experiment?

dependent variable	
independent variable	

c. Why do you think their coolest temperature was 22 °C instead of 20 °C?

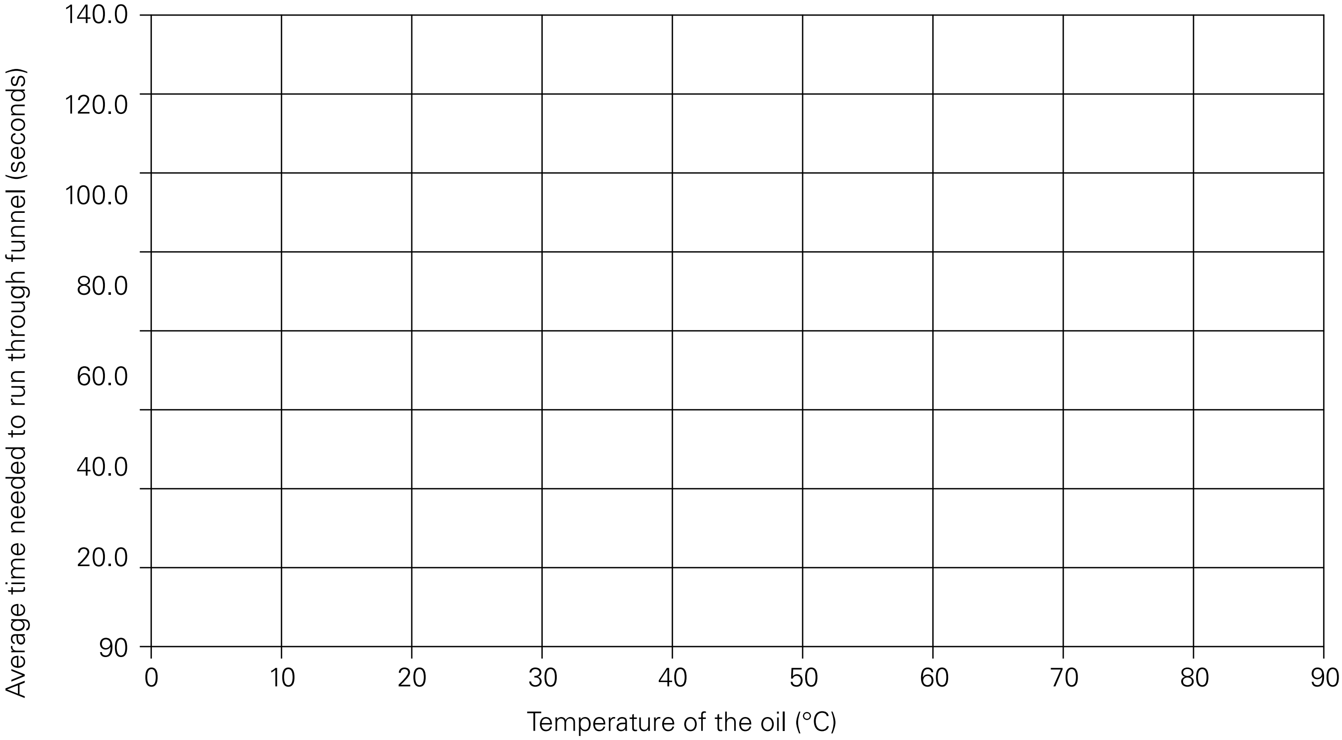
___

d. Work out the average time for each temperature and add it to the table above. Work out the average by adding all three results together, and then dividing by 3. Write your answers to one decimal place.

e. Plot a graph of these average values against the temperature.

Use the space below.

Average time needed for oil at different temperatures to run through a funnel



f. What is your conclusion from this experiment? Go back to the research question and see if you can answer it. What would be the reason for this happening?

Chapter 7

Forces and their effects

UNIT FLOW CHART

We experience forces constantly in our daily lives

↓

Forces can be measured

↓

Why do thinks float?

↓

Using force to stretch materials

↓

What is weight?

↓

Friction slows things down

INTRODUCTION

We should consider that forces cannot be seen and this may lead to incorrect assumptions, such as that an object will stop by itself unless a force continues to move it. So we need to make students aware of the forces of friction and air resistance. It provides the chance to put things in perspective: friction can be good or bad, depending on the circumstances.

This chapter, more than any other, makes students see the limits of their everyday perspective as a human on Earth. By questioning why things are the way they are, rather than taking them for granted, students can learn basic principles of science.

As with other sections, please attempt to allow students to engage in experiments and hands-on activities as this is the basis of an inquiry-based subject such as science.

It also provides opportunities for co-teaching with an IT colleague and showing that subjects do not exist in isolation.

Lesson 7-1

Pages 90-91

OBJECTIVES

- to build on previous work on force and its measurement
- to distinguish between mass and weight
- to identify the origins of weight and describe situations in which these forces act

LEARNING OUTCOMES

After this lesson, students should be able to:

- identify directions in which forces act.
- describe the effects of two forces acting in opposite directions.
- explain balanced forces.
- distinguish between mass and weight.

START (10 min)

Ask a student to push a book across the table, another to hold a pencil above the table, and someone to crumple up a piece of paper.

Imagine that the book was made of a special material and weighed 1000 kg and the student wanted to push it, what would need to be different? What if the pencil weighed 1000 kg? What if the paper were a sheet of steel?

In the discussion, the concept of 'force' will come up. So ask what a force is? Can forces be seen? Then, how do we know they exist? Forces cannot be seen but their effects are visible; e.g., the book is in a different position, the paper is crumpled, and the pencil did NOT fall down.

Ask students to write examples of forces on a sheet of paper to display on the wall.

MAIN (20 min)

Ask students how they would portray the concept 'force'. They can either draw it or act it, but no written or spoken words. This should lead to the conclusion that 'a force is a push or a pull'. Add this sentence as a heading to the examples of forces displayed on the wall.

Go through the worksheet, either individually, or in groups, or as a plenary session.

Use the first part of worksheet 7-1 to convey two messages:

1. Forces cannot be seen—but their results can be seen.
2. Forces can be represented by arrows since they have a direction and a magnitude (i.e. the length of the arrow represents how strong the force is).

Ensure students understand that more than one force can act on an object at the same time and that balanced forces (equal but in opposite directions) cancel each other.

Gravity is one type of force. If you wish, you can provide additional information about Newton and/or his work leading to his law about gravity. Information is easily available on the internet.

The concept of gravity leads to the difference between mass (how much there is, measured in kg) and weight (how strong the force of gravity is on this object, measured in N). The example focuses on the fact that Armstrong (first man on the Moon) walked and even jumped there, despite his heavy space suit). His mass was the same (he did not become thinner) but his weight on the Moon was less than on Earth.

PLENARY (15 min)

A lot of things were covered in this worksheet. Ask students to list them, summarize what they learned, and ask for clarification or pose additional questions. This could be done in a plenary session.

HOMEWORK

Read pages 94-95 of the student book.

Lesson 7-2

Page 91

OBJECTIVES

- To identify the origins of up thrust and describe situations in which these forces act

LEARNING OUTCOMES

After this lesson, students should be able to:

- explain why things float, and explain the concepts of density and balanced forces.

START (15 min)

Introduce the concept of floating and sinking by asking the students what this means in their everyday life.

Then do the experiment with the pieces of aluminium foil in worksheet 7-2. It is a simple experiment that students should be able to do individually or in small groups.

Discuss their findings and relate findings and/or comments to the concept of density.

MAIN (15 min)

Support students working through worksheet 7-2. You could demonstrate the two methods of finding the volume of an irregular object.

PLENARY (15 min)

Use the last part of the worksheet to go back to the experiment. The boat displaced more water because of its shape, so it floated.

HOMEWORK

Test yourself questions on page 92 of Student Book or

Workbook page 42, Question 5

Workbook page 43, Question 6

Lesson 7-3

Page 90

OBJECTIVES

- To build on previous work on force and its measurement

LEARNING OUTCOMES

After this lesson, students should be able to:

- describe the effects of tension and compression forces.
- describe how a force may be measured.

START (15 min)

You can put a ruler on two erasers (or other supports) and push down in the middle. The ruler will bend a little. Ask students how safe they would feel, crossing a river on a bridge that bends. Would it make a difference if they were on foot or in a car?

MAIN (15 min)

Support students working through worksheet 7-3. When things bend, one side will be longer than the other. In solid objects (not like a book where the pages are separate and can slide past each other), this causes compression and tension. Either of these could (and would) damage a bridge, so these forces need to be divided over other parts of the structure to avoid bending.

If you wish to extend this, you can find information about the structure of bridges on the internet. If you have time, invest a few lessons on creating spaghetti bridges as this enhances students' understanding. It could also be a school activity outside class time.

Springs have the unique ability to change shape when a force acts on them, but to return to their original shape when the force is removed. It would be great to have some springs or force meters for students to get hands-on experience working with them.

PLENARY (15 min)

You could discuss an example of a student destroying a force meter by putting too much force on it. It can no longer be used by others. What are the consequences of inconsiderate (or even downright destructive) behaviour on a community? What is a social conscience? Should we look after others we know? What about those we do not know—such as students in other classes?

Lesson 7-4

Page 92-93

OBJECTIVES

- To build on previous work on force and its measurement

LEARNING OUTCOMES

After this lesson, students should be able to:

- explain the term elasticity and describe how the elasticity of a spring may be measured.

START (15 min)

Read page 93 with students.

MAIN (15 min)

Hand out worksheet 7-4 to students. This activity about data analysis could be done in collaboration with the IT department. Students could use Excel to calculate the weights from the given masses and could use the data to plot a graph (by hand or using Excel).

Students will need support on graph plotting—even by hand. Reinforce that the independent variable is put in the X-axis while the dependent variable goes on the Y-axis.

If they plot by hand, ensure that the axes are linear (e.g. if there is 1 cm between 1N and 2N, then there should also be 1 cm between 7N and 8N, and 10 cm between 20N and 30N). Ensure students do not simply plot the next value on the next gridline.

PLENARY (15 min)

Discuss how a graph can help data analysis in general, and use the example of these data where the straight line of the results suddenly goes up more steeply after 0.4 N. Refer to page 92 and the explanation of the elastic limit. If you wish, this can be demonstrated by pulling a spring (e.g. from a ball pen) out of shape. You can also show that the spring can then no longer be used. If you wish, refer to the relationship of structure and function.

HOMEWORK

Test yourself questions on page 93 of Student Book.

Lesson 7-5

Page 95

OBJECTIVES

- To identify the origins of friction, air resistance, upthrust, and weight, and describe situations in which these forces act
- To show that the stopping distance of a car is influenced by a number of factors

LEARNING OUTCOMES

After this lesson, students should be able to:

- identify friction and air resistance as forces that slow things down.
- describe how the effects of friction and air resistance can be reduced.

START (10 min)

Show students this picture and ask them what they think happened?

Someone is likely to use the word ‘slipped’. (If not, you can ask them why they think the man fell.)

Why did the person slip? Maybe because the ground was slippery. What is the difference between a ‘normal’ surface and a slippery surface?

If students do not come up with the word ‘friction’, then introduce it yourself.

MAIN (20 min)

Read the beginning of worksheet 7-5 with students or ask them to read it themselves. Discuss the information provided to ensure all students understand.

The pictures of the bicycles given in worksheets already show that friction slows us down but, at the same time, is necessary.

Before moving on to air resistance, ask students to come up with examples where we need friction and/or problems caused by a lack of friction. Examples could include walking (and slipping on ice or oil), lighting a match, sanding a piece of wood to make it smooth, car’s tyres when going round a corner or braking, writing would be difficult without friction between pen and paper, friction between the floor and your chair ensures your chair does not move in all directions when you change position, your socks would fall off your feet without friction, etc.

AIR RESISTANCE

If you wish to expand this section, you could provide pictures and compare the shape of the first aircraft with current ones, and even include space ships (function of wings could be discussed). If you do so, be sure to have read up on the reason wings provide lift in air and why it is not needed in space.

When you discuss brakes, you could have a bicycle with this type of brakes in the room.

It shows the principle of the brake but is a little more intuitive to understand than the car brake. Ideally, a mechanic could show a car brake.

Please ensure you understand the calculations for determining thinking distances.

PLENARY (15 min)

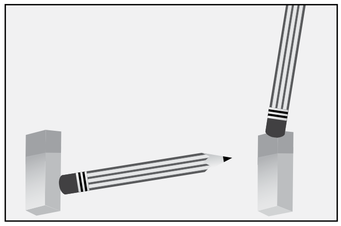
Industry has improved the brakes of cars so that, under ideal circumstances, car can be stopped in less time and distance than some years ago. However, industry can only reduce the time and distance the car covers **after** the brakes are applied. The time it takes for the driver to think and actually put his/her foot on the brake has not really changed.

It has been shown that this ‘thinking time’ (page 97 of the student book) is much longer when the driver is distracted and his/her attention is not fully on the road. Research suggests that the use of mobile phones, especially reading or sending text messages, is a main factor in many traffic accidents.

If you want to show a (funny) clip which makes this point, then do a video search on ‘you can’t even text and walk’.

1. You cannot see a force, but you can see the result of a force. A force can change the direction or the speed of an object, or it can change its shape.

   Place an eraser on your table. With a pencil, push the eraser as shown in the pictures.



https://www.tes.com/lessons/wFVMYVNxTum_tg/force

   a. Which way does the eraser move?

   ____

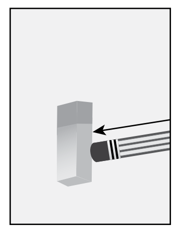
   b. Consider what would happen if you give the eraser a light push? What would happen if you give it a harder push?

   ____

   c. Look at what you wrote down above and complete the conclusion about a force.

   A force has a ______________ and a ______________.

   This is the reason that forces are often drawn as arrows. The direction of the arrow indicates the direction of the force and the size of the arrow shows the magnitude (= strength) of the force.



2. Consider the picture below.

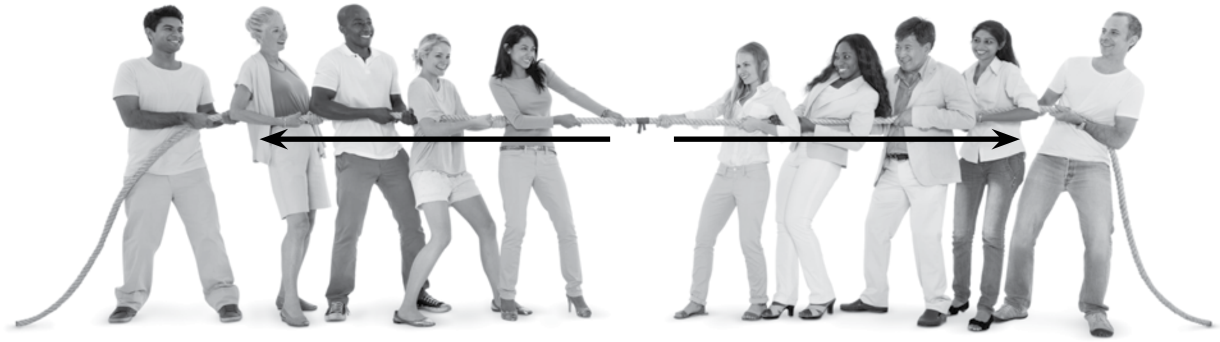
   a. In words, describe what is happening. Use words like ‘force’ and ‘pull’.

   ____

   b. If both teams are equally strong, what happens to the handkerchief tied to the middle of the rope?

   ____

If you represent the forces applied by the teams as arrows, you would see the following:



c. If both teams stop pulling, will there be a difference to what happens to the position of the handkerchief?

____

d. We started this worksheet by saying that a force can change the direction or speed of an object or it can change its shape. Did the handkerchief change speed or direction or did its shape change?

____

So, even though two teams were putting in a lot of effort, as the forces they generated were equal in size but opposite in direction, they cancelled each other out. These are called **balanced forces**.

3. One type of force is **gravity**. You know that if you push something off the table, it will fall down and you probably never questioned this fact. However, in the 17th century, Sir Isaac Newton, seeing an apple fall from a tree, wondered why the apple always fell straight down, and never sideways or even up. He worked out his theory of gravity which says *that* ***all objects attract each other and that this attraction force is bigger when the objects are bigger and closer***.

Since Newton made many other discoveries related to forces, we call the unit of force, the Newton.

In 1969, Neil Armstrong was the first man to walk on the Moon. He had to wear a heavy suit to protect him from conditions different from those on Earth. Still, with this heavy suit, he was able to walk and move fairly easily on the Moon, and there are even videos on the internet of him jumping.

On Earth, Armstrong might have found it difficult to do all these things, wearing his heavy suit.

a. What do you think this information about Armstrong tells us about gravity on the Moon compared to on Earth?

____

b. Which is bigger, the Earth or the Moon? __________________________

c. Do your two answers above match with Newton's theory of gravity which you just read?

____

d. If someone had weighed Armstrong, wearing his suit, on Earth and on the Moon, where would he have weighed more? __________________________

e. What if the same had been done while he was floating in his spaceship? What would the scales have shown then? ____________________

Armstrong was the same person, wearing the same suit, but you think correctly that his weight on Earth and on the Moon were not the same. You are actually saying that Armstrong's weight depended on the gravitational field (of Earth or the Moon) or no gravity at all (floating in space).

The conclusion is that the weight of an object (or person) is a force and depends on gravity. As forces are measured in Newtons, the weight of an object (or person) should be expressed in Newtons.

But Armstrong still had the same mass because his spacesuit still fitted him—even on the Moon.

4. Read page 94 of the Student Book and answer the questions below.

   a. Does the weight of an object change when gravity changes?

   ____

   b. Does the mass of an object change when gravity changes?

   ____

   c. Weight is a force and measured in ____________________.

   d. The mass of an object tells us how much of it there is. It is measured in ____________________.

   e. When discussing the fact that gravity on Earth is greater than on the Moon, should we consider the mass or the weight of the Earth and the Moon?

   ____

   ____

1. **Experiment**
   i. Take two pieces of aluminium foil of exactly the same size and shape.
   ii. Crumple one piece into as tight a ball as you can.
   iii. Fold the other piece into the shape of a boat.
   iv. Put both of them in a bowl of water

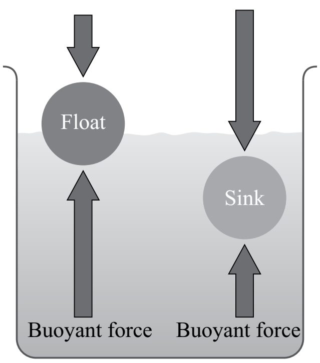
   What happened to each piece of foil?
   a. ball ____________________
   b. boat ____________________

2. **Up thrust**

When you are in the swimming pool, with the water up to your middle, you seem to weigh less than on land. Whereas gravity pulls you down, the water seems to push you up. As indicated on page 91 of your Student Book, this force is called upthrust.

How much this upthrust, depends on the volume of the object (or person), although the pull of gravity on Earth is relative to the mass of the object (or person).

If the upthrust is larger than the pull of gravity, the object will float. If the force of gravity is more than the up thrust, the object will sink.



a. What is the force of gravity on a small but heavy object? big/small
b. What is the up thrust on a small but heavy object? big/small
c. Will a small but heavy object sink or float? sink/float
d. What is the force of gravity on a large but light object? big/small
e. What is the up thrust on a large but light object? big/small
f. Will a large but light object sink or float? sink/float

3. Read the section on density on page 92.

   You found a beautiful blue stone on the beach. Is it a sapphire?

   The density of a sapphire is 3.98 g/ml. What is the density of your stone?

   The mass of the stone is 3.1 g.

   The volume of the irregularly shaped stone can be found by putting it in water. The stone will take up space (where water particles used to be), displacing the water. Therefore the level of the water will go up.

   The easiest way is to use a measuring cylinder. There was a certain amount of water in the measuring cylinder (volume 1). After adding the stone, the water level went up and is now at level 2. This 'extra' volume is caused by the stone.

   level 2 – level 1 = amount of water displaced = volume of the stone.

   If the object does not fit in the measuring cylinder, you can use another container. Put it on a plate or tray which will catch the spilled water and fill the container to the rim. Gently lower the object into the water. Some water will spill out. The volume of the spilled water is the same as the volume of the object. So pouring the spilled water into a measuring cylinder will tell you how much water was displaced, which is the volume of the object.

   Suppose there was 20.50 ml of water in your measuring cylinder. After adding the stone, the water level went up to 21.75 ml.

   What was the volume of the stone? ______________________________

   Density of the stone = $\frac{\text{mass}}{\text{volume}} = \frac{\_\_\_\_\text{ g}}{\_\_\_\_\text{ ml}} =$ ______________________________

   Is your blue stone a sapphire? ______________________________

1. Forces are an inevitable part of our daily lives. When you make use of a bridge, you are benefitting from the knowledge about forces which the engineer used to design the bridge.

   Maybe the simplest bridge is a piece of wood, supported on either end.

   Answer these questions.

   a. Describe what happens to a wooden plank bridge when a person walks over it?

   ____

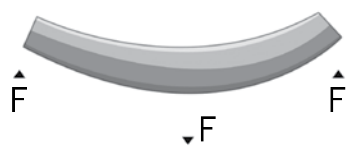
   b. How much force would you estimate the person puts on the plank? Explain your reasons.

   ____

   c. What would happen if a second person joined him/her on this plank? What if we kept adding people?

   ____

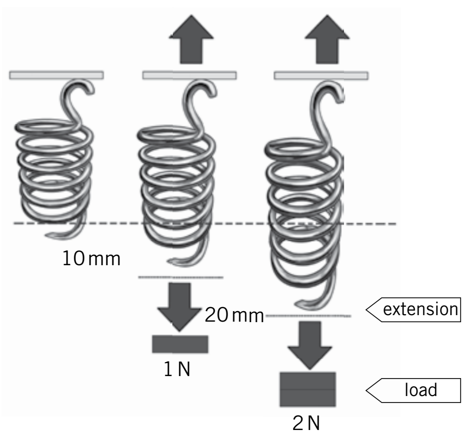
   This picture shows how the plank would bend, when a force acts on it.



   In many places, students compete to build the strongest bridge from uncooked spaghetti. They use different structures and the record is that a bridge built from less than 1 kg of spaghetti could hold 4660 N of force before it broke. If you are interested, look up more information on the internet and/or organize your own spaghetti bridge competition.

2. Springs will also change shape when a force acts on them. If you pull a spring, or put a weight on it, it will extend. However, it will return to its original shape when the force is removed.

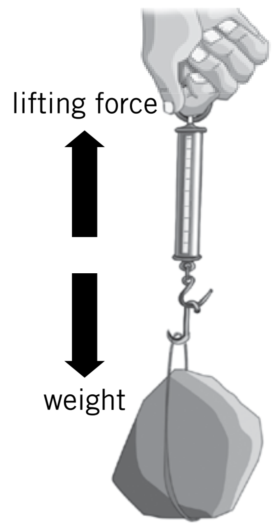
   This happens in a predictable way; i.e., if you put a certain weight on a specfic spring, it will extend by a certain length. If you repeat it the next day with the same spring and weight, you will find the same length of extension.



http://www.schoolphysics.co.uk/age11-14/Matter/text/Stretching_things/index.html

OXFORD
UNIVERSITY PRESS

So spring is used in force meters or Newton meters. Newton meters have a spring inside which extends a certain length with a certain weight.



a. Why would there have to be different meters for different maximum masses?

___

b. What would happen if you put too much force on the Newton meter, e.g., if you attach a mass of 50 kg to a meter designed for 250 g or less?

___

c. What would happen if you put a mass of 10 g on a meter designed for 5 kg?

___

Worksheet 7-4

Elasticity

Elastics are all materials that will become longer (or shorter) when a force acts upon them, but will return to their original shape when the force is no longer applied. We are mainly thinking of elastic bands and springs for use in the lab, but outside the lab, diving boards and bows (to shoot arrows) are also good examples.

1. A student has carried out an experiment where she put different masses on a spring and measured the length of the spring.

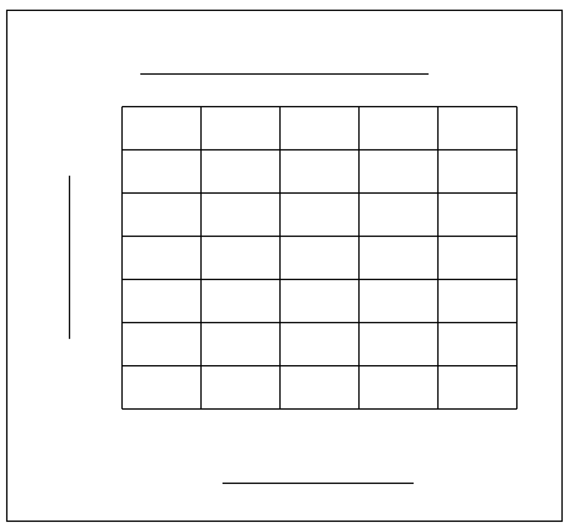
   She obtained the following results:

mass in g	length in mm
0	20
10	25
20	30
30	35
40	41
50	50

   a. Plot a graph of the length of the spring vs the force. First calculate the force put on the spring when these masses are attached.

mass in g	force in N	length in mm
0		20
10		25
20		30
30		35
40		40
50		50

   You will need to decide the following:



   b. What is the dependent variable (the one that is measured)? This goes on the Y axis.

   ____

   c. What is the independent variable (the one which the student changed)? This goes on the X axis.

   ____

   Read pages 92 and 93 of your Student Book and answer the questions on page 93.

Friction

Newton's first law states that an object will remain stationary or continue to move at the same speed and in the same direction unless a force acts upon it. But when you stop pedalling (applying a force), your bike will stop.

What happens when the driver of a car takes his foot off the accelerator?

What happens when you stop rowing a boat?

What happens when you stop pushing your skate board?

It seems that everything comes to a halt when we stop applying a force. Why, then, did Newton phrase his first law this way?

Read the second half of page 95 of your Student Book.

Friction is the force resisting the relative motion of two surfaces. Together with air resistance, they will cause all of the above examples to come to a halt when we stop applying the force that moved them.

Friction : friend or foe?

1. Friction costs us a lot of energy, both from our legs on the bike and from the fuel in the car. It is mainly found between the tyres and the road. Have a look at the tyres of the racing bicycles crossing the finish line. What do you notice about the tyres?

   a. ______________________________

   b. The second picture also shows a bicycle. What do you notice about the tyres on this bicycle?

   ____

   c. If you look carefully, you can see that the second picture is off-road. This is a cross country race, across fields and woods, over grass and through mud. Does this explain why this competitor has chosen different tyres from those competing in the first race? Explain your answer.

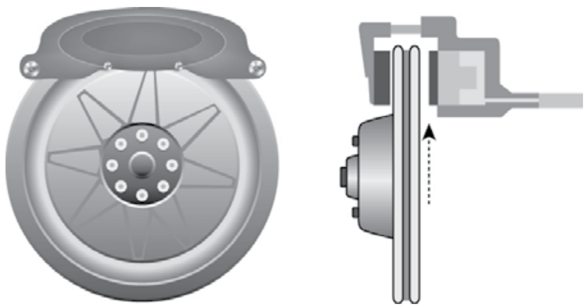
   ____

2. We need friction!

Not only polar bears find it difficult to walk on ice. We all risk falling over on a surface with little friction. Countries with winter frost spend a lot of money trying to keep ice off their roads because cars slip on ice and this results in serious accidents.

When you look closely at the wheels of some cars, you can see a coloured part. These are the car's brakes.

As you know, you want your car to move, but it also needs to slow down. For this, a car has brakes. But how do they work?



The part indicated by the arrow can move to the left so that is is pressed firmly against the circular metal part of the wheel. This happens when the driver of the car pushes down the brake pedal.

a. What happens to the friction on the wheel when the movable part of the brake is pushed hard against the metal part of the wheel?

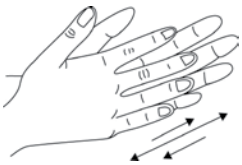
____

https://wonderopolis.org/wonder/how-do-car-brakes-work

b. What would be the result on the speed of the car?

____

c. Put your hands together like in the picture. Rub them for a few seconds with very little force. What do you feel?



____

d. Repeat the action, but this time, press your hands together quite strongly. What do you feel now?

____

e. If you were to put some oil on your hands and repeat the last action, would you feel the same?

____

f. When cars go to a garage for maintenance, the mechanics will ensure parts of the engine are oiled sufficiently. However, they will never oil the brakes. Why not?

____

3. Stop that car!

You may have been in the car when the driver had to make an emergency stop. You were thrown forwards and could have been hurt if you had not been wearing your seatbelt. And the car did not stop immediately, it took a few metres to come to a complete halt.

The time (and distance) it takes for a car to come to a complete stop is made up of two components. Read page 97 and answer the questions below.

a. Which are the two components that contribute to the stopping distance?

stopping distance = ____________________ + ____________________

b. A car is travelling at 50 km/h. How many metres will it cover in 1 second?

____

c. A car is travelling at 100 km/h. How many metres will it cover in 2 seconds?

____

The 'thinking time' or 'reaction time' varies. The minimum time is estimated at 0.7 seconds and the average would be around 1.5 seconds. Distractions (such as a mobile phone, or arguing children in the back seat, or just being tired) and also the use of alcohol or drugs, could increase this time a lot. Most drivers think their 'thinking distance' is a lot less than it really is.

d. How much distance would a car going at 50 km/h, cover during the average 'thinking time' of the driver?

____

How much is the 'thinking distance'? Put a chair in a sufficiently large space (maybe the lab or maybe a corridor). Put someone in this 'driver's seat' and measure out 21 m in front of the 'driver'. Ask another student to stand in this spot and for students to consider that this is the average distance the car covers even before the driver hits the brakes.

e. The braking distance (once the driver has applied the brakes) depends on a lot of factors. Can you name some of them?

____

Chapter 8 Food and digestion

UNIT FLOW CHART

Need of food
↓
Types of food
↓
Food tests
↓
Human digestive system
↓
Enzymes and its affects

INTRODUCTION

The food we eat contain different types of nutrients. The body needs these in the right quantities in order to stay fit. Deficiency as well as excess of nutrients can lead to problems. It is therefore important to eat a balanced diet.

Achieving the correct balance is not always easy. Many of us just leave it to chance and eat what we like. However, we often eat far too much fat, sugar, and salt. In addition, we often do not eat enough fibre. Fats and sugars are energy foods. If we do not use up the available energy, the body stores the excess food as fat and one becomes overweight.

Most people get more than enough proteins, vitamins, and minerals in their normal diet. The body cannot store proteins, so eating more will not make you stronger or healthier than you already are. Strength and fitness will only come by carefully balancing healthy eating with exercise.

Fibre or roughage is made up of the cell walls of plants which pass through the digestive system without being digested or absorbed. It adds bulk to the food, giving the muscles in the walls of the digestive system something to push on. Food containing a lot of fibre helps prevent constipation and other disorders of the digestive tract. We should eat around 30g of fibre each day.

Food additives should be listed and their function clearly explained on food packaging.

Lesson 8-1

Pages 102-104

OBJECTIVES

- To extend knowledge about food and nutrition

LEARNING OUTCOMES

The students should be able to:

- name the components of a balanced diet.
- give examples of foods in which these components are found.
- describe the roles of the main nutrients in the body.

START (15 min)

Give students four post-it notes or coloured paper sheets of two different colours (e.g 2 yellow and 2 green). Ask them to write one favourite food on each of the yellow pages and one of the foods they don't like much on each of the green notes.

Display the notes on a sheet of poster paper.

Ask students to sort these foods into 'healthy' on one side and 'unhealthy' on the other. Label the sides.

Put the poster on the wall for future reference.

MAIN (15 min)

Read page 103 of Student Book with students and help them to answer the questions on worksheet 8-1. They will need to read page 104 for information on the food tests.

Information on food rich in any one (or more) of the listed nutrients can be found on the internet and/or by studying food labels.

PLENARY (15 min)

Using the information from this lesson, go back to the poster and consider whether any of the foods should be moved.

HOMEWORK

Answer Test yourself questions on page 104 of Student Book.

Lesson 8-2

Pages 102-104

OBJECTIVES

- To extend knowledge about food and nutrition

LEARNING OUTCOMES

The students should be able to:

- name the components of a balanced diet.
- give examples of foods in which these components are found.

START (15 min)

Remind students of what they learned in the last lesson about the elements of a balanced diet and the different food groups. Ask them to write down what they had for breakfast and discuss how far this is a balanced meal. Not all meals need to be completely balanced, but over a day all components of a balanced diet should be met in reasonable proportions.

MAIN (15 min)

Ask students to create a menu for three days, including all meals and snacks. They can start by putting in all the food they like, but then they should ensure that the food eaten in a day is balanced. It is possible that their initial menu is lacking, for example, fruit and/or vegetables. These can be added, but it should be considered that pizza with a side dish of vegetables may not be realistic.

PLENARY (15 min)

Ask students to share their solutions. For example, a student may need to add fruit to create balance but s/he does not like fruit. A smoothie, possibly with low fat yoghurt, may solve this issue. Students can finish the menu at home using these ideas from classmates.

HOMEWORK

Complete the menu.

Bring in 2-5 empty food containers or wrappers which contain a food label. These will be used in next lesson.

Workbook pages 47-48, Question 4

Lesson 8-3

Page 104

OBJECTIVES

- To extend knowledge about food and nutrition

LEARNING OUTCOMES

The students should be able to:

- describe simple tests for starch, glucose, protein, and fat that can be carried out in the laboratory.

START (15 min)

Go over the menus which students developed. Let students discuss their menus in groups of four where the focus is on the reasons for choosing specific dishes ('I needed something with protein like fish.').

MAIN (15 min)

Ask each group to develop their three-day menu and from there create a menu for the entire class. It could be published in a school newspaper, posted on a notice board, and/or given to the cafeteria to see if they can provide some of these dishes.

Bring in some food for students to test for glucose, starch, protein, and fat. Use information from page 104 of the Student Book.

If a demonstration is not possible, search the internet for a video. Try searching using terms such as 'food test starch glucose fat protein', and choosing the option 'video'. Always preview the videos to ensure they are suitable and provide the information you want (enough but not too much).

PLENARY (15 min)

Ask students to consider if everyone needs the same amount and the same type of food. If they compared the balanced diet of an elderly person with limited physical activity with that of a young student who plays basketball, what would the differences be? (The elderly person would need less food; the student would need a lot of energy from carbohydrates and protein for building muscles.) A person recovering from a serious illness might need more vitamins and minerals.

So we all need the same nutrients but not in the same amounts. It will depend on our age and activity level as well as our health.

Now go back to the poster with 'healthy' and 'unhealthy' foods. Suppose you made this poster for the elderly person, would it look the same as the poster for the student or the recovering patient?

So are there really 'healthy' and 'unhealthy' foods? Most people consider oranges healthy, but would a diet of only oranges be healthy?

Overall conclusion: we need to eat a range of foods for a balanced diet, which is different for different people. Variation and moderation are key concepts in every diet.

Lesson 8-4

Page 105

OBJECTIVES

- To extend knowledge about food and nutrition

LEARNING OUTCOMES

The students should be able to:

- describe the human digestive system.
- describe how large molecules are broken down during digestion.

START (15 min)

Ask students to consider the entire process of digestion. Each student should think about their favourite food—in silence. Ask students to think of the name of the food. Ask them to visualize what it looks like, what it smells like, how often they eat it, and what the best thing about this food is. Encourage them to really think about this food—maybe with closed eyes.

Watch them closely and hopefully you will see some of them swallowing—thinking of this food made their mouths water.

Now engage in a group discussion. What does it mean when thinking of certain food 'makes your mouth water'. What does saliva do? Brainstorm but leave it open.

You can give them a piece of white bread to chew for a few minutes. Ask them what it tastes like after they have chewed it for a while. Someone will say it tastes sweet. Ask if it tasted sweet when they started chewing. If they say no, you can then draw their attention to the fact that something changed to make the bread taste sweet.

MAIN (15 min)

Before the lesson

Watch the video available at:

https://www.stem.org.uk/resources/elibrary/resource/35396/digestive-system-experiment

In class

Do the demonstration which you saw on the video. For once this is **not** recommended as a student activity as it may become a discipline problem.

Do **not** provide all the comments they do on the video; for example, do **not** say, that the plastic bag represents the stomach. Instead, explain that you will carry out a process which models the entire process of digestion. Ask them to write down the steps.

Ask students to read page 105 and use the information to discuss which part of the demonstration mimics which part of the digestive system. Pay special attention to the reasons that the objects/processes were chosen to mimic certain parts of the digestive system.

PLENARY (15 min)

Discuss where the model shown in the video of digestion is a good representation of digestion and where it is lacking. For example, the wall of the stomach absorbs some small molecules but the plastic bag does not.

Ask students if it matters that the model is not perfect. (Not really, it can even be helpful to consider the aspects in which the model does NOT resemble the original.) Make sure this point is understood.

HOMEWORK

Read pages 105 and 106 and do the Test yourself questions on page 105 of Student Book.

Lesson 8-5

Pages 106-108

OBJECTIVES

- To extend knowledge about food and nutrition
- To use the particle model to explain digestion

LEARNING OUTCOMES

The students should be able to:

- describe the human digestive system.
- describe how large molecules are broken down during digestion.

START (15 min)

Review the parts of the digestive system and go over homework questions.

MAIN (15 min)

Read pages 105 to 108 and complete the table in the worksheet 8-5.

PLENARY (15 min)

Our digestive system (and that of most animals, even insects) has different sections. Can you think of how this would be helpful?

(It allows different enzymes to work in different conditions, which helps to complete digestion.)

Lesson 8-6

Page 109

OBJECTIVES

- To extend knowledge about food and nutrition

LEARNING OUTCOMES

The students should be able to:

- explain how temperature and pH can affect the way enzymes work.

START (15 min)

Conduct following demonstration:

Demonstration

You will need to have ready:

- an apple (or ¾ of an apple)
- a cup of boiling water
- lemon juice
- a fork

Take a fresh, intact apple and cut it into four quarters. Immediately carry out the next steps.

Three of these quarters will receive different treatments.

1. Put one quarter on a saucer on the desk.
2. Put one quarter on the fork and dip it in boiling water for 30 seconds. Put it on its own saucer on the desk.
3. Put one quarter on a saucer and pour lemon juice over it. Pour off the juice and put the saucer on the desk

Leave the pieces of apple for 20–30 minutes.

MAIN (15 min)

Go through worksheet 8-6 with students. You can bring in a raw egg and a boiled egg if you wish, so they can see the real objects.

It would be great if you could bring some raw fish and some fish marinated in lemon juice overnight. We often associate raw fish with a somewhat translucent appearance and cooked fish with a white colour. Raw fish, especially when sliced thinly and marinated in lemon juice, also goes white because the proteins have been denatured like they are during cooking.

The enzymes in apple will turn the apple brown as soon as they come into contact with oxygen. The enzymes can be denatured by exposing them to a high temperature or to acid. When the enzymes no longer work, the apple does not turn brown.

PLENARY (15 min)

Dishes should be washed in very hot water to denature the proteins of the bacteria on the plates and forks, which kills the bacteria. Some household cleaning products contain lemon juice. This smells nice but also helps kill bacteria.

Milk is often pasteurised. This means it is brought to 70°C to kill most of the bacteria. Boiling milk would be even safer, but this changes the taste in a way that many people do not like.

HOMEWORK

Read pages 111 and 112 and do the Test yourself questions on page 113 of Student Book.

Lesson 8-7

Pages 107-108

OBJECTIVES

- To extend knowledge about food and nutrition

LEARNING OUTCOMES

The students should be able to:

- explain how digested food is absorbed into the body.

START (15 min)

Discuss why we need to eat. (Food is needed for energy, growth, and repair.) Refer back to the table in worksheet 8-1 if needed.

Ask for which parts of the body food is needed. (For energy: muscles, e.g., legs, arms, etc. For growth: anywhere, but obvious areas would be bones and muscles. For repair: anywhere)

Now connect the two points made above. When we eat food, it enters our bodies (mouth) and passes through the digestive tract. How do these nutrients get from our gut to where they are needed?

MAIN (15 min)

Hand out worksheet 8-7 and help students complete the task.

PLENARY (15 min)

Ask students what they remember most about this section and the reasons for this. This can help you shape your next lessons so it will be easier for students to learn.

1. **A balanced diet**

You know that eating only one or two kinds of food is not healthy and that you need a balanced diet. When you talk about 'a diet', most likely you mean a selection of foods or a programme, often aimed at losing weight or related to a food intolerance (e.g., a gluten free diet). In science, 'diet' simply means everything you actually eat—good or bad.

So, to eat a balanced diet means to obtain all the necessary nutrients from a range of different foods in the right balance; i.e., a diet with all the food types. But what does a balanced diet contain?

Read page 103 to find the components of a balanced diet and complete the questions below.

i. What are the elements of a balanced diet?

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

ii. Which one of the above is not easily digested?

____

iii. What do we also need quite a lot of, although it has no nutritional value?

____

iv. Why do we need it?

____

2. The table below has all the information about a balanced diet but it is not complete. Use pages 103 and 104 to complete the table. You may have to use the internet to check which foods are particularly rich in a certain nutrient.

nutrient *which kind*	**mainly used for**	**food rich in**	**test**
carbohydrates			
glucose	for energy (immediate)		
		rice, wheat (bread, pasta), corn, potatoes, beans	
	for energy for insulation		ethanol test
	for building muscles for enzymes	beans, meat, cheese	
minerals			
calcium			
iron			
vitamins			
vitamin C	for growth and repair		
vitamin D	to absorb calcium		
roughage/fibre		whole wheat products, bran, lentils, broccoli	
water	(important but has no nutritional value)		

1. Using the information from previous lessons, create a menu for three days where every day has all the food types more than once. Please make sure your menu is both healthy and tasty and all meals are different. Since we all like different foods, your menu should not be the same as those of the others in your class.

   Please make notes of the reasons you chose your foods, so you can explain it in class.

Day 1				
Breakfast	Snack	Lunch	Snack	Dinner
Day 2				
Breakfast	Snack	Lunch	Snack	Dinner
Day 3				
Breakfast	Snack	Lunch	Snack	Dinner

Worksheet 8-3

1. **Food labels**

Page 104 in your Student Book explains how to test foods for the different food types. This will help you determine if, for example, orange juice contains proteins or bread contains glucose, but you need a lab and the right chemicals.

Most of us buy our foods in the supermarket and some of it is likely to be processed. We may bake our own biscuits but buy breakfast cereal. In many countries, packaged foods must show what the food contains. This information is often shown on food labels and/or on the list of ingredients, but does not always look the same since the food may come from different countries.

Many countries have food labels which look like the one below.

The amount listed is for one 1-cup serving. If you eat two servings the amounts doubles.

This package has two t-cup servings

Nutrition Facts Serving Size 1 cup (228g) Servings Per Container: 2	
Amount of Serving	
Calories 260	Calories from Fat 120
	% Daily Value*
Total Fat 13g	
Saturated Fat 5g	20%
Trans Fat 2g	25%
Cholestrol 30 mg	
Sodium 660 mg	28%
Total Carbohydrate 31g	10%
Dietary Fiber 0g	0%
Sugars 5g	
Proteins 5g	10%
Vitamin A 4%	Vitamin C 2%
Calcium 15%	Iron 4%
*Percentage Daily Values are based on a 2000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.	

One serving has 660 milligrams of sodium

One serving has 28% Daily value of Sodium.
- 5% or less is low
- 20% or more is high

For this food label, 28% Daily value is high for sodium

http://www.delawarekidney.com/How-to-Read-a-Food-Label/

Use the information on the food label to answer the following questions.

a. If you were to eat the entire container of this product, how many servings would you have had?

____

b. How much sugar does one serving contain?

____

c. Suppose, one day, you only ate this product (and nothing else). How many containers would you have to eat to get enough carbohydrates?

____

d. What percentage of the daily required amount of sodium (a mineral) would you have had?

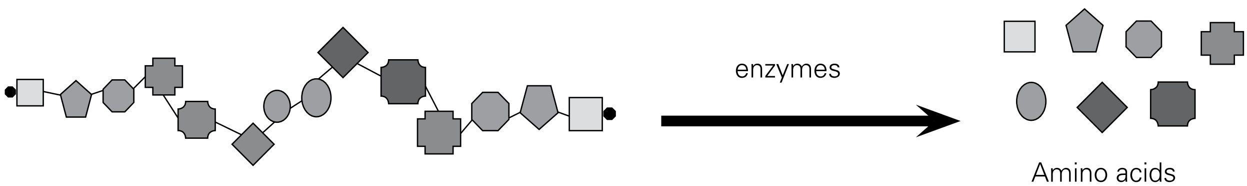
____

e. Would you consider eating only this food to be a balanced diet? Explain your answer.

____

1. **Digestive enzymes**

All matter is made of particles. So our food is also made of particles and they are often relatively big. Digestion is the process where large food particles are broken down into smaller particles which can be absorbed into your blood. An example would be protein.



Amino acids

A protein - a long chain of amino acids.

Enzymes help to break down the larger protein particles into smaller amino acid particles. Different enzymes break down starch particles into smaller maltose particles. Of course, enzymes themselves are also particles.

Enzymes are specific. An enzyme for protein cannot break down starch.

Enzymes turn substrates into products. We often write it this way: substrate $\xrightarrow{\text{enzyme}}$ product

Read pages 106 – 108 of the Student Book and complete the table below.

parts of the digestive system	**digestive juice produced**	**substrate**	**enzyme**	**product**
	saliva	starch	amylase →	
	no digestion; moves food through peristalsis			
			protease →	amino acids
		produced by liver; stored in gall bladder emulsifies fats		
	__________ juice and __________ juice		amylase →	
		protein	→	
			lipase →	
		carbohydrates	carbohydrase →	
	stores good bacteria			
	absorption of water storage and egestion of faeces			

Denaturing enzymes

1. Answer the questions below.
   a. Consider a raw egg and a boiled egg. What are the differences?

   ____

   ____

   b. If you cool down the boiled egg, does it go back to being a raw egg? Explain your answer.

   ____

   ____

   c. Eggs are rich in one nutrient or food type. Which one is it?

   ____

   ____

2. Your teacher has done a demonstration, putting parts of an apple under different conditions. Please observe what happens to the different parts and record your observations below.

   Apple parts in different conditions:

part	conditions	after 25 min
1	on table	
2	dipped in boiling water and then on the table	
3	covered in lemon juice and then on the table	

Enzymes in the apple will make the apple turn brown as soon as it is in contact with oxygen.

Enzymes are proteins.

a. What happened to the protein in the raw egg when it was exposed to high temperatures?

____

b. What happened to the protein in the fish when it was exposed to acidic conditions?

____

c. What happened to the enzymes in the apple when exposed to high temperature?

____

d. What happened to the enzymes in the apple when covered in acidic lemon juice?

____

Conclusion

e. Enzymes are ______________ and they are changed by ______________ and ______________ so that they no longer work.

Chapter 9 Elements, compounds, and mixtures

UNIT FLOW CHART

What are elements and atoms?

↓

metals and non-metals

↓

uses of elements

↓

structure of atom

↓

molecules

↓

compounds and mixtures

↓

a mixture called air

INTRODUCTION

This section looks at the building blocks of matter. As teachers, we know a fair bit about the world around us, but we should not hesitate to share our wonder about some of it with our students. We know (or can look up) the size of an electron but can still be amazed by it. We know that all matter is made from protons, neutrons, and electrons, but the diversity achieved from only three building blocks can still astonish us.

Please make sure by the end of the chapter that students understand the building blocks of an atom. Atoms are the particles of an element. Alternatively, they can be combined into molecules which can build a compound. Atoms and/or molecules can be put together to make a mixture. The variation possible from all of this is really endless. If you or your students do an internet search on 'new compounds made' you may find articles referring to a compound that could give you a 'sun tan, a new lining for pans in the kitchen, or an exceptionally hard compound containing carbon and/or something completely different. Some 'new' compounds are discovered, some are created in the lab for a specific purpose, and some are created and then found to have unexpected, sometimes useful, properties.

The processes involved in creating compounds and mixtures are different, and students should understand this. Once again, trying to connect to everyday life examples and comparisons with food preparation seem appropriate here.

Lesson 9-1

Pages 118-123

OBJECTIVES

- To explain the structure of the atom

LEARNING OUTCOMES

The students should be able to:

- describe the structure of an atom.

START (15 min)

Revise the key information about particles in Chapter 6 and ask students to complete the first section of worksheet 9-1.

MAIN (25 min)

Read pages 118-123 of Student Book.

Hand out worksheet 9-1 and support students while they work through it. This task is best done individually.

PLENARY (5 min)

Ask students what is in between the electrons in an atom. It is likely that someone will suggest air, but this is not correct since air is also made of atoms. The answer is nothing, which is a concept that some students struggle with. Introducing it at this time will allow them to understand it gradually.

HOMEWORK

Test yourself questions on page 124 of Student Book.

Or Workbook page 56.

Lesson 9-2

Pages 118-123

OBJECTIVES

- to distinguish between elements, mixtures, and compounds

LEARNING OUTCOMES

The students should be able to:

- define the term element.
- recognize chemical symbols.

START (15 min)

Go over the homework from last lesson to check for understanding.

Ensure the following points are clear to all students:

- All matter is made of particles.
- The state of a substance (solid, liquid, or gas) is decided by the speed of the particles, the type of movement of the particles, and the distance between the particles. The particles themselves remain the same.
- Substances made of only one chemical which cannot be broken down by chemical means are elements.
- The smallest particle in an element is an atom.
- Atoms have a nucleus (with protons and neutrons) surrounded by an electron cloud.
- Atoms of different elements have different numbers of protons, neutrons, and electrons.
- The number of protons in an atom is the same as the number of electrons.
- Neutrons have no charge and keep the nucleus together.
- charge and mass of protons, neutrons, electrons

MAIN (20 min)

Hand out worksheet 9-2 and support students working through the questions. This may be suitable for group work.

PLENARY (10 min)

It seems unlikely, but the basic components of all matter are very few: protons, electrons, and neutrons. The number of protons in an atom is the same as the number of electrons and decides the properties of the chemical. It may help to draw a comparison with Lego blocks. Ask students to imagine what they could build if they had an unlimited supply of only three different types of Lego blocks.

Lesson 9-3

Page 124

OBJECTIVES

- To distinguish between elements, mixtures, and compounds

- To show that a huge range of materials can be made from a relatively small number of elements

LEARNING OUTCOMES

The students should be able to:

- explain the difference between an element, a mixture, and a compound.
- explain the difference between a physical and a chemical change.
- explain that compounds have different properties from the chemicals from which they are made.

START (10 min)

Last lesson, you explained the structure of the atom. Revise this briefly and go on to discuss what can be made from these atoms.

MAIN (20 min)

Hand out worksheet 9-3 and support students working through the questions. This may be suitable for group work.

PLENARY (15 min)

It is important that we, as teachers, make it obvious to our students that what they learn at school is linked to their lives at home. Even when we think we have shown how the work in class links to everyday life, not all students may have really understood this. Showing that science is part of 'real life' and not just some abstract information to be memorized for a test, will make students more interested and will make it easier for them to remember the information. They will also talk about it at home, which will make the parents more supportive of the school, which also has a positive influence on the students' academic success.

One of the ways of linking students' science learning to real life can be by using models. Cooking is an area which relates closely to science, as we saw when discussing the denaturation of proteins, and most students have some awareness of what is involved in preparing food. So this link with reality should be made explicit whenever possible.

Mixing flour, butter, milk, and eggs to make batter is a physical change (although one which would, in reality, be hard to undo), but baking the batter to make a cake is a chemical change. For those of you who love French and Italian dishes, tomatoes, onions, garlic, and paprika (bell peppers or capsicum) can be chopped and mixed into a salad (physical change) or cooked and pureed (blended) into a sauce for pasta (chemical change).

Ask students to consider their usual meals and favourite dishes to identify what the 'elements' would be, and if other dishes or meals can be made with them. Where are the physical or chemical changes involved?

Lesson 9-4

OBJECTIVES

- To distinguish between elements, mixtures, and compounds

LEARNING OUTCOMES

The students should be able to:

- identify metals and non-metals.
- name the main gases in the air and give approximate proportions of each of them.

START (15 min)

In previous sections and chapters, we often talk about matter. Is air matter? How do you decide if something is matter? i.e. What is the criteria for matter? Avoid commenting on students' ideas, but keep a record of them since you may want to refer back to them later.

Read the first part of worksheet 9-4 and ask students to write down individually what they know about air. After a few minutes they can discuss their answers in small groups and add to what they wrote down. You may decide to open it up to a plenary session and collect the answers.

MAIN (20 min)

In the discussion on whether air is matter, students may have said something like, 'Matter has mass.' In our everyday perception, air does not have mass but our common sense ideas are not always scientifically correct.

In order to check if air is matter, take an empty basketball. Weigh it, record the mass, and pump up the basketball before weighing it again. Most air-filled basketballs are about 1% heavier than empty ones, so use an accurate balance on a stable horizontal surface and take your measurements with care.

If you can get a canister of compressed air, you could weigh it, empty it, and weigh it again. This should produce a good result, but not everyone may be able to get a canister of compressed air. Compressed carbon dioxide (in a fire extinguisher), or compressed oxygen (medical use) would strictly speaking not be air and not give the correct information. Although a filled balloon will be heavier than an empty one, the difference is likely to be too small to measure in your lab.

A demo that adds a bit of fun but can start a discussion would be the following:

Preparation before class: mix 2 tablespoons of baking soda with 2 table spoons of vinegar in a glass bottle. This will produce (invisible) carbon dioxide gas which is heavier than air. Cover the bottle with your hand to keep the carbon dioxide in. When the reaction is complete, 'pour' the CO_2 gas into an empty jar or bottle and close it. Prepare an identical jar/bottle containing only air.

Light two small candles and place each inside a transparent glass. Pour the air from the bottle over one flame and see that it makes no difference. Repeat with the bottle filled with CO_2 and watch the flame go out.

Please try this out beforehand to ensure it goes smoothly. Reference can be made to the website https://www.thoughtco.com/candle-science-magic-trick-607494 .

Videos can be searched using the terms 'pour carbon dioxide candle flame'.

Discuss with students that both bottles seemed empty but had a different effect on the flame. You could even put a candle under a glass and watch it go out (due to lack of oxygen).

They can speculate on what was in each bottle and what caused the flame to go out. It can lead to the concept that air is a mixture of gases and if the composition changes (such as replacing most of it with CO_2) 'normal' things, like lighting a candle, are suddenly not possible. It shows again how much we take this vital mixture of gases for granted.

If you wish, you can discuss how (and why) even a relatively small amount of carbon monoxide (from incomplete combustion, e.g.,in a fire) can endanger human life.

Support students completing the worksheet 9-4.

PLENARY (10 min)

Go back to the question about whether air is matter and see if this lesson answered it. (Yes, it is matter; it is a mixture of gases). Ask students to check if what they wrote down about air at the start of the lesson is correct—they should work in pairs.

HOMEWORK

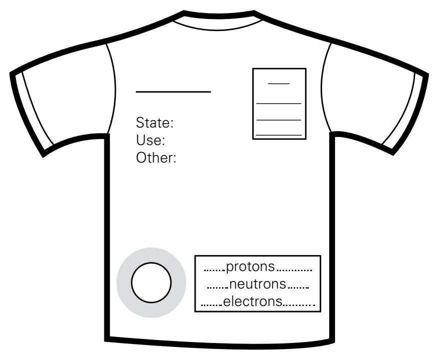
Test yourself questions on page 127 of Student Book,

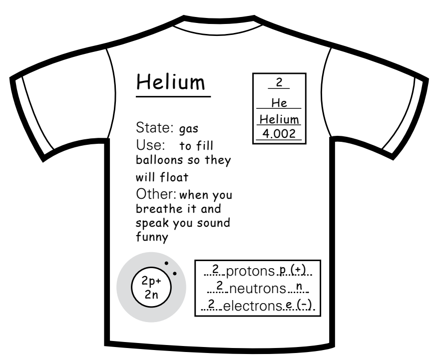
Workbook page 55, Question no. 4

Recommended activity. This will take at least one lesson.

Either ask students to bring in a white T-shirt or cut out T-shirt shaped chart papers as shown in diagram. Each student should research one element (from the first 20) and put the information on the shirt. You will need to agree the format with the students so there is some uniformity between the shirts. If resources are available, shirts can be pre-printed so they will look somewhat similar.

Please use your imagination (and get students' input) to come up with your school's unique design. If desired, dress shirts, aprons, waist coats, lab coats, etc could be used instead. The back could also be used for more information.





Revision

In section 6, you learned that all matter is made of particles.

1. Look at the statements about gases, liquids, and solids below. Put a tick (✓) where statement is applicable or a cross (×) in the empty sections.

	gas	liquid	solid
keeps it shape			
takes shape of the container			
cannot be compressed			
volume becomes smaller under pressure			
particles move close together			
particles move far apart			
particles vibrate but remain in position			
particles move around a bit			
particles move around freely			

All matter is made of particles. Some substances are made of only one type of particle which only contains one kind of chemical. These are called elements and their particles are atoms.

Read pages 118 -120 and answer the questions on page 119.

The periodic table is a way of organizing the elements. First, they are put into a line, based on increasing atomic mass. Then, this line is cut into sections, called periods, and placed under each other so that elements with similar properties are in vertical groups.

The chemical symbol is based on the (Latin) name of the element which may or may not be similar to what we call the element today.

2. Use the periodic table to find the name of the following elements.

H	
O	
Na	
K	
Ca	

Consider the elements magnesium (number 12) and manganese (number 25). A logical symbol would be Ma, but both elements could have this symbol. So they had to come up with two different symbols.

3. Find them in the periodic table and write them below.

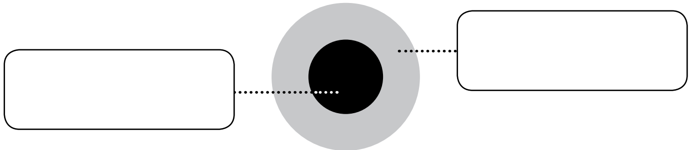
	magnesium
	manganese

Read page 123 and answer the questions on page 124.

An atom is the smallest part of an element. It cannot be seen, even with a very good microscope. Atoms of different elements are not the same. Scientists discovered that atoms are made of even smaller particles.

Use the information from page 123 to help you answer the questions.

4. This is a simple diagram of an atom. Label the two areas.



The number of protons in the nucleus of an atom is also called the atomic number and usually written above the symbol of the element in the period table.

5. What is the name and the number of protons in an atom of each of the elements below?

symbol	name	number of protons
Li		
B		
N		
Ne		
Mg		

6. How many electrons does an atom of the following elements have?

symbol	name	number of electrons
Li		
C		
O		
F		
Na		

1. Answer the questions below.

   a. What particles are found in the nucleus of an atom? ____________________

   b. What is the name of the positively charged sub-atomic particle? ____________________

   c. Where in the atom are electrons found? ____________________

   d. Particles with the same charge repel each other. Particles with opposite charges attract each other.

      What is the charge of a neutron? ____________________

   e. Could you suggest a reason to have neutrons in the nucleus of an atom?

      ____

2. Use the information above, on page 123, and below to complete the table.

   Atoms are too small to see, even with a microscope. Sub-atomic particles are even smaller—it is difficult to imagine how small they are. Their mass is too small to be conveniently expressed in grams so it can be expressed in 'atomic mass units (a.m.u.)'. Protons and electrons have a mass of around 1 a.m.u., and just under 2000 electrons together would also have a mass of 1 a.m.u.

name of the sub atomic particle	charge of the particle	mass (in a.m.u.)
proton (p)		
(n)		
(e)		

3. The very small electrons whiz around the nucleus in an electron cloud. If their movement was just random, they would collide from time to time and this does not happen. Instead, they spend most of their time circling around the nucleus in their specified area called a 'shell'.

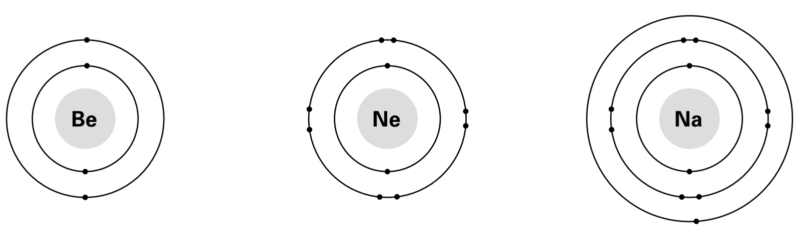
   As you can see on page 123, hydrogen and helium have one and two electrons respectively. The two electrons belonging to helium are in the same shell, relatively close to the nucleus. But have a look at lithium.

   a. How many electrons does lithium have? ____________________

   b. Are they all in the same shell? ____________________

4. It seems that the first shell, closest to the nucleus, has enough room for two electrons to buzz around. But if an atom has more electrons, the others are found in the next shell, a little further away from the nucleus. This second shell can hold eight electrons. Any electrons after that will have to occupy a third shell, again further away from the nucleus.

   Draw the electrons of the elements below according to the periodic table. Use the diagrams of page 123 to help you.



1. Find the definitions of the following terms on pages 119, 123, 124, and 125 and write them below:

   a. element

   ____

   ____

   b. compound

   ____

   ____

   c. mixture

   ____

   ____

   d. atom

   ____

   ____

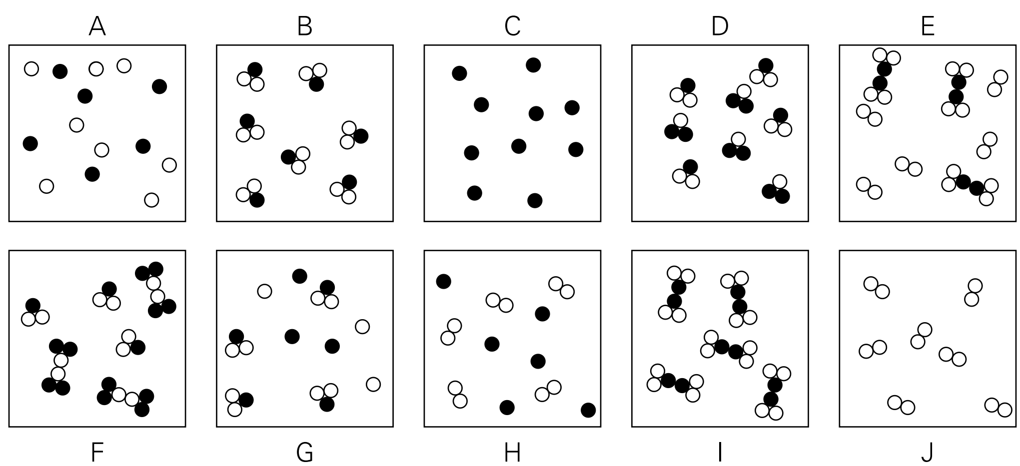
   e. molecule

   ____

   ____

2. Each of the ten squares below represents matter, using the particle model. Answer the questions below. Put a tick or a cross in each empty box in the table below.

	A	B	C	D	E	F	G	H	I	J
Which of the squares contain atoms?										
Which of the squares contain molecules?										
Which of the squares represent an element?										
Which of the squares represent a compound?										
Which of the squares represent a mixture?										



3. Use page 125 to find the definitions of a physical and a chemical change. Write them below.

   a. In a physical change ____

   ____

   b. In a chemical change ____

   ____

   Which of the processes listed below are physical changes and which are chemical changes?

process	physical change	chemical change
boiling water		
boiling an egg		
mixing iron powder and sulphur powder		
heating a mix of iron and sulphur powder		
setting off fireworks		
burning paper		
mixing salt and sand		
dissolving salt in water		
filtering a mixture of salt, sand, and water		
peeling, cutting, and mixing different fruits into a fruit salad		
mixing hydrogen gas and oxygen gas		
igniting a mixture of hydrogen gas and oxygen gas		

Metals and non-metals

1. A few lessons ago, you learned about the periodic table. Use this information to answer the questions below.

   a. How are the elements in the periodic table initially arranged?

   ____

   b. How are elements with similar properties placed in the period table?

   ____

   c. Each element has a chemical symbol. What do you know about the chemical symbol?

   ____

   One of the first ways of organizing the elements was to divide them into metals and non-metals. This is still important today and can often be seen in the periodic table. If you look carefully, you can see a zig-zag line dividing all elements into two groups: metals and non-metals. One group is the 21 elements on the top-right, the other group is everything else.

   Read page 121 of your Student Book and take a good look at the two groups of elements. Read their names and consider what you may know about some of these metals.

   Which group are the metals and which the non-metals?

   d. The 21 elements found at the top-right of the periodic table are ____________________

   e. All the other elements are ____________________

2. Air: it is really there!

Someone gives you a small box. You open it and look inside but cannot see anything. You friend asks: 'What is in it?' You may answer: 'Nothing.' Your answer shows how much we take air for granted. Although we know we cannot survive without air for longer than a few minutes, and the news tells us about the damage air pollution causes, we still seem to ignore the presence of air most of the time.

   a. So let us take a look at this vital but often forgotten matter. Write down what you already know about air.

   ____

   ____

   Read page 126 of your Student Book and answer the question below.

   b. When you are somewhere in the mountains or a forest, you may enjoy the 'pure air'. From a scientific perspective, is this correct? Can air be a pure substance? Explain your answer.

   ____

   ____

Chapter 10 The solar system

UNIT FLOW CHART

How did the universe begin?

↓

What is the solar system?

↓

Days, month and years

↓

The seasons

↓

The Moon and eclipses

↓

Information from space

INTRODUCTION

The universe contains everything that exists. We do not know how big the universe is. A galaxy is a star system. Our Earth is part of a galaxy called the Milky Way. There are thousands and thousands of stars in the Milky Way. These stars give a milky appearance to the sky, hence the name.

Galaxies are very far apart. The nearest galaxy to the Milky Way is called *Andromeda*. *Andromeda* is two million light years away. This means that the light we see from Andromeda has taken two million years to reach us. We are seeing it as it was two million years ago. Astronomers believe that there are many more galaxies further out in space that cannot be seen.

There are several theories regarding the origin and formation of the universe.

The big bang theory: This theory suggests that the universe began 10,000 million years ago with an enormous explosion.

The pulsating universe theory: Scientists assume the universe to be continually contracting and expanding. When the universe has expanded to a certain size it will begin to shrink. The galaxies will be pushed closer and closer together. Eventually they will explode causing the universe to expand again.

The expanding universe theory: Scientists suggest that the universe will never collapse but keep on expanding. This theory implies that there has only ever been one big bang.

Lesson 10-1

Pages 132-135

OBJECTIVES

- To extend knowledge about the planets of our solar system

LEARNING OUTCOMES

Students should be able to:

- name the planets of the solar system and recall some information about them.

This sections starts with some calculations for two reasons. First, it is important that students have some idea of the size of Earth relative to our solar system. For this reason, they may hypothetically create a model of the solar system which is the size of the classroom. After doing the calculations, they will find that they cannot build this model to scale since Earth would be too small. The second reason is that students should see the use of working with numbers beyond what happens in mathematics. Many students struggle with numbers, but even those who can do the sums in mathematics do not always see how their skills can be applied in other situations. Please make sure you understand fully how the calculations work so you can help your students.

The questions at the end of the worksheet 10-1 refer to the information on pages 134 and 135. Another way of getting students to interact with this material would be for students to create a bingo game. Groups of four students prepare, e.g., 25 questions where the answers could be the name of a planet and/or facts about the solar system. It is important that answers are very brief. The group then prepares bingo cards with 15 correct answers. Each card should have correct answers to different questions. The game is played by the group reading out the questions in a random order. The other students in the class have each received a bingo card. When a question is asked by the group, the other students will individually and in silence think of the answer and if they find it on their card, cross it off. When a student has crossed off all answers on his/her card, he/she calls out 'Bingo' and a group member will check if they have crossed off the correct answers.

For example: a question could be 'Which planet is closest to the Sun?' Student 1 will know the answer is Mercury and will cross it off his/her card. Student 2 also knows the answer but his/her card does not have 'Mercury' as an answer so s/he cannot cross off anything. Student 3 thinks the answer is Venus and crosses this off his/her card. The next random question is then read out. If student 3 is the first to cross off all his/her answers, s/he will call out Bingo and a team member will check and see that s/he crossed off an incorrect answer. She/he will be disqualified and the game continues to the next question. So winning the game depends on knowing the correct answers, but also on luck as you may not have each answer on your card.

START (10 min)

Discuss what students know about the solar system. Often one or a few students will have been interested in this topic when younger and may remember some information. Invite (some of) these students to take turns to share their knowledge with the class and encourage the class to question these 'expert students'. Your role is only to monitor that the information provided is correct; try to avoid giving any answers.

MAIN (25 min)

Steer the discussion towards the size of the solar system and the relative sizes of the planets and the distances between them. Then ask students to use the exercise where they calculate whether they can make a scale model of the universe in the classroom.

PLENARY (10 min)

Ensure students have understood the purpose of the exercise: that Earth is very small in the solar system. If you wish, you can take the discussion to the level of the Milky Way, the galaxy of our solar system, and eventually the size of the universe, but do not be surprised if this becomes meaningless—most adults find it hard to really understand.

HOMEWORK

Workbook Question 4, page 59 and Question 5, page 60.

Lesson 10-2

Pages 139-140

OBJECTIVES

- To extend knowledge of the Sun and Moon by introducing eclipses

LEARNING OUTCOMES

Students should be able to:

- explain the difference between luminous and non-luminous objects.
- describe how lunar and solar eclipses are produced.

START (10 min)

Introduce the idea of luminous and non-luminous objects. Students can name examples of either.

MAIN (25 min)

Copy the definition of luminous and non-luminous objects and classify a number of them. This should be a brief exercise.

The concept of solar and lunar eclipses often takes a bit of time and more than one approach to fully grasp. During this lesson, it would be useful to read the relevant sections in the Student book and discuss what is written to check your students' understanding.

It might be useful to have students model the movements of the Sun, Earth, and Moon to facilitate their understanding. If you wish, you can do this in a dark room with the student playing the role of the Sun shining a torch towards Earth and/or the Moon to show what happens during an eclipse. If you do this, you may wish to give students their roles and challenge them to show the arrangement for a solar or lunar eclipse and let them use their Student book to work out how to place themselves. Others could then say if this is correct—of course, under your supervision.

PLENARY (10 min)

Ask students to investigate how common solar and lunar eclipses are in their part of the world and when the next one might be visible.

Lesson 10-3

Pages 136-138

OBJECTIVES

- To extend knowledge of the Sun and Moon by introducing seasons

LEARNING OUTCOMES

Students should be able to:

- explain what causes days, months, and years.
- explain what causes the seasons on Earth.
- describe and explain the phases of the Moon.

START (10 min)

Have a discussion on whether it is important to measure time. If so, what would be more difficult if we did not measure time? Examples could be manufacturers producing winter and summer clothing. They want to know when they need either, how long the winter or summer will be, etc. Farmers need to know when the best time is to plant crops. Home owners want to repair their roof during the dry season, so it helps to know when to expect it.

MAIN (30 min)

Day and year

Modelling can help students visualize the relative movement of the Sun, the Earth, and the Moon. In order to model a 'day' and a 'year', one student can hold a large ball which would be the Sun and another can have a smaller ball which would be the Earth. The student could stand still and rotate the Earth around a vertical axis. One rotation would be a day. If the student holding 'Earth' walks around the 'Sun', this would be a year. Combining these two (rotate 'Earth' while walking around the 'Sun') would model what happens in reality. No need to rotate 'Earth' 365 times while walking around the 'Sun'—it is the idea that counts.

Seasons

Explaining the seasons is the next step. In the previous model, the student presumably rotated 'Earth' around a vertical axis. If this were the case, the climate of different places on Earth would be constant: constantly high temperatures in the tropics and a climate which gradually becomes colder as you go further from the Equator and nearer to one of the Poles.

Instead, we experience seasons. Although the yearly average temperature follows the pattern described above, there are times of the year when it is warmer (summer) and when it is colder (winter). This is caused by the fact that the Earth does not rotate around a vertical axis, but is tilted relative to the Sun.

Use the illustration on page 138 and the model above it. Ask the student holding 'Earth' to hold it at an angle and walk around the 'Sun'. The angle should not change; i.e., if the top of the 'Earth' is towards, for example, the door of the classroom, it should remain tilted that way as the student walks around the 'Sun'. This means that at some point, the top of the 'Earth' (the North Pole') is closest to the 'Sun', while half an orbit later, it is furthest from the 'Sun', modelling summer and winter in the northern hemisphere. Once this concept is visualized, it will not be difficult to grasp that if you are nearer to the Sun, it is warmer.

Phases of the Moon

Wrapping your head around the concept of the phases of the Moon is not always easy, but the demonstration described in the sites below is very helpful. As usual, you are urged to do the demonstration rather than just showing the video. If possible, get students to do the activity too, and observe closely. This activity only requires a dark room, a lamp, a (Styrofoam) white ball, and a pencil.

http://www.nsta.org/publications/press/extras/moon.aspx

http://static.nsta.org/extras/nexttime/MoonModeling.pdf

Please note that the person holding the 'Moon' does not rotate it independently. The time for the Moon to complete one rotation is identical to the time it takes to orbit the Earth. This means we always see the same side of the Moon. If you search for videos about 'Why Do We Only See One Side of the Moon?' you should be able to see several clips illustrating this, which will help you understand the concept. This concept is not part of the students' content and you do not need to teach it, but just to ensure that you are prepared for questions which may be raised.

PLENARY (5 min)

Check that students have really understood the phases of the Moon.

There are models of the Sun, Moon, and Earth commercially available which show the phases of the Moon and/or what happens during an eclipse. To make your own model, the website at the end of the section may be helpful.

HOMEWORK

Workbook Question 8, page 65-63

Lesson 10-4

Pages 140-143

OBJECTIVES

- To show how information about our solar system is obtained

LEARNING OUTCOMES

Students should be able to:

- explain how information about the solar system is obtained.

START (10 min)

You could have a general discussion about 'How do we know what we know?' and come to the conclusion that most of our knowledge is shared knowledge, i.e., it comes from what others tell us.

However, someone needs to come up with new ideas from time to time and where do these come from? How did we acquire our knowledge of the solar system? Pages 140–143 of the Student book provide a lot of information on this.

You could discuss with students what they feel is the best way of learning. If someone suggests that direct experience is preferable, you could start a discussion about the feasibility of space travel—going back to the distances involved, as they discovered at the start of the topic. The inhospitable conditions of space travel as well as on the other planets of our solar system add to the difficulties.

MAIN (25 min)

http://scaleofuniverse.com/

This site allows you to zoom from the smallest sub-atomic particle to the entire universe. It requires Flash so will not work with Chrome, but works fine with, Internet Explorer.

This makes you wonder how we know all these things. With regard to our solar system, mankind simply watched the night sky and detected patterns. It took time and some open minds to realize that our direct observation of the Sun rising in the east and setting in the west is not actually caused by movement of the Sun, but by the Earth's rotation.

When people started using telescopes to observe the sky, more details could be seen. It resulted in modifying our understanding of our solar system to make sense of what was observed, and eventually led to the acceptance of the heliocentric model of our solar system. History shows that heliocentrism was suggested in different cultures, but also that each took some time to become accepted.

More modern equipment, including telescopes in space which are not hindered by dust or pollution in the atmosphere, provided more detail, and space probes travelling to planets provided even more information.

PLENARY (10 min)

Obviously, the day/night situation directly affects (nearly) all our actions and the seasons also affect our lives, although maybe less than they did a century ago. But how strong is the influence of the Sun, Moon, and the stars and planets on us?

Some people claim that the day of your birth affects your personality. Western zodiac signs (e.g. Aquarius, Gemini, or Leo) roughly relate to the month of the year, while Chinese signs (e.g. Rat, Dragon, or Goat) roughly relate to the year of your birth. Each will describe certain traits as characteristic of the person born under this sign. If this is suitable to your school, look at the descriptions with your students and consider their value, but be aware that this topic might be sensitive.

Website with additional activities:

http://downloads.bbc.co.uk/tv/stargazinglive/sgl_eventpack_with_links2013.pdf

The last activity is making a model of the Sun, Earth, and Moon to show their relative movements.

HOMEWORK

Test yourself Questions, page 144 of Student Book.

1. As it may be difficult to imagine all the planets circling the Sun, you could build a model of the planets of the solar system to scale in your classroom. Use the information on pages 134 and 135 to do your calculations.

   Suppose your classroom is 20 m long.

   If you put the Sun on one side, Neptune will be on the other side.

   a. What is the real distance between Neptune and the Sun? ______________________

   b. What would this be in metres? ______________________

   c. So if you are going to build a model of the solar system in your classroom, you will put the Sun on one side of the room and Neptune on the other. The scale of your model will be determined by the size of your classroom. Let us assume your classroom is 20 m long. This 20 m will represent the distance between the Sun and Neptune. Other distances and the sizes of the planets need to be calculated to the same scale. In order to work out the scale, you will need to do the calculation below.

distance of Sun-Neptune (in m)		
Length of classroom		=

The number in the grey box is your scale.

So 1 m in the classroom model = ______ m in the solar system, or

______ m in the solar system is 1 m in the classroom.

Now you need to use the number in the grey box to work out how big Earth would be in your model.

   d. What is the real diameter of Earth? ______________________

   e. What would this be in metres? ______________________

   f. Now you need to divide the diameter of the Earth by the scale you calculated in the grey box to get the size of Earth in your classroom model.

diameter of Earth (in m)		
scale		= ______ m

   g. This number in the grey box is in metres. What would be the size of the Earth in your classroom model in mm?

   ____

So it may not be realistic to make a model of the solar system to scale in your classroom, but you now have an idea of the size of the solar system in relation to Earth. Just for comparison, the diameter of a pin (used by tailors) is 0.5–1 mm. Earth in your classroom model would be less than one tenth of the diameter of a pin when the distance of the Sun to Neptune is 20 m.

But what you can do is to model the distances between the Sun and the planets of the solar system inside your classroom. String a rope from one end of the room to the other. If the length of the rope is not 20 m, you will have to redo the previous calculations to find the scale for converting the distances in the solar system to the scale model inside your classroom.

h. Once you have calculated the scale, you need to calculate the relative distance of each planet to the Sun on the scale of your classroom.

$$\frac{\text{distance to the Sun (in metres)}}{\text{scale factor}} = \underline{\hspace{6cm}}$$

Please also include Neptune in your calculations. If the relative distance to the Sun on the scale of your classroom is NOT the length of the string, you need to check your calculations.

Use clothes pegs or paperclips to hang a piece of paper with the name of the planet (or Sun) at the correct spot on the string. You can also add more information about each planet and put the string up high so everyone can see it while going through this unit.

2. In order to remember the planets of the solar system, you can make a mnemonic of the first letters of their names. You can make a sentence using any words you like as long as their first letters are the same as the names of the planets in the solar system (in order).

M(ercury), V(enus), E(arth), M(ars), J(upiter), S(aturn), U(ranus), N(eptune).

Example: **M**y **V**ery **E**ducated **M**other **J**ust **S**erved **U**s **N**uggets

a. Now write your own mnemonic:

____

b. Answer the following questions. Use the information provided on pages 134 and 135

Which planet is closest to the Sun?	
Which planet is the farthest from the Sun?	
On which planet would night be the longest?	
Which planet is the largest?	
Which planet is the smallest?	
On which planet would you have the most birthdays?	
On which planet would you be unlikely to live even one year?	
On which planet would you be able to wash?	
On which planets would you be able to breathe oxygen?	
Which planet is the warmest?	
Which planet is the average temperature of your freezer at home?	
Which planets have no moons?	
Which planet has the most moons?	

1. During the day, we often have sunshine. Some nights, the moonlight is bright. Other nights, there may not be a Moon, just a little starlight. You might misunderstand for considering them all as similar sources of light, but this would not be correct from a scientific perspective.

   Read page 133 and write the definitions of luminous and non-luminous objects.

   a. Luminous objects ______________________________

   b. Non-luminous objects ______________________________

   c. Considering these definitions, classify the following as luminous or non-luminous by writing them in the correct columns.

diamond	ice cube	Moon	traffic light
fire fly	light bulb	stars	Venus
flame of a candle	mirror	Sun	

Luminous	**Non-luminous**

The diameter of the Moon is 3500 km and its distance from Earth is less than 400000 km. Compared to Earth, the Moon has less than 1/3 of its diameter, so it is small. In your model, the distance between Earth and the Moon would be about 1.7 mm, which is very close.

Despite its limited size, the Moon is close enough to have some impact on Earth. Due to the fact that the Sun is much bigger but much further away from Earth, we see the Sun and the Moon as about the same size.

One of the most striking phenomena is an eclipse. There are two kinds of eclipses: a solar eclipse and a lunar eclipse. In a solar eclipse, we do not see the Sun (because it is blocked by the Moon). In a lunar eclipse, we do not see the Moon (because the light from the Sun does not reach the Moon—it is blocked by Earth).

Sometimes a partial lunar eclipse is actually more spectacular because you can see the shadow of the Earth starting to shade the Moon.

2. We use a number of units to keep track of time, but you may wonder about their duration and how we decided them.

   Read pages 136 and 137 and answer the following questions.

   a. What is one day? ______________________________

   b. Explain why you experience night and day. ______________________________

   ____

   c. How long does it take for the Earth to complete one orbit around the Sun? ______________________________

   d. Explain the number of days in a 'normal' year and compare it to a leap year. ______________________________

   ____

   e. On what date is the extra day in a leap year? ______________________________

   The yearly calendar is based on the solar year: the time it takes the Earth to orbit the Sun. However, a lunar calendar also exists and is based on the time it takes for the Moon to orbit the Earth. A lunar year would be the time it takes the Moon to orbit the Earth 12 times. The lunar year is about 11 days shorter than the solar year, so events based on the lunar calendar (such as Ramadan) move through the solar calendar, falling approximately 11 days earlier every year.

   The Gregorian calendar, which is our most commonly-used calendar, is based on the Earth's orbit around the Sun. The months in this calendar are lunar months modified in such a way that there are 12 months in a year.

   You must have noticed that the Moon does not always look the same. Sometimes it is a crescent, sometimes you see half of it lit, and sometimes you see a full moon. These phases of the Moon are described on pages 136 and 137.

Chapter 11

The Environment

UNIT FLOW CHART

Where things live

↓

Food chains

↓

Food webs

↓

Investigating food webs

↓

Energy flow through ecosystem

INTRODUCTION

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

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

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

Lesson 11-1

Pages 148 – 151

OBJECTIVES

- To develop knowledge of the environment and to show how animals and plants are adapted to a range of very different environments

LEARNING OUTCOMES

Students should be able to

- explain that the environment is made up of living and non-living components.
- describe how animals and plants are adapted to live in different habitats.

START (10 min)

Ask your students to imagine a wild animal (or plant). Once they have something in mind (e.g. whale, camel, palm tree) they can imagine what this organism needs to live. Students could create a mind map of the factors, and by looking at what other students include, they might realize they overlooked some aspects. For example, an animal needs food but also water, shelter, a mate, a suitable temperature, etc.

When you have named a number of these factors, you can ask students to read page 148 and divide the factors into biotic and abiotic.

If you do an internet search on 'abiotic and biotic factors' and choose 'video', you will have a choice of videos. Please preview them and choose the one which is correct for your students' level.

MAIN (25 min)

By asking students to consider the reason(s) for which an organism does not live in a certain environment, they will usually focus on the abiotic elements of this environment.

By asking students for the reasons why an organism can survive in a certain environment, they usually consider the animal's adaptations.

PLENARY (10 min)

Discuss that both plants and animals adapt to the environment, but that they also make changes to the environment. Some examples: The very small roots of moss growing on rocks will create and/or enlarge any tiny crack in the rock, creating a little bit of soil. Sheep will graze and eat many very small bushes and seedlings of trees. Without sheep, a grassy area would become a forest. Beavers build dams, flooding areas to create a better place for themselves.

HOMEWORK

Read pages 148 – 151 and answer the Test yourself questions on page 151 of Student Book.

Lesson 11-2

Page 149

OBJECTIVES

- To develop knowledge of the environment and to show how animals and plants are adapted to a range of very different environments

LEARNING OUTCOMES

Students should be able to:

- describe how animals and plants are adapted to live in different habitats.

START (5 min)

Handout worksheet 11-2 to students. In this lesson your students are given a description of an island which they have to draw. They then have to speculate how rabbits would have to adapt in order to survive there. As long as their ideas make sense in the scenario described, their answers are 'correct'.

MAIN (30 min)

Give them about 30 min to complete the activity, making sure each group has at least one student who is confident about drawing.

REFLECTION (10 min)

Discuss each poster with the entire class. Encourage students to ask questions and the group who made the poster to explain their reasons for their ideas.

Lesson 11-3

Pages 152-155

OBJECTIVES

- To explain the feeding relationships between groups of organisms
- To introduce the concept of energy flow through ecosystems

LEARNING OUTCOMES

Students should be able to:

- identify some features of predator and prey animals.
- explain what a food chain is and name the links in a food chain.
- explain the difference between a food chain and a food web.
- describe the flow of energy from the producer to the final organisms in a food chain.

START (10 min)

Review the adaptations students envisioned in the last lesson as they often relate to the role of prey or predator.

Ask student why consumers need to eat (to obtain energy). Introduce the concept that plants use energy from the Sun to make their own food, and that eating plants means you are eating large molecules which were put together from smaller ones using the Sun's energy. By breaking down the larger molecules, we release this energy, e.g., to move our muscles.

When an animal eats another animal, the Sun's energy is passed on again until it reaches the top predator. When this animal dies, the large molecules in its body are broken down to smaller ones by decomposers.

MAIN (20 min)

Ecology has a number of terms which students need to understand well. It may be useful to memorize the definitions, especially for second language learners. Please continue to check throughout this unit that students really grasp the meanings of these words.

PLENARY (15 min)

According to the UN, approximately 11% of the world's population is undernourished. This means that for every 8 people who have enough of the right food to eat, one person is hungry. Add to this the large impact that farms have on global warming: you might want to ask your students if they would be interested in organizing a vegetable day (or week) at school.

Some information can be found on

https://www.peta.org/issues/animals-used-for-food/meat-environment/

Examples of predator prey relationships can be found on

https://animalsake.com/examples-of-predator-prey-relationships

HOMEWORK

Read pages 154 and 155 and answer the Test yourself questions of Student Book.

Lesson 11-4

Page 155

OBJECTIVES

- To explore how changing one part of a food web can have an effect on other parts

LEARNING OUTCOMES

Students should be able to:

- describe some ways in which food chains have been affected by human activity.

START (10 min)

You may want to start the lesson by talking about human impact on ecosystems. This may take many directions. You could ask students how an area looks with elephants and how it would change if they were not there. For example, elephants dig water holes which also provide water for other animals, and eat young trees which would otherwise turn grasslands into forests. If students bring up overfishing, you could ask what would happen to the species normally eaten by the fish which are removed, and also what happens to the species which eat the species which humans take out.

The purpose is to make students see that every species has its own role, and by drastically changing the number of one species, you impact the balance. A new balance needs to be found, which could work, but as we are used to the existing balance, it may not be good.

MAIN (25 min)

Go through the section on eutrophication with your students. This aims to show students that anything to do with ecology is rarely simple and that something small, like adding some nutrients to the water, may destroy an entire food web.

The questions afterwards, relating to hypothetical changes to a food web, again show students the far-reaching impact of what may seem like a simple change.

PLENARY (10 min)

What students should take from this lesson is the concept that systems are in balance. A small change could upset the balance. In a very diverse system it is likely to find a new balance relatively quickly, but a bigger change, especially in a system with less diversity, could cause quite an upheaval and a new balance will take longer to reach, and may be very different from the previous one.

If you want to pursue this concept, you could research the effect of rabbits as introduced on page 155.

EXTENSION MATERIAL:

http://coolclassroom.org/cool_windows/home.html

This is a game to create a food web. It is not easy, but maybe it can be played with the entire class. The site requires Flash player so please do not use Chrome. (Internet Explorer works well.)

http://new.coolclassroom.org/files/adventures/1/Eutrophication_Teacher.pdf

This site shows you how to demonstrate eutrophication and test for the effects on dissolved oxygen, phosphate, and nitrates. If you have the resources, this would be good to show your students.

Worksheet 11-1

1. Answer these questions.

   a. Why do camels not live at the North Pole?

   ____

   ____

   b. Why do sharks not live in the desert?

   ____

   ____

All organisms need the right environment to live. The environment includes biotic and abiotic factors.

Use page 148 to find the following definitions and write them below.

   c. Abiotic factors are ______________________________

   d. Biotic factors are ______________________________

   e. An ecosystem is formed by ______________________________

2. List the biotic and abiotic factors shown in the picture below.

Abiotic factors	Biotic factors

3. Go back to the questions at the start of the worksheet. You wrote some reasons that camels do not live at the North Pole. We can now look at this from a different angle.

   Deserts are not the easiest places to live, but camels seem to be able to survive there.

   a. Why are camels able to live in deserts?

   ____

   These special things that camels have which allow them to live in the desert are called adaptations.

   Find the definition on page 149 and write it below.

   b. Adaptations are special

   ____

Four large groups of rabbits are placed in different environments (which are given below) and will have to adapt in order to survive. Fortunately, they are able to do so but after several generations they will look different.

Draw the environment of rabbits with their adaptations. Annotate your drawing with explanations.

Island ONE

This is an old volcano, filled with fresh water. The temperature is moderate, with sufficient rainfall to keep the crater lake filled. Surrounding the crater lake there are many tall trees with leaves high in the canopy which block out the light on the ground. The island hosts different species of plant-eating animals and one species of fox, which lives on the ground.

Island TWO

This island has a fresh water spring in its centre but almost no soil or vegetation other than the plentiful seaweed washed up on the shores. There is minimal shelter between and under rocks. Snails and shellfish are found in rock pools, which remain filled with sea water during low tide. No predators live on the island but small sharks are found in the sea.

Island THREE

This island is covered in grass and herbs all year round which grow on a thick layer of sandy soil. It has a small fresh water lake. It is very windy and shrubs or trees do not survive. Many large fish-eating birds have their nests on the ground and they attack and kill any small creature approaching. In addition, a few foxes roam around who occasionally manage to steal an egg or a young bird.

Island FOUR

This island is covered with a layer of snow for most of the year. In spring and summer, a lush carpet of grass and herbs grows and these plants remain edible even when covered with snow. Trees or shrubs are absent. Birds of prey from neighbouring islands can be seen regularly. The sea around the island is frozen for part of the year but full of predators at any time.

1. Earlier in this section, you already came across animals that eat plants and animals.

   a. Read page 152 and write the definitions of the terms below.

producer	
consumer	
herbivore	
carnivore	
omnivore	
decomposer	

   b. A predator is an animal which hunts, kills, and eats other animals.
   It is therefore a [producer/herbivore/carnivore].

   c. The prey is the animal which is hunted. It is a [producer/consumer] and it can be a herbivore or a carnivore.

   A predator must be adapted to catching and killing its prey. Prey animals adapt in such a way that they reduce the chance of being seen, caught, or killed.

2. Consider the list of features of animals below. Some are typical features of predators, others of prey. Copy the features into the correct columns.
   - camouflage to avoid being seen by predators
   - camouflage to avoid being seen by prey
   - defences such as poison or stings
   - eyes to the front of the head to judge size and distance well
   - eyes to the side of the head to get a wide field of vision
   - live in groups
   - sharp teeth and claws

predators	prey
built for speed	built for speed

OXFORD UNIVERSITY PRESS

3. We said the prey can be an herbivore or a carnivore. If it is a carnivore, it will be the prey for some animals and the predator for others. An example would be the seal which is prey for the polar bear but a predator of fish and squid.

   We can represent this situation in the following way

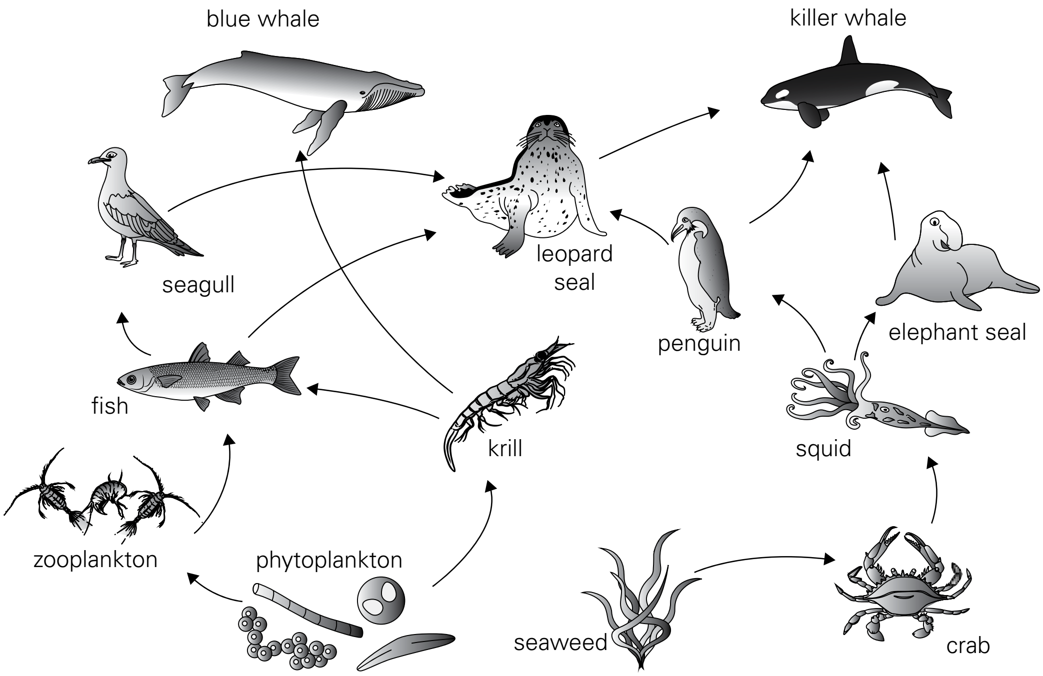
   fish → seal → polar bear

   This is an example of a food chain.

   The arrows show in which direction the food or energy in the food travels, so the arrows represent 'is eaten by'.

   As we said, the seal does not only eat fish, it also eats squid. The polar bear does not only eat seals. So this food chain is incomplete and this information should be added. If we try to represent a more complete picture of the feeding relationships in an area, we end up with a food web, as you can see on page 153 of your Student book. The food chains which made this food web are shown above it.

   Consider the food web below. Phytoplankton are tiny, plant-like producers which form the start of many food chains in water. They are eaten by zooplankton, which are tiny animal-like consumers which, in turn, are eaten by others.



   a. Use this food web to identify different food chains. How many can you find? Write down at least 3 of them.

   ______

   ______

   ______

   Did you put the arrows in the correct direction?

4. Read page 157 and carefully study the diagram.

   The Sun gives out a lot of energy. In this example, some of it is taken up by the grass.

   a. How much energy is taken up by the grass? ______________________________

   b. The grass uses some of this energy for respiration. How much? ______________________________

   c. How much energy from the grass is taken up by the bullock? ______________________________

   d. The bullock needs to breathe, move, chew its food, etc. In order to do all these things, the bullock releases energy in a process called respiration. How much energy does the bullock use for respiration?

      ____

   e. How much energy does the human take up when s/he eats some beef (i.e. meat from this bullock)?

      ____

Humans cannot eat grass, but some of the land which currently grows grass (or other crops) for animals, could grow food for humans. If we were to eat less meat (and more beans and seeds instead), the same plot of the land could not only feed more people (instead of feeding cows to make beef to feed people), it would also be much better for the environment.

1. Plants produce oxygen, so the more plants the better. Right? Wrong!

   Yes, plants produce oxygen, but the situation is more complicated than just that.

   If we follow the flow of energy, we start with sunlight. The plants in the pond use the sunlight to make their food and grow. The herbivores will eat (most of) the plants and the carnivores will eat the herbivores and each other. Plants and animals which are not eaten will eventually die, and decomposers will break them down, returning the nutrients to the pond so that the growing plants can take them up again.

   The nutrients will be the 'limiting factor', i.e., the fact that nutrients not readily available in this system stop plants from growing more.

   Now humans will change this situation. A farmer with a field next to the pond may put manure or fertilizer on his land. When it rains, some of the plants' nutrients in the manure or fertilizer will end up in the pond. Another possibility is that humans decide to dispose off their sewage in the pond. This will also add nutrients for plants to the pond water. Again, this all seems great. Plant power!

   Indeed, plants will grow and animals will happily eat them and grow more numerous too. But the plants near the surface will block the sunlight of those below, and they will die.

   Of course, this is not good. But the problem is just starting. The dead plants are broken down by decomposing bacteria. Since there are so many plants, there will be more and more bacteria and they use oxygen for the process of decomposition.

   The herbivores, whose numbers had grown because there was so much plant food to eat, now have a problem. Most of the plants they eat are dead and the amount of oxygen in the water is dropping because the bacteria use so much of it. So the herbivores die and are decomposed, and even less oxygen is available. Now the carnivores die and are decomposed.

   So, from a healthy pond with not too many nutrients in the water, living plants, herbivores, and carnivores all in balance, we have gone to a slimy, green, smelly pond where the bacteria are flourishing. To top it all off, some of these bacteria will give off toxic substances.

   This process is called eutrophication and the only way to make this pond healthy again is to remove the surplus nutrients. This can be done by scooping out the algae and the sediment on the bottom—a tedious and labour-intensive job, and really only possible in relatively small ponds.

   This is an example of human impact on a food web and we can use these ideas to consider what happens in other food webs.

   Use the food web on page 153 of your Student Book to answer the questions below.

   a. If humans decided to grow roses where grass grows in the existing situation, what would happen to the population of rabbits?

      ____

   b. Would there still be the same amount of lettuce? Explain your answer.

      ____

   c. How would this affect the population of slugs? Explain your answer.

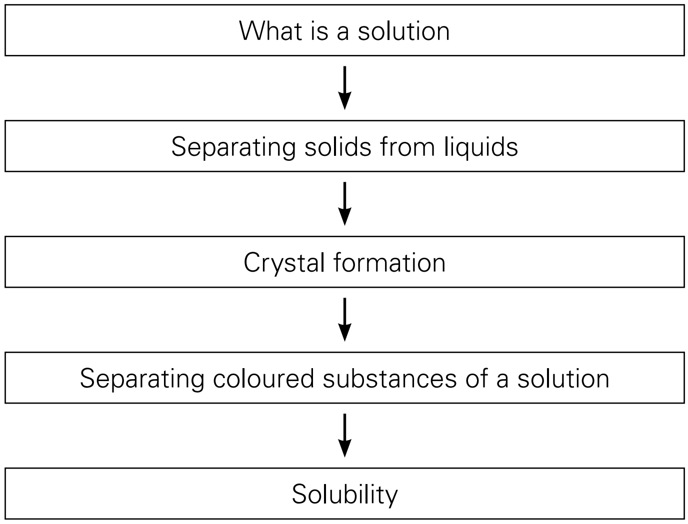
      ____

d. How would this affect the population of thrushes? Explain your answer.

e. If, in the existing situation, the sparrow hawks eat equal numbers of blue tits, thrushes, rabbits, and chaffinches, would that still be the case if the grass were replaced with roses? Which species might become much more important as food for the sparrow hawks? Explain your answer.

Chapter 12 Solutions

UNIT FLOW CHART



INTRODUCTION

We know that a material can be a solid, a liquid, or a gas. But materials in the same state, or in different states, are often mixed together. One special kind of mixture of two or more materials is called a ‘solution’. The most common type of solution is made by dissolving a solid in a liquid.

If we put sugar in lemonade, we make a solution. Perhaps you have sprayed a solution on plants to keep them from being eaten by insects. Solutions are so important in our body that we cannot stay alive without them. We cannot use the air that we breathe or the food that we eat until they are in our blood in solution.

This unit really requires students to get involved in some hands-on experiments. Please avoid teaching this only theoretically or as demonstrations or videos. It is easy to let students carry out experiments and requires very few resources. The experiments are described in the Student book. The worksheets only include one very simple experiment which requires no lab equipment, but even for this an interactive site provides a virtual alternative.

Lesson 12-1 and 12-2

Pages 164 - 170

OBJECTIVES

- To build on work done on solids, liquids, and gases, and extend previous experiences of separating mixtures

LEARNING OUTCOMES

Students should be able to:

- classify some solids as soluble or insoluble.
- explain the meanings of the terms solvent, solute, and saturated solution.
- explain the difference between a dilute and a concentrated solution.
- explain the difference between a solution and a suspension.
- describe how mixtures can be separated by filtration, evaporation, sublimation, distillation, and chromatography.

START (10 min)

It would be useful to revise the particle model and use it to quickly go over the three states, the changes between the states (melting, evaporating, etc), and elements, atoms, compounds, molecules, and mixtures. Read pages 164 and 165 from the Student book.

Some of the terms in worksheet 12-1 can be defined after reading this section, others will be done as you go through the material.

MAIN (25 min)

The following separation techniques are covered in the text: filtration, evaporation, crystallization, distillation, chromatography, sublimation.

The link http://www.bbc.co.uk/education/guides/zgvc4wx/revision provides information about some separation techniques. The activity is a video, revising elements, compounds, and mixtures, and showing the following separation techniques:

- filtration
- evaporation
- distillation
- fractional distillation
- chromatography

You can read about each technique in the book and on the site in either order. The easiest experiments your students could do would be filtration, crystallization, and chromatography.

If only simple lab equipment is available, you might be able to demonstrate separating salt from sand (filtration and evaporation).

Distillation requires relevant equipment, and if you want to do fractional distillation, please do NOT use a flame but an electric heating device as alcohol is flammable.

Especially for chromatography, many diagrams and/or questions are highly idealized versions of what a real result looks like.

PLENARY (10 min)

It might be useful to revisit the concept of physical and chemical changes. All these techniques only separate components from a mixture. They are physical processes and do not separate substances which have undergone a chemical change.

The techniques given are only some of those available. For example, a mixture of iron and sulphur could be separated by using a magnet, and gas chromatography can separate gases.

Students could use the second and third exercises on worksheet 12-1 to show they understood the techniques.

HOMEWORK

Read pages 164 and 165 and do the Test yourself questions on page 165.

or

Workbook page 73, Question no. 5

Lesson 12-3

Pages 171 - 172

OBJECTIVES

- To introduce the relationships between temperature and the solubility of solids and gases

LEARNING OUTCOMES

Students should be able to:

- describe the relationships between temperature and the solubility of solids.

START (5 min)

Today's experiments investigate the following research question:

How does temperature affect the time it takes for a set amount of solute to dissolve in a constant volume of solvent?

Briefly discuss with students what they expect the answer to be. Make sure you do not accept just blind guesses—they have to explain their reasons for their expectations.

You can choose one of the two experiments below or do the bunties experiment in class and ask students to do the virtual lab at home.

MAIN (30 min)

Hands on experiment - simple

This experiment requires clear plastic cups, water (cold, room temperature, hot) and bunties (every colour except brown). *Please make sure students do not eat the bunties. Eating in the lab and/or eating materials meant for science experiments is potentially unsafe.*

Depending on your students, you could allow them to pour the water or you can give them the filled cups. You could put the different temperatures in thermos flasks (add ice cubes to the cold water). The 'hot' water should not exceed 50°C—some may be spilled and you do not want anyone to get scalded.

You may ask your students to take pictures of the bunties after they have been in the water for one minute, or you may take pictures yourself when you try this experiment. They would help when you are discussing the results.

VIRTUAL LAB

http://www.learningliftoff.com/high-school-science-learning-activity-solubility-experiment/#.WcyXtul03rd

This interactive site allows your students to model the activity of dissolving salt in a given amount of water at selected temperatures. The site will also plot the data for the students, but you could have two students paired up to do this: one to drop the salt in the water and the other to clock the time. This way, they could draw their own graph with numbers. (The graph on the site has no numbers.)

(Again, this uses Flash, so Chrome will not work. Internet Explorer works well.)

PLENARY

Compare students' expectations from the beginning of the lessons with their findings during the (virtual) lab. Did they match? If not, why not?

In general, ask students to name one thing they learned in today's lesson.

HOMEWORK

Workbook page 73-74, Question no. 5 and 6.

1. It is important to have an accurate understanding of the scientific terms used in this unit. Use chapter 12 in your Student book to help you put the right term with each definition. Once this is complete, you will be able to use this list for reference.

chromatography	distillation	filtration	saturated solution	solute	sublimation
concentrated solution	evaporation	insoluble	sediment	solution	suspension
dilute solution	filtrate	residue	soluble	solvent	unsaturated solution

term	**definition**
	a substance which will dissolve
	a substance which will not dissolve
	a mixture of a liquid and a solid
	a mixture of an insoluble solid and a liquid where small particles float around in the liquid
	insoluble particles which have settled at the bottom of a suspension
	the liquid in which a solute is dissolved
	the solid which is dissolved in a solvent
	when the maximum amount of solute is dissolved in the solvent
	when less than the maximum amount of solute is dissolved in the solvent
	a solution containing a large amount of solute relative to the amount of solvent
	a solution containing a small amount of solute relative to the amount of solvent
	the separation of an insoluble solid from the liquid by pouring the mixture through filter paper
	the liquid which passes through the filter paper
	the solid which does not go through the filter paper
	changing a liquid into a gas to separate it from a mixture
	changing a solid into a gas to separate it from a mixture
	separating the solvent from a solution or mixture of liquids which have different boiling points
	a method for separating dissolved substances from one another

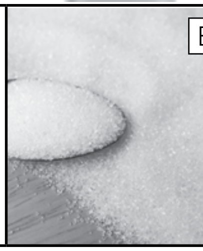
2. a. Select the correct option for each picture. Cross out the ones which are not correct.

dilute solution or
concentrated solution

A

dilute solution or
concentrated solution

A solute or
solvent or
solution



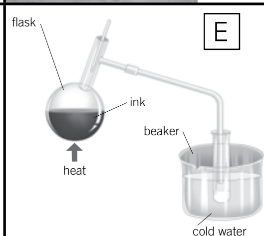
B solute or
solvent or
solution

C solute or
solvent or
solution

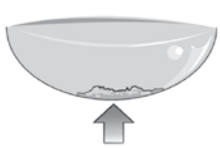
A solution or
suspension

D solution or
suspension

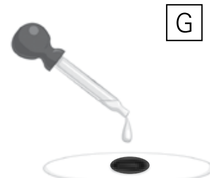
E chromatography
or distillation or
evaporation or
filtration



E chromatography
or distillation or
evaporation or
filtration



F chromatography
or distillation or
evaporation or
filtration



G chromatography
or distillation or
evaporation or
filtration

1. If you drop a buntie into water, some of the colour on the outside of the buntie will dissolve. Does the temperature affect this?

   If you wanted to find this out, what are your variables?

   a. independent variable (= the one you decide to change)

   ____

   b. dependent variable (= the one you measure)

   ____

   c. controlled variable (= the ones you need to keep the same)

   ____

   ____

   i. Prepare three pieces of paper with 'cold', 'room temperature' and 'hot' written on them and put them side by side on the table/desk.
   ii. Put three clear plastic cups next to each other on the sheets of papers. Use a ruler and a waterproof marker to mark a line on the cups, 3 cm from the bottom. (Your teacher may tell you to change this, depending on the cups you use.)
   iii. Put three bunties of the same colour (not brown) on your table/bench.
   iv. One lab partner should hold the cup, the other can pour the water.
   v. Pour cold water into the cup on the paper marked 'cold', up to the mark.
   vi. Pour room temperature water into the cup on the paper marked 'room temperature' , up to the mark.
   vii. Pour hot water into the cup on the paper marked 'hot', up to the mark.
   viii. Drop one buntie in each cup. Try to do them at the same time and start the stopwatch.
   ix. After one minute, observe how much of the colour is still on the bunties and how much of the chocolate is visible.

Describe and/or draw what you saw

cold water	room temperature water	hot water

   d. Does the temperature affect the speed with which the colour of the buntie dissolves? YES / NO

e. How do you know this?

____

f. Using the particle model, what happens when any solute dissolves in a solvent?

____

____

g. Why could temperature affect the speed of this process?

____

____

Answers

Chapter 1 Science skills

Taking measurements Page7

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

Making difficult measurements Page 8

1. 4 grams
2. Put some water in a measuring cylinder and measure the volume. Push the cork down so that it is just under the surface of water. Measure the volume again. The difference between the two readings is the volume of the cork.
3. 1/250 s or 0.004 s

Handling data Pages 9 & 10

1. Scientific information
2. a. 18°C
   b. Day 3 at 11.00 pm
   c. The higher the night-time temperature, the more amount of cloud.
3. It can be used to read off values which have not been measured.
4. a. 151 cms b. 160 cms c. 7

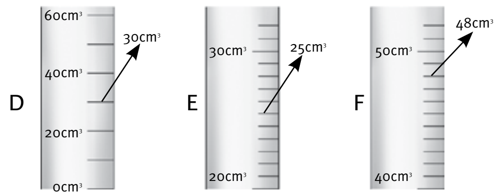
(Page 10)

5. a. 60°C b. 2 mins c. 20°C
6. a. Summer b. 16% c. 10 students

Exercise Pages 14 - 15

1. Multiple choice questions
   i. b ii. a iii. b
   iv. a v. c
2. True or False
   i. False ii. False iii. False
   iv. True v. True

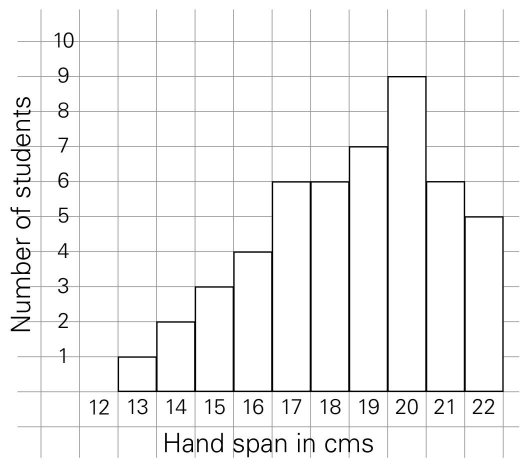
3.



4.

Measurement	Instrument used	Unit	Symbol
	ruler or tape measure		m
mass		gram or kilogram	
volume			cm^3
	thermometer	degrees celsius or centigrade	
		second	

5. i.



ii. 12 cms
iii. 20 cms iv. 49

Chapter 2 Life and living things

Life processes Page 18

1. An animal needs to move quickly in order to search for food and to escape from its enemies.
2. Animals eat food in order to produce energy and to grow.
3. Living things use the energy produced by respiration to grow, to move, and to enable the body to work properly.
4. Plants excrete carbon dioxide.

5. A car is not a living thing because it is not made up of cells, it does not grow and it cannot reproduce. A car does not move on its own, it has to be driven by a human being.

Animal cells vs Plant cells Page 20

1. The nucleus contains the information which controls everything that happens in the cell.
2. The cytoplasm is all the living matter of the cell except the nucleus. b) It is a jelly-like substance which is fluid in nature.
3. The vacuole is a space that is filled with a fluid. In plant cells the fluid is cell sap. In animal cells it usually contains waste matter.

Special cells for special jobs Page 21

1. Nerve cells, red blood cells, muscle cells.
2. Epithelial cells are thin and flat. They cover the surface like skin protecting against infection and from losing too much water.
3. Red blood cells have a large surface area to pick up lots of oxygen.
4. Pollen grains have a spiky surface to help them stick to the bodies of insects; others have tiny wings to enable them to be carried by the wind. This way they are carried from one plant to another and thereby help in plant pollination.

Cells, tissues, and organs Page 22

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

Eyes Page 25

1. Changes the shape of the lens.
2. Upside down (inverted) and smaller than the object.
3. In the dark the iris increases the size of the pupil allowing more light into the eye. When the light is switched on the opposite happens.

Ears Page 26

1. To determine where a sound is coming from.
2. Collect vibrations in the air and send them down the ear canal.
3. Vibrations in the eardrum are transferred and amplified by the hammer, anvil, and stirrup to set up vibrations in the liquid in the cochlea. These vibrations are detected by nerve endings in the walls of the cochlea. Signals are sent to the brain to be interpreted as sound.
4. Semi circular canals are at right angles to each other. Movement of fluid inside the canals is detected by nerve cells in the walls which send messages to the brain. The brain 'tells' the muscles to keep you upright.

Skin Page 27

1. Stops germs and harmful chemicals entering the body. Protects against sunlight and prevents water loss.
2. Three. Outer, inner, and fatty layers.
3. There are touch sensitive nerve cells at the root of every hair on the body.
4. There are fewer heat sensitive nerve cells on your back so it takes more heat to give the sensation of warmth.
5. White skinned people do not have the colouring that protects against sunlight.

Tongue and nose Page 28

1. In ridges on the surface of the tongue.
2. To stimulate as many different taste buds as possible.
3. Flavours of food are detected by the nerve cells in the nose.
4. Sight – eyes. Hearing – ears. Touch – skin. Taste – tongue. Smell – nose.

Exercise Pages 29 - 31

1. Multiple choice questions
   i. d   ii. d   iii. b
   iv. c   v. b
2. True or False
   i. True   ii. False   iii. False
   iv. True   v. True
3. i. reproduce   ii. move
   iii. grow   iv. respiration
   v. respond   vi. excretion
   vii. feed
4. a. It is an animal cell because it has a no cell wall, vacuole or chloroplasts.
   b. The nucleus controls the whole working of the cell.
5. i. a. It carries messages from one part of the body to another.
      b. It has long thin fibres which enable it to carry messages.
   ii. cell, tissue, organ, organ system, organism.

Page 31

6. i. A - iris B – cornea
   C – pupil D – lens
   E – retina
   ii. A ring of muscle running around the edge.
   iii. E – retina
   iv. Interprets them as the picture that you see.

Ideas for investigations

These two investigations aim to enable students to experience for themselves the benefits of stereoscopic vision. In investigation 1, students should report the pencil appearing to move. This is because the image received from each eye is slightly different.
In investigation 2, students should find it easier to align the pencils with both eyes open.

Chapter 3 Energy resources

Energy resources Page 33

1. Most of the world's energy comes from burning fuels.
2. a. The chemical reaction which takes place when a fuel reacts with oxygen to give out thermal energy (heat) is called combustion.
   b. The small amount of energy needed to light a fuel is called ignition.
3. coal, natural gas, kerosene oil, wood, charcoal
4. Oil products are used in vehicles, for heating homes, and in power stations.

Fossil fuels Page 35

1. A fossil fuel is formed from the remains of living things. Coal, oil, and natural gas are fossil fuels.
2. There were no human beings living on the Earth at that time.
3. a. Peat is the decomposed remains of forests that covered the Earth about 300 million years ago.
   b. Over millions of years, layers of mud, and gravel built up above the peat. These layers eventually turned to rock.
   Pressure and temperature increased causing the peat to slowly turn into coal.
4. a. Crude oil is thick and black.
   b. Crude oil is a fossil fuel because it was made from the dead bodies of microscopic plants and animals that once lived in the sea.
5. Porous means something having sponge-like holes through which liquid or gas can seep.
6. Gas deposits collect above the oil because they are less dense.

Burning fossil fuels Page 37

1. When fossil fuels are burnt they produce harmful substances that cause air pollution and, in turn harm the environment.
2. carbon dioxide, sulphur dioxide, nitrogen dioxide
3. When acid rain falls over forest areas, the acids release poisonous aluminium from the soil into the water.
   This aluminium is taken in by the tree roots and so kills the trees.
4. The layer of air which surrounds the Earth acts as an insulating layer. Carbon dioxide gas in the atmosphere absorbs the heat from the Sun and keeps it in thereby maintaining a suitable temperature for life on Earth.
5. a. Like a greenhouse, carbon dioxide is very good at keeping heat within the Earth's atmosphere. This is why it is called a greenhouse gas.
   b. methane
6. a. An increase in the amount of carbon dioxide in the air is increasing the greenhouse effect, which is causing the temperature of the Earth to rise. This is global warming.
   b. Global warming will cause the ice caps at the Poles to melt which in turn will cause the sea level to rise, thus causing a change in weather patterns: more flooding will occur in the low-lying parts of the world.

How long will fossil fuels last? Page 39

1. natural gas
2. There are three things that can be done:
   a. Make the best possible use of the energy we get from fossil fuels now.
   b. Find alternative fuels to coal, oil, and gas.
   c. Find new sources of energy where fuels do not have to be burned.
3. a. Conservation means making the best use of energy supplies and reducing waste as much as possible.
   b. More energy is used for heating in cooler parts of the world so it is important not to waste fuel in the home, in vehicles or in industry.
4. The floor of the loft and the cavity in the walls can be filled with material such as glass fibre or mineral wool.
   The fibres of the insulating material trap lots of air between them. Air is a poor conductor of heat and so less energy escapes.

5. a. through the roof, through the windows, through walls and through draughts
   b. by insulating roof and walls of a house, double glazing, draught excluders, covering cylinder with thick jacket

Renewable energy resources Page 41

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

More renewable energy resources Page 41

1. a. Panels which use energy from Sun for generating electricity or heating.
   b. They should be located on the roofs of houses in order to make maximum use of the Sun's energy.
2. a. A solar cell produces a small amount of electricity when light shines on it.
   b. They produce electricity for satellites.
   c. A large number of solar cells are needed to produce useful energy.

Page 43

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

Energy from living things Page 45

1. Green plants get their energy from the Sun.
2. a. carbon dioxide
   b. Because they will be able to supply energy for millions of years.
3. a. Fermentation is the process by which sugar is changed into alcohol by using yeast.
   b. The alcohol produced by the fermentation of sugar in Brazil is mixed with petrol and used in cars and lorries as fuel.
4. a. Rotting biomass produces methane (natural gas) which is collected and used as a fuel. This gas is called biogas.
   b. Since most of the population in developing countries lives in villages and keeps cattle, biogas can easily be generated by using plant and animal waste and can be used as a fuel for heating and cooking.
   It is a cheap renewable energy source.
5. a. food
   b. i. Green plants make their own food by using the energy from the Sun. The process is called photosynthesis.
      ii. Animals get their food energy by eating plants or other living things.
   c. This energy is used by their body for carrying out different activities.
6. a. Some of the heat is absorbed by the container, the test tube, and some is lost to the surroundings.
   b. Diagram showing some indication that heat loses have been reduced e.g. heat shield around the burner and text tube, and a wider container for the water so as much heat as possible enters the water and not the air around it.

Exercise Pages 46 - 49

1. Multiple choice questions

i. c	ii. d	iii. d
iv. d	v. a	

2. True or False
   i. True ii. True iii. False
   iv. True v. True
3. i. Cardboard, paper, petrol, and tree branch can be used as fuel.
   c. When a fuel is *ignited* the energy is used to *break* the bonds holding the *atoms* in the fuel together. Once free, the atoms can *react* with oxygen to form new *molecules*. Energy is *released* when new bonds are made.
4. i. Coal was formed from the remains of plants which grew in huge forests about 300 million years ago. Bacteria changed the decaying plants into peat. Gradually the land sank and water covered it. As time passed layers of mud and gravel were deposited over the decaying plants. As more and more rocks were laid down by the sea above, the pressure on the peat layers as well as the temperature increased. Eventually, over millions of years the decaying plants formed coal.
   ii. Coal is called a fossil fuel because it is made from the remains of plants that lived millions of years ago.
   iii. Scientists are trying to find alternative energy sources now because we will run out of fossil fuels soon.
   iv. geography, geothermal, geology, geometry thermometer, thermoplastic, thermal, thermostat
5. i. sulphur dioxide, nitrogen dioxide.
   ii. These gases dissolve in rainwater and form acids which fall as acid rain. Acid rain harms plants, trees, and stone work.
   iii. An increased production of greenhouse gases will lead to global warming, which will eventually cause:
   ice caps to melt
   sea levels to rise
   weather patterns to change
   more flooding in the low-lying parts of the world
   larger deserts
   more droughts
   poor growth of crops
   spread of disease-carrying insects that live in warm areas
6. i. a. The Sun
   b. photosynthesis
   ii. The stepwise process involved in the production of ethanol from sugar cane.
   iii. A energy from sunlight taken in by sugar cane
   B pieces of sugar cane crushed
   C plant juice filtered and heated
   D plant juice fermented with yeast for several days
   E extract distilled to give 95% alcohol

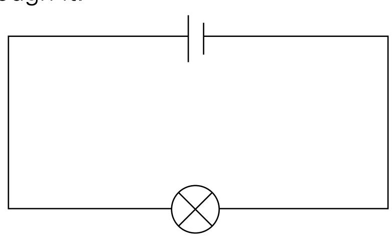
Ideas for investigations

Both of these investigations give students the opportunity to see for themselves the advantages of insulation in preventing the unnecessary loss of thermal energy.
Investigation 1 looks at pipe lagging and investigation 2 provides a simple scientific model of double glazing. Students should obtain significant results after 5–10 minutes. Heat loss will be greater in the non-insulated test tubes in both investigations.

Chapter 4 Electrical circuits

Conductors and insulators Page 52

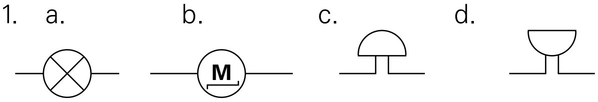
1. a. An electrical conductor allows electricity to pass through it.
   b. An electrical insulator does not allow electricity to pass through it.
2. conductors: metals, graphite, carbon
   insulators: glass, rubber, wood
3. They are made of plastic because plastic is an insulator and does not allow electricity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



   b. a switch

More electrical components Page 54

1. a. b. c. d.



2. a. Electrical energy is turned into sound energy.
   b. Electrical energy is turned into heat and light energy.
   c. Electrical energy is changed to mechanical/ movement energy.
   d. Chemical energy is turned into electrical energy.
3. Electrical components must be kept clean so that they do not corrode, they are reliable and last longer.

4. The gap between the contacts acts as an insulator.
5. A reed switch is operated by a magnet. When a magnet is held close to the switch, the contacts close and the switch is on. The switch is off when the magnet is removed.

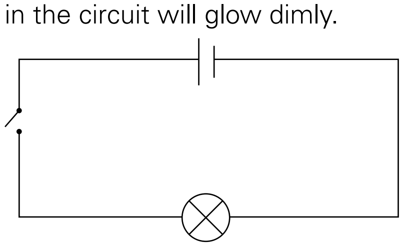
Current Page55

1. Electric current is measured in amperes (amps).
2. An ammeter is used to measure current flow accurately.
3. The symbol 'A' means amperes (amps).
4. The positive connector of the ammeter should be connected to the positive terminal of the battery and the negative terminal of the ammeter should be connected to the negative terminal of the battery.
5. The same amount of current i.e. 4 A flows out of the bulb.

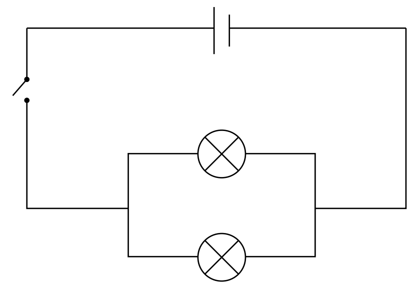
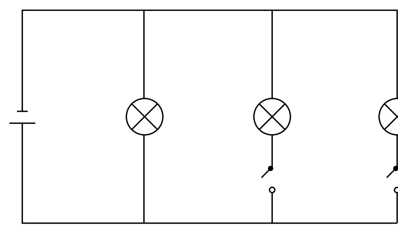
Voltage Page 57

1. Voltage is the 'push' needed to make a current flow in a circuit.
2. The unit of voltage is the volt (V).
3. The bulbs glows brighter.
4. A voltmeter is always connected in parallel with a component in a circuit, never in series. Also, always connect +ve on the voltmeter to +ve on a battery or power supply, and –ve on voltmeter to –ve on battery or power supply.

Series circuits Page 58

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

Parallel circuits Page 60

1. In a series circuit, all the components are joined together in a line. In parallel circuits, the components are arranged in such a manner that provides more than one pathway for electricity to flow.
2. If one bulb blows, the other bulbs keep glowing. This happens because the circuit still remains complete through the undamaged bulb or bulbs.
3. a. 
   b. Both bulbs glow with equal brightness as the same amount of current flows through them.
4. 

Parallel circuits in the home Page 62

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

Resistance Page 63

1. too much current flowing through the bulb
2. The thin filament of the bulb gets hot, burns and melts when a large current flows through it.
3. a. copper, glass
   b. Copper has the lowest resistance.
4. The resistance of a wire decreases as its thickness increases.

Exercise Pages 64 - 67

1. Multiple choice questions

   i. c ii. c iii. b
   iv. a v. a

2. True or False

   i. False ii. True iii. False
   iv. False v. True

3. i. Conductor is a material that allows electricity to pass through it.
   ii. iron wire, aluminium foil
   iii. The connections might be loose or the battery might be low. He could tighten the connections or change the battery.

4. a. 0.4 A b. 0.4 A c. 0.4 A

5. A2= 0.3A A3= 0.3A
   A4= 0.3A A5= 0.6A

6. i. electric fire: electricity to heat
   table lamp: electricity to light
   hairdryer: electricity to heat and mechanical energy
   television: electricity to light and sound energy
   toaster: electricity to heat energy
   ii. a. electric fire
   b. table lamp
   iii. A toaster needs thicker wires to carry a larger current with less resistance—hence safer.
   iv. a. 13A b. 5A c. 3A
   v. A fuse is made of a wire which has a high resistance. When too much current flows through it, the wire melts and breaks the circuit. When this happens the supply of electricity is cut off and the rest of the circuit, including any device attached to it, remains safe.

7. i. bedroom 1 ii. bathroom
   iii. a. It is called a ring main.
   b. The circuit is made in the form of a ring, and devices can be placed anywhere in the ring between the two wires.

8. i. a. towards A b. towards B
   ii. A thicker wire has lower resistance due to which the bulb will glow more brightly.

Ideas for investigations

Investigation 1 looks at the relationship between the length of a wire and its resistance. Using a simple circuit consisting of a battery, ammeter, connecting wires, and crocodile clips and resistance wire e.g. nichrome, students should obtain good results by taking ammeter readings using 10 cm, 20 cm, 30 cm and 40 cm of resistance wire in the circuit.

Using the formula for Ohms law

$$\frac{\text{voltage}}{\text{current}}\quad \begin{matrix}\text{(voltage of the battery or power supply)}\\ \text{(taken from the ammeter)}\end{matrix}$$

students should be able to obtain resistance values to complete the table and draw a graph of their results. The results should clearly show the longer the wire, the greater the resistance.

SAFETY NOTE: The resistance wire may get hot during this experiment depending on the voltage used.
Investigation 2 requires students to set up a test circuit containing a bulb (or bulbs), connecting wires and the battery to be tested. The circuit will be left set up and the time for the bulb to go out recorded. Clearly this will take some considerable time, possibly a day. However using more bulbs to increase the load on the batteries will speed things up.

Chapter 5 Plants and photosynthesis

Photosynthesis Page 70

1. Plants are part of our food chain.
2. Energy for photosynthesis comes from the Sun.
3. Leaves are well adapted for the function they perform. Their broad, flat, thin shape provides a large surface area, ideal for absorption of carbon dioxide and sunlight.

The starch test Page 71

1. The iodine turned from brown to blue-black at the end of the test. It does so only in the presence of starch. Therefore, the test shows that the leaf had been photosynthesizing.
2. a. brown b. blue-black

Testing the equation Page 72

1. carbon dioxide
2. Starch will be present only in the uncovered part.
3. It bursts into flame.

What happens to the glucose? Page 74

1. A thin cell membrane makes it easy for water and minerals to pass through. It also helps the cells to absorb oxygen easily from air in the spaces between the soil particles.
2. a. Osmosis is the movement of water from a region of high water concentration to a region of low water concentration.
   b. There is more water outside the root hair cells than inside so water enters the cells by osmosis.

c. Water moves from cell to cell by osmosis because of the different water concentrations inside them.
Eventually water enters the xylem to be carried round the plant.

3. a. from air in spaces between the soil
   b. Oxygen is important for respiration in the root cells.

Plants need minerals Page 75

1. Plants need minerals for normal, healthy growth.
2. Some minerals come from rocks, dissolved in rainwater. Others come from the faeces and urine of animals, and the dead bodies of plants and animals as they decay. Farmers add artificial fertilizers to the soil which contain all the minerals that crop plants need.
3. In cultivated soils, removal of minerals takes place by uptake of minerals by plants and by leaching. So fertilizers have to be added to improve the fertility of the soil.
4. Mineral salts get into the roots of plants in solution. Some dissolve in the water in the soil and then enter the root hair cells in water. Most minerals, however, are moved into the plant root cells using energy.

Exercise Pages 76 - 79

1. Multiple choice questions

   i. b ii. d iii. b
   iv. a v. c
2. True or False
   i. False ii. False iii. True
   iv. False v. False
3. i. A: water B: carbon dioxide
   ii. D: oxygen E: glucose
   iii. sunlight
   iv. carbon dioxide + water + energy from the Sun → glucose and oxygen
   v. By testing it for starch.
4. Put a leaf in boiling water for two minutes to soften it.
   Put out the Bunsen flame.
   Heat the leaf in alcohol to take away the green colour.
   Soften the leaf in water.
   Add iodine to the leaf.
5. i. It uses the stored glucose for growth, respiration, and for storage when the leaves fall off.
   ii. Cellulose is used for making cell walls.
   iii. a. nitrogen b. from the soil
   iv. Because they contain stored sugar.
6. i. from the soil
   ii. By osmosis from the soil into the root hair cells. Osmosis is the movement of water from a high concentration to a low concentration.
   iii. They have thousands of tiny root hairs which have very thin walls which can absorb water easily.
   iv. Water travels in tubes called xylem.
   v. Plants use water for photosynthesis and to keep their cells fully stretched.

Ideas for investigations

Investigation 1 enables students to investigate chlorophyll to find out if it is a pure substance. Using chromatography (see also Chapter 12) students will find out that chlorophyll is made up of several different coloured pigments. Of these, green, yellow and orange should be visible.

SAFETY NOTE: Put on safety goggles. No naked flames. Work in a ventilated space.
Investigation 2 enables students to investigate osmosis. Students should take special care to ensure there is a tight seal between the Visking tubing and the capillary tube, and also ensure the knot in the Visking tubing is tight. Once the apparatus is set up, the level of sugar solution will rise quite quickly indicating an increase in the volume of the contents of the tubing. Water molecules pass through the wall of the Visking tubing by diffusion because they are small. Sugar molecules are too large to pass in the opposite direction.

Chapter 6 Particles

Evidence for the particle model Page 84

1. The ‘skin’ of the balloon has millions of tiny holes in it. The air molecules are small enough to pass through these holes and so the balloon deflates slowly.
2. When a pin is stuck in an inflated balloon, it deflates quickly because a larger hole has been made through which the gas particles escape.
3. The spreading of one substance through another.
4. Diffusion does not happen in solids because the particles are held together by strong forces of attraction. Although the particles vibrate, they are unable to break free.
5. The three physical states of matter are solid, liquid, and gas.

6. a) A solid has a well-defined shape.
   b) A gas does not have a well-defined shape.
   c) A liquid has a specific volume.
   d) A solid has a definite volume.
7. Natural gas has a specific smell which spreads through the air.
8. Water exists in all three states: solid (ice), liquid (water), steam (gas).
9. a. Strong forces of attraction hold the atoms or molecules close together in a solid that is why they do not flow.
   b. Due to the large distances between gas particles, gases can be compressed easily.

Expansion and contraction Page 85

1. When a metal bar is heated, its molecules gain energy and begin to move faster. They bump into each other more often and with greater force. This makes them move further apart and the space between them increases, thus causing the bar to expand.
2. Heating gives atoms and molecules more energy. This causes them to move faster and bump into each other more often and with greater force. As a result, they move further apart. Since the particles are much further apart in gases as compared to solids, expansion is more in gases than in solids.

Pressure in gases Page 86

1. Gases are squashy and can easily be compressed. If a sealed container can resist the expansion when a gas is heated, gas pressure will be produced inside it.
2. Millions of air molecules inside the balloon move rapidly in all directions, bouncing off each other and the walls of the balloon. Each time a molecule hits the wall of the balloon, it gives the wall a tiny push. Millions of tiny pushes add up to one big push, leading to increasing air pressure that inflates the balloon.
3. Air pressure is highest inside the balloon. That is why it remains inflated: otherwise it would become squashed.

Exercise Pages 87 - 89

1. Multiple choice questions

   i. d ii. c iii. c
   iv. b v. d
2. True or False
   i. False ii. False iii. False
   iv. False v. True
3. i. gas ii. solid iii. solid
   iv. liquid v. gas vi. liquid
   vii. gas
4. In a gas, particles are **far apart** and move very **quickly**. They frequently change **position**, moving in **straight** lines and **bouncing** off each other and the walls of the **container** they may be in. Gases have no **shape** and they can be easily **compressed** because the particles are not packed closely together.
   Gases usually have a low **density** because there are few particles in a small **volume**.
5. i. Heating gives atoms and molecules more energy, which makes the particles move at a much faster rate. They bump into each other more often and with greater force, thereby pushing each other further apart and causing an increase in size or volume of the material.
   ii. Aluminum expands three times as much as concrete so it will damage a concrete structure.
   iii. i. It will bend with the steel strip inwards as brass expands more than steel when heated.
   ii. It will straighten out then bend the other way.

Ideas for investigations

Investigation 1 enables students to investigate diffusion in liquids. A dish of large diameter will make measurements easier. After only a few minutes, students should be able to obtain the data to enable them to use the given formula to calculate the speed of diffusion.

As an extension to this investigation, students could repeat the experiment using water at different temperatures. This should enable them to confirm that diffusion is quicker at higher temperatures.

Investigation 2 looks at the effect of temperature on melting of ice and the evaporation of water. A thermometer in a beaker of ice will read 0°C irrespective of the amount of heat applied to the beaker. The temperature will only rise once all of the ice has turned to water. Similarly students will discover that water boils at 100°C no matter how much heat is applied.

SAFETY NOTE: Put on safety goggles. Take care with hot apparatus.

Chapter 7 Forces and their effects

Why do things float? Page 92

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

Stretchy materials Page 93

1. a. The ability of the body to return to its original length after being stretched.
   b. Elastic limit is the maximum amount of force beyond which the material which is being stretched will not come back to its original length.
2. a. Rubber is a very elastic material. It can stretch several times its original length so it is useful for making rubber bands.
   b. Since bicycle tyres need to bear a lot of pressure of the air inside them, the elasticity of the rubber helps them to bear the pressure without bursting.
3. Springs are good force measurers because when forces are applied, they stretch and spring back into shape evenly afterwards.
4. Answers similar to the following.
   Hang a metre-ruler and a strong spring from a nail. Mark the position of the end of the spring on the ruler. Hang the given standard masses to the end of the spring and note the extension in the spring on the ruler.
   Now hang the unknown object on the spring and mark the extension of the spring on the ruler. Use the obtained information to plot a graph and calculate the weight of the unknown object.
5. a. i. 5 cm ii. 0.5cm iii. 7.5 cm
   b. 15 cm

Calculating weight Page 95

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

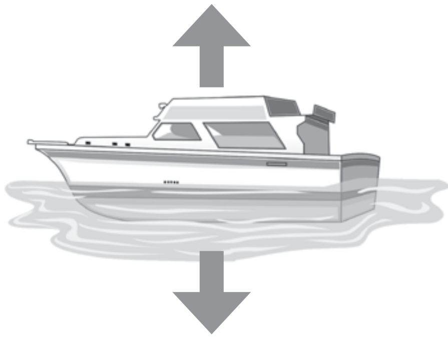
Slowing things down Page 96

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

Exercise Pages 98 – 101

1. Multiple choice questions
   i. b ii. c iii. b
   iv. b v. c
2. True or False
   i. True ii. False iii. True
   iv. True v. True
3. i. lawn mower, digging, weight-lifting
   ii. pulling the arrow, dragging a sledge, rowing
   iii. Magnetic force such as a bar magnet attracting iron filings. Frictional force, for example, a bicycle wheel rubbing against the road when brakes are applied.
   iv. Gravitational force
4. i. The density of an object is mass per unit volume.
   ii. 1g/cm^3
   iii. a. oil b. gold and lead
   c. hydrogen d. wood
   iv. Water has an up thrust which is the force that opposes the weight of wood. That is why wood floats on water.

5. i. a.



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

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

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

6. i. thin tyres of the cycle, proper oiling of parts

ii. By reducing friction, the cyclist would be able to move faster. More friction would require the cyclist to apply more force and energy to ride the cycle.

7. i. a. The car's streamlined shape allows air to slip past easily.

b. The big, wide rear wheels have more contact with the road creating greater friction.

Ideas for investigations

This experiment enables student to investigate that how elastic an elastic band is and also to find its elastic limit. By hanging weights from an elastic band suspended from a stand, students should measure the extension and record their findings in a table.

Loads of 1N, 2N, 3N, 4N and 5N are suggested although more may be needed depending on the thickness of the elastic band. To find the elastic limit of the elastic band, students will need to see if the elastic band returns to its original length after each weight is used.

Enough data should be obtained for students to draw a graph and see if the results support Hook's law.

Chapter 8 Food and digestion

Food and digestion Page104

1. Food
2. The body needs fuel for energy, for growth, and to keep it working properly.
3. Our body needs different types of food in the right quantities. If one type of food is missing, a person can become ill. On the other hand, large quantities of a particular type of food can make a person unfit. Therefore, a balanced diet is required to maintain a healthy body.
4. A balanced diet is one which provides the right balance between:
   - foods that provide energy
   - foods that help in body growth and repair
   - foods that help control chemical reactions inside the body
   - foods that contain dietary fibre (roughage)
5. Water is an essential part of a balanced diet because all the chemical reactions in the body take place in solution.
6. An illness that is caused when a vitamin is missing from our diet is called a deficiency disease. For example, a deficiency of vitamin C causes scurvy, a disease that makes the gums swell and bleed, and slows down the healing of wounds.
7. a. Add some Biuret solution to the milk in a test tube and shake it carefully. If the Biuret solution changes colour from light blue to purple, it means that protein is present.

   b. Shake a small amount of cheese with some ethanol in a test tube. Filter the solution into a clean test tube and then add some clean water to the filtrate. A white, cloudy emulsion will appear to prove the presence of fat.

   c. Add Benedict's solution to some crushed biscuits in a test tube. Put the test tube in a beaker of water and heat gently. If glucose is present, the Benedict's solution will change colour from blue, to green to brick-red.

   d. Add a few drops of iodine on to a fresh potato slice. If starch is present, the colour of iodine will change from brown to blue-black.
8. Wear safety glasses and handle hot equipment and harmful chemicals with care.

Digestion Page 105

1. Food consists of large molecules which cannot be dissolved. These must be broken down or digested into smaller soluble molecules, so that they can be easily absorbed into the blood.

2. Enzymes help to break down the large food molecules, thereby bringing about digestion of food.
3. A long tube called the alimentary canal that runs from mouth to anus, plus a few other organs such as the liver and pancreas that produce digestive enzymes.
4. About 10 metres
5. About 24 hours.

Digestion Page 107

1. The muscles in the walls of the alimentary canal contract and relax rhythmically in order to push food along, this action is called peristalsis.
2. To break down food into smaller pieces and to be mixed with saliva.
3. Saliva is slippery, it mixes with food to make it easier to swallow.
4. It is an enzyme that digests starch.
5. A short tube connecting the mouth with the stomach.
6. The stomach is a muscular sac with valves at each end to control the flow of food into and out of the stomach.
7. Gastric juice contains protease enzymes which digest protein, and hydrochloric acid which kills bacteria.

Digestion Page 109

1. The first part of the small intestine
2. In the gall bladder.
3. Emulsifies fats and neutralizes stomach acid.
4. In the pancreas.
5. In the walls of the small intestine.

6. & 7. Amylase digests starch to maltose
Protease digests protein to amino acids
Lipase digests fats to fatty acids and glycerol
Carbohydrase digests remaining carbohydrates to glucose.

8. Glucose, amino acids, fatty acids and glycerol.
9. The appendix is a small organ lying at the junction of the small and large intestines. In many herbivores such as rabbits the appendix is large to assist in the digestion of cellulose in plant cell walls.

Enzymes Page 110

1. A biological catalyst speeds up a chemical reaction, but is not broken down or changed by it. It lowers the amount of energy required for a chemical reaction to take place.
2. Starch, protein, and fat.
3. Glucose, amino acid, fatty acid.
4. A starch molecule is made up of several glucose molecules joined together like a string of beads.
5. Starch breaks down into glucose molecules.
6. Protease—acts on proteins and breaks them into amino acids.
Carbohydrase—acts on starch and breaks it into simple sugars like glucose
Lipase—acts on fats and breaks them into fatty acids and glycerol.

What affects enzymes? Page 113

1. a. Amylase is an enzyme found in saliva in the mouth.
   b. Amylase helps to break down starch into glucose.
2. To make a fair test and therefore obtain accurate results.
3. A sample was taken each minute. By counting the number of minutes from the first spot to the point when the starch was digested, the speed of the digestion can be found.
4. Enzymes work best at 37°C. At temperatures above this, enzyme activity is affected.
5. No starch had been digested. Not enough time.
6. pH7 neutral conditions in the mouth.
7. The stomach is pH4, very acidic. Amylase only works in neutral conditions.

Exercise Pages 114 - 117

1. Multiple choice questions
   i. a ii. d iii. c
   iv. d v. d
2. True or False
   i. True ii. False iii. True
   iv. False v. True
3. i. fat: energy and insulation
   protein: body building
   starch: energy
   sugar: energy
   ii. a. cheese b. meat
   c. bread d. sweet biscuits
   iii. Water is essential because all the chemical reactions in the body take place in solution.
4. i. glucose ii. amino acid
   iii. fatty acid and glycerol
   iv. amylase v. lipase
   vi. protease
5. a. i. E ii. H iii. D
   iv. B v. A vi. F
   vii. J
6. i. Villi increase the surface area of the lining of

the small intestine for the absorption of food into the bloodstream.

ii. a. Soluble substances can easily diffuse through the walls of the villi.
    b. More digested food will be absorbed.
    c. Small molecules of digested food pass through the thin capillary walls and enter the blood plasma easily.

Ideas for investigations

Investigation 1 uses a model of the small intestine to enable students to see that only small (digested) molecules such as glucose will pass through the wall of the small intestine and into the blood. Dialysis ('Visking') tubing is used to represent the small intestine. It behaves like a microscopic sieve allowing only tiny molecules such as water and glucose, through. Students should take special care to ensure the knots at each end of the 'Visking parcel' are tight. Testing the surrounding water for the presence of glucose will confirm that glucose passes through this model intestine.

Investigation 2 requires students to apply their knowledge of food tests and the effect of temperature on enzyme activity. Samples should be taken at 1 minute intervals and tested for the presence of starch (iodine) and sugar (Benedict's solution), until no more starch is found. Testing the saliva/starch mixture at room temperature should show that the starch is digested quite quickly. However the sample mixture containing boiled saliva should only show the presence of starch. From this students will see for themselves that enzymes are destroyed at high temperatures.

SAFETY NOTE: Put on safety goggles. Take care when handling hot apparatus. Take care when boiling the saliva in a test tube.

Chapter 9 Elements, compounds, and mixtures

What is an element? Page 119

1. An element is a substance containing only one kind of atom. Carbon contains only carbon atoms.
2. About 90
3. Solids: iron, silver, zinc
   Liquid: mercury
   Gas: bromine
4. a. silver b. copper c. mercury

Metals and non-metals Page 121

1. Dividing them into metals and non-metals.
2. a. Can be easily bent.
   b. Copper
3. a. Makes a ringing sound when hit.
   b. Iron
4. Refer to diagram of apparatus on Page 121.
5. Carbon

Uses of elements Page 123

1. Glows brightly when electricity passes through it.
2. Liquid helium is very cold which makes it ideal for cooling the magnet in medical scanner
3. Good conductor of electricity and can be drawn into wires.
4. Computers (electronic brains) are made up of silicon chips.

What is an atom? Page 124

1. An atom is the smallest part of an element that can exist and take part in a chemical reaction.
2. proton: a +ve charged particle
   neutron: a neutral particle with no charge
   electron: -ve charged particle
3. Nucleus.
4. Hydrogen has no neutrons. Hydrogen has only one electron shell. Other differences—numbers of electrons/neutron/protons.
5. Electron whizz around the nucleus in tiny orbits, so quickly that they turn into a blurry cloud.

Compounds and mixtures Page 125

1. Iron (Fe) and sulphur (S)
2. a. A mixture of copper and sulphur would be formed.
   b. A compound (copper sulphide) would be formed.
3. The chemicals are not chemically combined so can be separated by physical means.
4. Physical change—no new substance is made and a change, if any, is easy to reverse.
   Chemical change—a completely new substance is made and the change is difficult to reverse.

A mixture called air Page 127

1. a. Nitrogen, oxygen, and carbon dioxide.
   b. Nitrogen 79 cm^3, oxygen 20 cm^3, and carbon dioxide 0.04 cm^3.
   c. i. Nitrogen and oxygen
      ii. Carbon dioxide
2. a. Oxygen
   b. Carbon dioxide and nitrogen.

3. a. Carbon dioxide is denser than air and settles over a fire, putting it out.
   b. Liquid nitrogen is so cold it freezes food immediately.
   c. With argon surrounding it, a wire filament in a bulb can get very hot without burning.
4. a. Oxygen is used in hospitals for breathing.
   b. Oxygen is used for producing a very hot flame for welding.
5. The gases in the air can be separated by fractional distillation.

Exercise Pages 129 – 131

1. Multiple choice questions
   i. c ii. c iii. d
   iv. c v. b
2. True or False
   i. True ii. False iii. True
   iv. False v. True
3. Which of these is an element, compound, or mixture?
   i. Mixture ii. Compound
   iii. Compound iv. Element
   v. Element vi. Compound
   vii. Mixture viii. compound
   ix. Element
4. i. does not tarnish
   ii. can be drawn into wires
   iii. can be melted
   iv. can be hammered into thin sheets
5. i. A – proton B – neutron
   C – electron D – nucleus
   ii. a. electron b. proton
   c. neutron
   iii. Because atoms have same numbers of protons and electrons.
6. i. chemical change ii. physical change
   iii. physical iv. chemical change
   v. chemical change vi. physical change

Ideas for investigations Page 131

In investigation 1 students will investigate the conductivity of electricity by a selection of elements. Electrical conductivity is a property of metallic elements. Using the apparatus referred to, students will soon find out that, in general, metallic elements will conduct electricity and non-metallic elements will not.
When testing the carbon, students should find that it will conduct electricity, confirming that it is the only non-metallic element that has the same properties as metallic elements.

Investigation 2 requires students to find out what uses metals are put to in the home. The following is a list of metals and their uses which students may suggest (though there will probably be others). Alongside each is written whether it is an element or a compound.
Copper wire – element
Aluminium saucepan – element
Steel cutlery – compound
Brass door knobs – compound
Silver jewellery - element
Gold jewellery - element
Mercury thermometer - element

Chapter 10 The solar system

The planets of our solar system Page 133

1. A galaxy is a huge mass of stars.
2. Universe is so big that it contains 100 billion galaxies and scientists had to invent a new unit to measure it.
3. Eight
4. Luminous objects reflect light. Non-luminous objects do not.
5. All the planets and other bodies revolving around the Sun are held in orbit by the force of gravity.

Planet facts Page 135

1. a. 4500 million km b. –23°C
   c. 10 hrs
2. a. Mercury b. Neptune
3. a. Mars
   b. For Mars to rotate once takes 24 hrs 30 min. Its surface is rocky. It has nitrogen gas.
4. Venus has a much higher temperature than expected because its atmosphere contains carbon dioxide which has a greenhouse effect.

Days, months, and years Page 137

1. Night-time falls when our part of the Earth faces away from the Sun, where there is no light.
2. When the side of the Moon lit by the Sun faces the Earth, we see a full Moon. When the Moon is on the side of the Earth nearest the Sun it is called a new Moon.
3. a. The time taken for the Earth to complete one rotation on its axis.
   b. 27.3 days. The time taken for the Moon to orbit the Earth once.
   c. 365.25 days. The time taken for the Earth to orbit the Sun once.

4. Since the Earth takes 365.25 days to orbit the Sun, we cannot have a quarter of a day at the end of each calendar year. So the quarters are added together to produce an extra day every four years. Years that have an extra day are called leap years.

The seasons Page 138

1. 23 degrees
2. a. The part of the Earth which is tilted towards the Sun receives more light and is warmer, therefore, it experiences summer.
   b. The part of the Earth which is tilted away from the Sun receives less light and is colder, therefore, will be having the winter season.
3. a. The northern half of the Earth is tilted towards the Sun in June.
   b. The southern half of the Earth is tilted towards the Sun in December.
4. In December the northern half of the Earth, where UK is located, is tilted away from the Sun while the southern part, where Australia is located, is tilted towards the Sun. So it is warmer in Australia than in the UK.
5. Answers depend on students.

The Moon and eclipses Page 140

1. a. The craters were caused mainly by meteorites as they collided with the Moon.
   b. The Moon's seas are areas of basalt rock.
2. The Moon rotates once as it completes one orbit of the Earth. This means that the same side of the Moon is always facing the Earth.
3. a. An eclipse takes place when one planet or Moon blocks off light from another.
   b. i. During a solar eclipse, the Moon passes between the Earth and the Sun. As a result, light from the Sun is hidden and the Moon appears to us as a black disc surrounded by a halo of bright light.
      ii. During a lunar eclipse, the Earth is positioned between the Moon and the Sun. The Moon dims as the shadow of the Earth moves across the face of the moon.
   c. The Moon's orbit is slightly tilted (not in the same plane).

Information from space Page 141

1. a. We look at the stars from the Earth which is slowly revolving. So, like the Moon, the stars appear to move across the night sky.
   b. The Pole Star stays in the same position because it is in line with the Earth's axis.
2. The modern telescope uses large mirrors instead of lenses to focus light on to detectors. High quality images are then generated by computers.
3. Radio telescopes detect radio waves sent out by objects in space. These telescopes have large reflectors which focus the radio waves on to detectors.
4. The Hubble space telescope is not affected by dust and other pollution in the air.
5. Computers help to generate high quality images from the telescope detectors.

Information from space Page 144

1. a. Magellan flew to Venus.
   b. From May 1989 to August 1990.
   c. It found out that most of the planet was covered with volcanoes and lava.
2. Galileo and Cassini.
3. a. Yuri Gagarin. b. Russian.
4. The space ship was launched in 2001, which was part of the title of the movie.
5. a. The strong evidence that Mars had water.
   b. From April to October 2001.

Exercise Pages 145 -147

1. Multiple choice questions
   i. d ii. b iii. a
   iv. b v. a
2. True or False
   i. True ii. False iii. False
   iv. False v. False
3. The **Universe** contains everything that exists. Planet Earth is just a tiny part of a galaxy called the **Milky Way**. Our galaxy is only one of many star systems scattered throughout the Universe. Each galaxy contains millions of **stars** together with clouds of dust and gases. Galaxies are very far apart.
   Scientists gave estimated that the Universe contains 100 billion galaxies. It is so big that it is measured in light **years**. This measurement is the distance light travels in one year moving at 300,000 km per **second**.
4. i. a. Stars have light of their own, so they shine all the time.
      b. Planets reflect the light of the Sun so they can only be seen at night.
   ii. A star will appear to move across the night sky over a period of time.
   iii. a. The Earth is slowly revolving so the stars appear to move across the night sky.

b. The Pole Star does not appear to move because it is in line with Earth's axis.

5. i. It does not reflect light.
   ii. Sun
   iii. a. B and C   b. A
   iv. 24 hours
6. i. An eclipse takes place when one planet or moon blocks off light from another.
   ii. Light from the Sun is blocked so the moon appears to us as a black disc surrounded by a halo of bright light.
   iii. If the orbits of the Earth and the Moon were in the same plane there would be a lunar eclipse every month. However, the Moon's orbit is slightly tilted so it does not occur very often.

Ideas for investigations

These investigations enable students to develop their knowledge and understanding of night and day, sunlight intensity over the Earth and the seasons of the year.

Investigation 1 is very simple, best carried out in a darkened room. On a piece of vertical card the beam of light from the torch will be circular. When the card is lowered to 45° the shape changes to oval and the brightness of the light dims a little.

After carrying out investigation 2 students will hopefully appreciate why it is hotter in the equatorial regions than at the N and S Poles.

Investigation 3 enables students to model the relative positions of the Earth and the Sun during a year. The seasons in the N and S hemisphere should be easy to see. Students may wish to refer to the diagram of the seasons in the Student Book for extra guidance.

Chapter 11 The environment

The environment Page 149

1. a, b, and c. Answers depends on students. For example the student could be in a school environment with chairs, desks, cupboards etc.
2. a. Living things together with the abiotic (non-living) parts of their environment.
   b. A wood, river, seashore etc.

Where things live Page 150

1. Where animals and plants live.
2. The development of special features to enable a plant or animal to survive in its habitat.
3. Fruits/seeds in the shrub layer.

Habitats and adaptations Page 151

1. a. By filtering microscopic animals and plants from sea water.
   b. For cracking open the shells of crabs/mussels etc.
2. Sea currents and waves that might wash seaweeds away. Being submerged for long periods can deprive them of light for photosynthesis.
3. a. i. Stops them sinking into the sand.
      ii. Stores food as fat (not water!).
4. Leaves reduced to spines so there is a smaller surface area for evaporation of water. Water stored in fleshy stems. Waxy covering of leaves and stems to retain water.
5. a. Sleep during the day. Active at night.
   b. During the hot day animals will quickly dehydrate (lose water) and die. At night it is cooler so more comfortable to find food.
6. a. So that their leaves float closer to the surface to get light for photosynthesis.
   b. Streamlined bodies. Fins to help them swim through the water.

Food chains Page 153

1. a. Any living thing that makes its own food. Green plants are producers.
   b. Animals obtain their food by eating plants or other animals.
2. Most humans are omnivores as they eat both plants and animals.
3. Green plants use the Sun's energy to make their food during photosynthesis. Herbivores obtain this energy when they eat plants. When herbivores are eaten by other animals, this energy is transferred from them to the flesh-eating carnivores.
4. a. pond weed → tadpole → water beetle
   b. three.

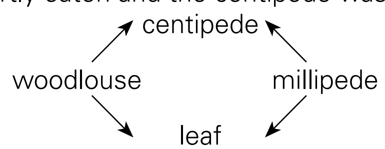
Food webs Page 154

1. a. i. E.g. rose → bee
      ii. grain → dormouse → owl
      iii. lettuce → slug → thrush → sparrow hawk
   b. slug, rabbit, chaffinch, dormouse, greenfly
   c. Sparrow hawk has the most varied diet as it eats different birds and rabbits.
   d. i. The sparrow hawk eats rabbits which eat the farmer's lettuce.
      ii. Slugs spoil a gardener's lettuce plantation. Thrushes eat slugs thereby keeping a control on their population. By eating the thrush, the sparrow hawk allows more slugs to feed on the lettuce.

2. a. It will reduce the number of blue tits and in turn the number of sparrow hawks will be affected.
   b. Encourage more blue tits e.g. provide safe nesting sites.

Investigating food webs Page 155

1. a. leaf b. woodlouse or millipede
   c. centipede d. woodlouse
   e) centipede
2. dead leaf → woodlouse → centipede.
   In dish 1 the leaf was partly eaten and the woodlouse was alive. In dish 4 the woodlouse was partly eaten and the centipede was alive.
3.



4. a. To prevent the animals escaping and also to prevent other animals getting into the dishes.
   b. To let air in and out.
   c. The animals live in the dark (leaf litter) where it is cool and dark.

Change part of a food web and… Page 156

1. Rabbits destroy all sorts of young plants by eating the young shoots. They also eat grass which could be used for grazing sheep and cattle.
2. a. Buzzards that fed mainly on rabbits became fewer in number.
   b. Plant-eating animals like deer increased in numbers because there was more to eat.
   c. Since the number of rabbits reduced, meat-eating animals had to look for other things to eat. For this reason smaller animals like mice were preyed upon and their populations began to decrease.
3. In Poland, otters were killed to protect fish stocks. In fact fish stocks fell. This is because otters often feed on diseased fish which are easy to catch. By killing the otters, the number of diseased fish increased leading to a fall in the fish stock.
   The DDT which was sprayed on to apple trees actually killed the small animals that lived in the barks of these trees and fed on the red spider mites. With the absence of a predator, the number of red spider mites increased.
   DDT that is sprayed on to fields to kill insects dissolves in rain water and is carried to rivers where the fish retain it in their bodies. Fish-eating birds such as herons and grebes accumulate DDT in their bodies after eating these fish.

Predators and prey Page 158

1. If one animal eats another, their populations affect each other. The number of predators affects the size of the population of its prey.
2. a. The number of snowshoe hares is reduced.
   b. It takes time for the effects of population changes to happen.
   c. There would be an overpopulation of snowshoe hares. They would start competing for food and ultimately they would start dying.
3. The Arctic lynx keeps the population of snowshoe hares under control. Sick and old animals are removed leading to a healthy hare population. The population of lynx is regulated by the number of hares available for food.

Exercise Pages 159 - 163

1. Multiple choice questions
   i. b ii. b iii. d
   iv. a v. a
2. True or False
   i. False ii. False iii. True
   iv. True v. True
3. i. Green plants can make their food during the day time. When the Sun sets, the process of photosynthesis stops and the plant makes use of the stored food.
   ii. In summer, trees make food by photosynthesis and store it in their stems. In winter the trees lose their leaves and can survive by using the food stored inside their stems.
   iii. Examples of competition:
   Two stags fighting for control over a herd of deer.
   Trees in a forest growing upwards to get light.
   A seagull chasing off other birds from food in a garden.
   Examples of predation:
   Farm cats killing mice, stopping them eating cereal crops.
   Lions hunting a zebra for food
   A spider catching a fly in its web.
   iv. zebra, fly
4. i. damp grass near a pond - frog
   ii. farmland growing crops - owl
   iii. damp ground with lots of soft-leaved plants - snail
   iv. a rose garden - bee
   v. fast running water - fish
   vi. an apple orchard - green fly
5. i. a. An eagle has sharp claws and beak.

b. The leaves of a cactus are reduced to spines, and the stem is covered with a waxy coating to reduce water loss.
c. Its mouth is shaped like a long tube.
d. It has sharp, pointed canine teeth and strong jaws.

ii. a. Not urinating and staying in their holes during the day helps gerbils to avoid water loss from their body.
b. Feeding at night helps gerbils to avoid being seen by their predators.

6. There are four links.
The arrows indicate flow of energy along the food chain.
Energy comes from the Sun.
Energy enters the food chain from sunlight by photosynthesis.
7. i. elodea → snail → water beetle
milfoil → tadpole → water beetle
ii. a. duckweed/elodea/milfoil/microscopic algae
b. snail
c. stickleback/water beetle/leech/ dragonfly nymph etc.
iii. The number of animals that feed on the snails e.g. water beetles, will be reduced in number.
iv. Bacteria and fungi decompose the dead remains of the organisms living in this pond. These are used by producers thereby recycling important elements.

Ideas for investigations

The first part of this investigation aims to develop student's understanding of the interaction between living things and with their environment. The second part test their understanding of predator—prey relationships.
The complete activity is very much dependent upon what sort of habitat students choose to study. The suggested small pond or pile of dead leaves should provide plenty of opportunity for the study of food chains and webs. Accurate identification of plants and animals may be difficult so it is probably best for students to use simple names such as grass, leaf, tree, bush tree, fish, snail, worm, fly, bird etc..

Chapter 12 Solutions

Solutions Page 165

1. a. The liquid in which a solute dissolves.
b. The solid which dissolves in a solvent.
c. A solution is formed when two substances mix completely with each other.
d. A suspension is formed when small particles of an insoluble substance float in a solvent.
2. a. sugar b. water
3. Sugar, salt. We call them soluble.
4. Sand, oil. We call them insoluble.
5. Fizzy drinks contain carbon dioxide dissolved in flavoured water. When the bottle is opened the carbon dioxide rushes out of solution causing the drink to foam.
6. When no more solid will dissolve in a liquid the solution is saturated. Before that, the solution is unsaturated.

Separating solids from liquids Page166

1. a. The removal of suspended solid particles from a mixture by pouring the mixture through filter paper.
b. The liquid part of the mixture which passes through the filter paper.
c. The solid particles that are left on the filter paper.
2. Filtration is not a good method for removing dissolved solids because all the solution would pass through the filter.
3. a. Filter the sea water to remove the suspended insoluble matter from it. Heat the filtered sea water in a china dish. Dry salt crystals will be left behind.
b. The water will evaporate.
4. Add water to the mixture and stir it. Sugar will dissolve in the water and chalk will be suspended in the liquid. Filter the mixture. Chalk will be left as residue on the filter paper. Sugar can be recovered from the filtrate by heating it to dryness.

Liquids from solutions Page169

1. The steam will be colourless because it is only the water that is evaporating and not the ink particles.
2. a. distilled water.
b. It is used in car batteries, steam irons and laboratories.
3. a. boiling b. condensing
4. As the solution is heated and the temperature rises to 56°C, the liquid with the lowest boiling point (A) evaporates first. It condenses and can be collected in a beaker. When the temperature begins to rise, it means that liquid A has evaporated completely. Continue heating and

when the temperature reaches 72°C, liquid B begins to evaporate. This can be condensed and collected in a second beaker.
The liquid that is left behind in the flask is water. It can be tested by heating the solution further to 100°C as pure water boils at that temperature.

Separating coloured substances Page 172

1. Water moving across the absorbent paper.
2. The movement of the colours depends on their solubility. The most soluble colour moves the furthest.
3. Absorbent paper is rolled up and stood in a solvent. The solvent rises up the paper carrying the substances with it. Each substance travels a different distance.
4. The base line is drawn so that all the chemicals start from the same point and distance travelled by each substance can be measured
5. Some coloured dye (not chemical) could be added so that the distance the amino acids travelled could be seen easily.

Separating solids from a mixture Page 171

1. When a solid turns directly into a gas without passing through the liquid state.
2. Heat the mixture in a heatproof dish covered with a plugged inverted funnel. Iodine will sublime then condense on the cool walls of the funnel.

Solubility Page 172

1. a. A saturated solution is one which cannot dissolve any more solute at that particular temperature.
   b. Take 100 cm^3 of water in a beaker, add a teaspoonful of sugar and stir it well. Keep adding sugar and stirring until no more sugar can dissolve in it. Sugar will start settling at the bottom of the beaker. This is a saturated sugar solution at room temperature.
2. a. 180 g   b. 250 g
3. 85ºC
4. Salt. Solubility of each solute is different at a particular temperature.
5. As the temperature rises the solubility of a salt also increases.

Exercise Pages 173 -175

1. Multiple choice questions
   i. b   ii. c   iii. b
   iv. b   v. c
2. True or False
   i. True   ii. False   iii. False
   iv. True   v. False
3. i. The filtrate is brown.
   ii. To remove or hold back the ground coffee beans.
   iii. i. the dissolved coffee
        ii. the undissolved particles of coffee beans
   iv. a. the insoluble particles will be seen floating or settled at the base of the coffee
       b. suspension
       c. When some of the insoluble particles settle at the bottom of a liquid, they form sediment.
4. i. fractional distillation
   ii. filtration and evaporation
   iii. fractional distillation
   iv. filtration
   v. evaporation
   vi. paper chromatography
5. i. Place a drop of ink at the centre of a piece of filter paper. Carefully squeeze drops of water on to the ink. Leave a little time between the drops to let the ink spread out. As the water moves across the filter paper it will carry the colours with it.
   ii. Refer to the diagram on page 168 of Student Book.

Ideas for investigations

Investigation 1 aims to enable students to extend their knowledge of chromatography. The use of washable pens is because their inks dissolve easily in water. Water can therefore be used as the solvent in this investigation rather than other more hazardous chemicals. Surprisingly many coloured inks are not pure substances and students will see an array of different coloured results which they can present in the table.
In investigation 2 students are presented with the challenge of obtaining pure salt from rock salt. By carefully carrying out the processes of grinding to a powder, dissolving in warm water, filtering and evaporating to dryness, student should achieve good results. Reference to the appropriate pages of the Student book will provide any necessary guidance.

SAFETY NOTE: Put on safety goggles. Take care handling hot apparatus.

Answers (Workbook)

Chapter 1 Science skills

Page 2

1. i. False ii. True iii. False
   iv. True v. False
2. i. a ii. c iii. b
   iv. c v. a

Page 3

3. i. pipette ii. scales
   iii. round bottomed flask
   iv. test tube v. filter funnel
   vi. beaker vii. thermometer
   viii. evaporating basin ix. flat bottomed flask
   x. ruler
4.

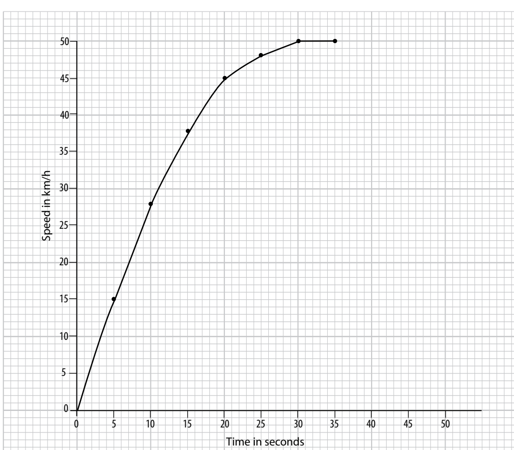
Measurement	Units	Unit symbol
length		m
	kilograms	
volume	metres cubed	
	seconds	
temperature		

Page 4

5. i. 40 ml ii. 64 ml
   iii. 122 ml iv. 70 ml
6. i. 20° C ii. 50° C
   iii. 75° C iv. 25° C
7. i. 5 min 7s ii. 36 min 26s
   iii. 8s iv. 20 min 56s

Page 5

8. 4.8g 72.6g 199.1g 0.5g
9. i.



   ii. 25 km/s (± 1 km/s)
   iii. 12 s (± 1 s)
   iv. Cyclist has reached his/her maximum speed

Chapter 2 Life and living things

Page 6

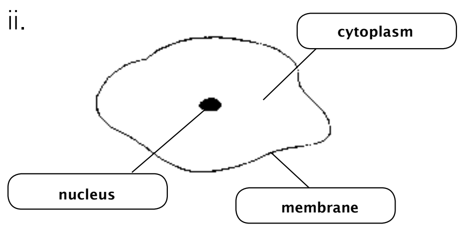
1. i. False ii. True iii. False
   iv. True v. True
2. i. c ii. b iii. a
   iv. a v. c

Page 7

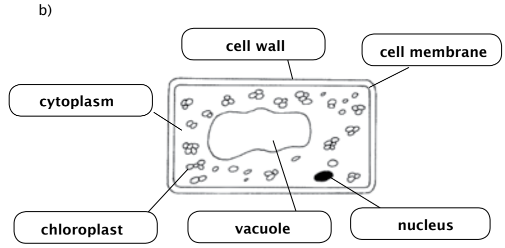
3. Respiration - getting energy out of food
   Growing - getting bigger
   Reproduction - making more of the same kind
   Movement - going from one place to another
   Excretion - getting rid of waste
   Response - reacting to something
   Feeding - taking in nutrients

Page 8

4. i and ii.



b)



   iii. a. Plant cells have a cell wall.
   b. Plant cells have chloroplasts.
   c. Plant cells have a vacuole.

Page 9

5. red blood cells - smooth and circular shape to squeeze easily past other cells.
   nerve cell - long extension to carry messages over long distances
   pollen grain - spiky surface to help them stick to the insects.
   epithelial cell - thin and flat to form a protective layer against infection.

Page 10

6. Lungs to exchange oxygen and carbon dioxide with the surrounding air.
   Kidneys to remove waste from the body and to regulate the amount of water in the blood.
   Stomach and intestines digest and absorb food into the body.
   Heart is a muscular pump which send blood around the body.
   Nerve is made up of nerve cells which carry messages around the body.

Page 11

7. i. A - eyepiece lens   B - objective lens
   C - stage   D - mirror
   E - focus knob
   ii. To magnify the image.
   Putting the microscope slide on.
   Reflects light through the object and then through the lenses.
   Adjusts the objective lens to focus the image.
   iii. It magnifies the image 10 times so it appears 10 times larger
   iv. $10 \times 10 = 100$ times

Page 12

8. i. 1. Light from an object
   2. Light passes through the cornea, pupil, and lens.
   3. Light strikes the retina and stimulates nerve cells.
   4. Picture (image) on the retina is small and upside down.
   5. Nerve cells send signals to the brain along the optic nerve.
   ii. Two from:
   Upside down
   Smaller than the object
   Laterally inverted
   iii. Light rays are focussed by the cornea and lens
   iv. The lens

Page 13

9. i. a. fingertip
   b. elbow
   ii. It is not the same all over the body.
   iii. They are not the same distance apart all over the body
   iv. Repeat the test on more people.

Chapter 3 Energy resources

Page 14

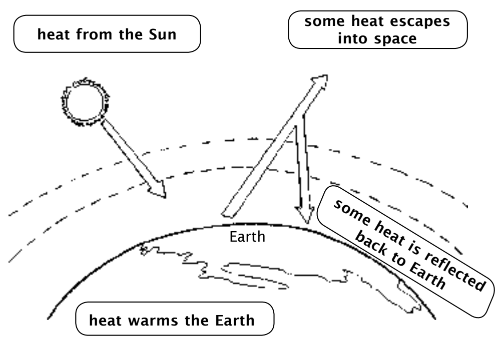
1. i. True   ii. False   iii. False
   iv. False   v. True
2. i. b   ii. d   iii. b
   iv. a   v. a

Page 15

3. When animal and plant waste **decays**, a gas called **methane** is given off. This gas can be collected and used as **fuel**. Some villages in developing countries have **biogas** generators. Animal waste is put into a tank with a lid. As **microbes** digest the waste, gas is given off. This can be used for **cooking** and heating homes in cold countries.
4. i. Any two from coal, oil, natural gas, wood, peat.
   ii. a. oxygen
   b. oxygen + carbon → carbon dioxide
   iii. When ignited, energy is used to break the bonds in the fuel molecules. Fuel atoms combine with oxygen to form new molecules. Making of new bonds releases energy.

Page 16

5. i.



   ii. Global warming
   iii. Carbon dioxide is a good insulator/good at keeping heat in. Just like the glass in a greenhouse.
   iv. Ice caps melt, sea levels rise so low-lying countries flood.

Page 17

6. Solar panels absorb heat from the Sun to heat water so saving fuel.
   Double glazing has a layer of air trapped between the glass. Air is a good insulator so reducing heat loss.

Shutters trap a layer of air between themselves and the window. Air is a good insulator so reducing heat loss.
Conservatory facing south will get most available heat from the Sun. Heat is retained (like a greenhouse) during the night thus saving fuel to heat the house.
Cavity wall insulation traps air which is a good insulator and prevents heat loss by conduction/ radiation.
Loft insulation traps air which is a good insulator and prevents heat loss by convection.

Page 18

7. i. Electricity is produced from the rising and falling of the tides.
   ii. estuaries/mouths of rivers.
   iii. At high tide water passes through a turbine and into the river. At low tide water moves in the other direction also turning the turbine producing electricity.
   iv. a. Constant supply of electricity
       b. Once built it provides cheap electricity
   v. a. Expensive to build
       b. Considerable environmental impact.

Page 19

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

Page 20

9. i. to make it a fair test ii. walnut
   iii. sunlight iv. chemical
   v. a. sleeping/sitting b. running
   vi. a. put a screen around the apparatus.
       b. to prevent heat loss to the surroundings (by radiation)

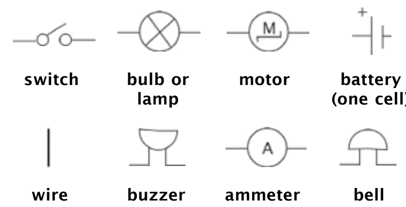
Chapter 4 Electrical circuits

Page 22

1. i. True ii. False iii. False
   iv. False v. False
2. i. b ii. c iii. c
   iv. d v. b

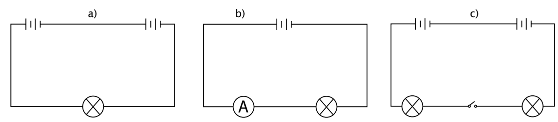
Page 23

3.



Page 24

4.



5. i. 0.4 A
   ii. a. The brightness decreases.
       b. The total current is divided equally between the two bulbs.
       c. It becomes difficult for the current to flow in the circuit.
       d. The cell is pushing the current through two bulbs.

Page 25

6. i. a. B2
       b. The switch to B1 is open so no current can flow to B1
   ii. They will be dimmer than when B2 was lit on its own.
   iii. Parallel circuit
   iv. in the home

Page 26

7. i. a. The reading on the ammeter also increases.
       b. The wire wool becomes hotter and glows red.
   ii. The wire wool should not be touched.
   iii. It tries to stop the current from flowing through it.
   iv. in an electric bulb or in fuses

Page 27

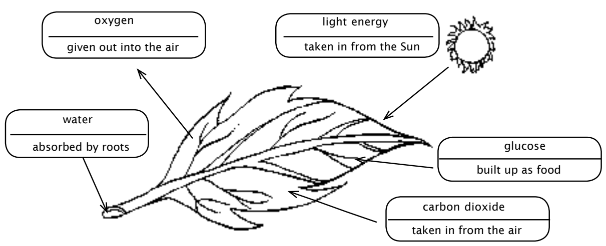
8. i. a. 13 A b. 3 A
   ii. If the current flow becomes too large, the 13 A fuse will not break the circuit, and the food processor may burn out.
   iii. a. 13A b. 920/230 = 4 A
       c. 5A

Chapter 5 Plants and Photosynthesis

1. i. False ii. False iii. True
   iv. True v. True
2. i. a ii. c iii. b
   iv. a v. c

Page 29

3. Glucose is a type of **sugar**. It is the 'food' made by plants during photosynthesis'. A plant can do lots of things with the glucose it makes.
   Some of it will be used straight away to produce energy during **respiration**.
   Some glucose is changed into **cellulose** to make new cell walls. It gives a strong coat to plant cells.
   Some glucose will be changed into **starch** or oil and stored in the roots, **stem**, seeds, and fruits.
   Some is joined up with **minerals** from the soil. Nitrogen, for example, is joined with glucose to make **protein** which is needed for growth.
4. i.



   ii. carbon dioxide + water → glucose + oxygen

Page 30

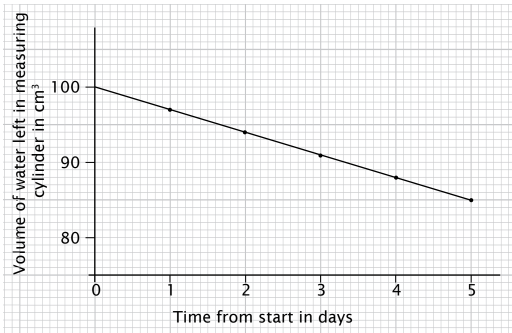
5. i. a. to soften/kill it
      b. alcohol will catch fire
      c. removes chlorophyll
      d. iodine
      e. blue-black
   ii. a. sunlight
      b. The part that was covered did not receive sunlight therefore it could not photosynthesize and make starch.
      c. So the leaf gets enough water. Only one variable is changed.

Page 31

6. i. So there is enough light for photosynthesis
   ii. Bubbles of gas are produced during photosynthesis and are lighter (less dense) than water.
   iii. a. oxygen
      b. Test the gas with a glowing splint, it will burst into flame.
   iv. a. The rate of the bubbles rising in the tube will slow down.
      b. Less light means less photosynthesis therefore less oxygen produced.

Page 32

7. i.



   ii. So the only water lost is through the leaves.
   iii. The volume of water in the cylinder falls.
   iv. Water is absorbed by the plant through the roots and carried to the leaves where it is lost to the air (by transpiration).
   v. Root hairs increase the surface area for absorption. Their thin walls help to absorb water quickly.

Page 33

8. i. a. Its leaves will be yellow. Good root growth.
      b. Its leaves will be yellow. Poor root growth.
   ii. A plant starved of nitrogen has yellow leaves, a short stem and a poor root system.
      A plant starved of magnesium also has yellow leaves but the stem is longer and has better root growth.
   iii. Through the roots. Some in solution in soil water. Some transported directly as mineral ions.
   iv. Nitrogen joins with glucose to make protein which leads to successful and rapid growth of leaves etc.. The better the growth the more food is produced.

Chapter 6 Particles

Page 34

1. i. True ii. True iii. True
   iv. False v. False
2. i. a ii. c iii. a
   iv. b v. a

Page 35

3. i. a. bricks, timber, tiles
      b. They are solid so have a fixed shape and volume.
   ii. a. Paint and polish

b. They are liquid so have no fixed shape. They take the shape of their container. A lid is useful to prevent spillage.

iii. a. Propane, butane, and compressed air.

b. Gases take up all available space and escape easily so need to be kept in sealed containers.

Page 36

4. i. solid
   ii. The particles are held close together (but not tightly) in rows and they are arranged a definite pattern.
   iii. The particles have enough energy to move about (vibrate) but not break away.

Page 37

5. i. melting ii. boiling iii. cooling
   iv. freezing v. melting and boiling

Page 38

6. i. The particles of water fill the spaces between the alcohol particles and this makes the volume smaller than expected.
   ii. There are tiny holes in the skin of the balloon through which the air particles escape.
   iii. The molecules of the gas collide with the moving air molecules and spread through the room by diffusion.
   iv. The air pressure inside the tyre increases as more air particles will be pumped into it. It will get harder as more particles bounce off the inside of the tyre.

Page 39

7. i. a. There will be an even light brown colour in both jars.
   b. No, the result should be the same. The gases would mix evenly by diffusion irrespective of their position.
   ii. Since particles are always in motion, some of the manure particles collide with the air particles and the smell of the manure will spread by diffusion.
   iii. The smell of food cooking in the kitchen spreads throughout the house.
8. i. The top would expand, loosen and come off easily.
   ii. The particles of the metal screw top will gain heat energy and will start moving faster, thus bumping into each other and pushing each other away and causing expansion.
   iii. Plastics do not not expand and contract as much as metals so plastic tops will usually be easier to remove.

Chapter 7 Forces and their effects

Page 40

1. i. True ii. True iii. False
   iv. False v. True
2. i. a ii. c iii. b
   iv. b v. c

Page 41

3. i.

Pull cables	Brake pads	Pulls brake pads onto the wheel	Brake cables
Turns the main gear around	The wheels	Turns the wheels round	A chain

ii. a. brakes, gripping pedals, gripping handlebars, tyres on the road

b. oiling the chain and other moving parts, keeping tyres inflated to reduce contact with the road

iii. a. increases

b. surfaces rub together more as speed increases

Page 42

4. i. A life jacket is filled with air so it is less dense than water. Upthrust of the water is greater than the weight of the body and lifejacket.
   ii. A ship displaces much more water than a block of steel. The upthrust of water on the ship is greater than that of the steel block due to the difference in the amount of water displaced.
   iii. As the load increases, the weight of the ship becomes greater so reducing the upthrust of the water.
   iv. When in water, upthrust acts upon the whale's body making it feel relatively light. On land, its weight pulls down on it making it difficult for the whale to move.
   v. Upthrust of the sea water acts on our feet, therefore, reducing the force being applied on the pebbles and causing less pain.

5. i. copper block
   ii. cork, wood, magnesium, china, aluminium, copper
   iii. wood 6 / 8 = 0.75 g/cm^3
   cork 2.4 / 8 = 0.3 g / cm^3
   copper 70 / 8 = 8.75 g/cm^3
   magnesium 14 / 8 = 1. 75 g/cm^3
   aluminium 22 / 8 = 2.75 g/ cm^3
   china 19 / 8 = 2.38 g/cm^3
   iv. a. wood and cork
   b. They have a density less than that of water.

Page 43

6. i. 4 kg ii. 10 N iii. 10 N
   iv. 1 kg
7. i. 10N ii. 2 kg iii. 6 times
   iv. a. Nothing He/she is weightless.
   b. No gravitational pull in outer space.

Page 44

8. **ladder**
   i. large ii. otherwise the ladder would slip
   hand gripping handle
   i. large ii. otherwise the person's hand would slip and not grip the handle
   sliding door
   i. small ii. otherwise it would need a lot of force to open and close the door
   ship
   i. small ii. otherwise it would be difficult for the ship to move
   subway track
   i. large ii. so the wheels grip the track
   skier
   i. small ii. otherwise the skier would not be able to ski downhill

Chapter 8 Food and digestion

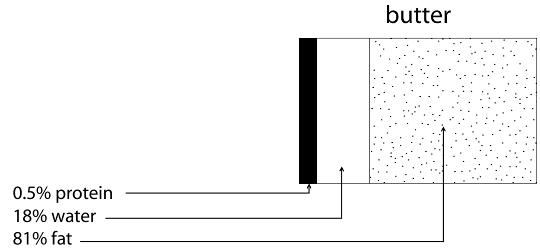
Page 46

1. i. False ii. True iii. False
   iv. True v. True
2. i. b ii. a iii. a
   iv. b v. b

Page 47

3. 'The end products of digestion are glucose amino acids, fatty acid and glycerol. The molecules are absorbed through the wall of the small intestine into the bloodstream, where they are carried in solution in the plasma. The wall of the small intestine is folded and covered in tiny projections called villi which have very thin walls.'

4. i. a. bread, potato, biscuit
   b. milk, Cheddar cheese, biscuit
   c. Cheddar cheese, bread, meat, fish, milk, egg
   d. lettuce, egg, orange , milk potato
   ii. Fruit and green vegetables have no fat and very little carbohydrate.
   iii. Milk contains less fat than cheese. It also has some carbohydrate which cheese does not. Cheese contains more protein.
   iv.

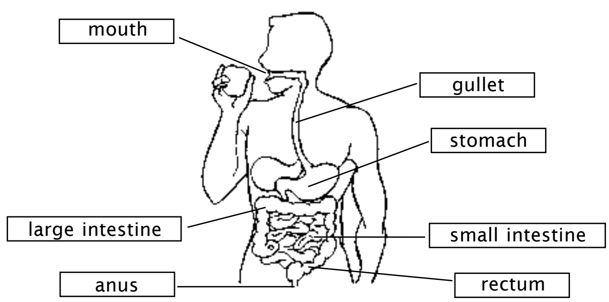


Page 48

5. i. a. 14.1 g
   b. It helps to retain water keeping the faeces soft. It also gives the intestine muscles something to push on, to keep the food moving through the system.
   ii. a. It contains few minerals and vitamins.
   b. Minerals important for making body parts e.g. calcium for bones and teeth. Vitamins for chemical reactions in the body.

Page 49

6. i.



   ii. a. Food is chewed and mixed with saliva, and then swallowed.
   b. Food is churned and mixed with gastric juice.
   c. The process of digestion is completed and digested food is absorbed through the walls into the blood stream.
   d. Water is absorbed from the waste leaving semi-solid faeces.

Page 50

7. i. a. Starch and protein molecules are complex molecules which exist as chains.
   b. Protein molecules break down to form amino acids. Starch molecules break down to form glucose molecules.
   ii. From the type of food substances that they act upon.
   iii. a. Carbohydrase (in saliva) can only act in a neutral medium. The medium in the stomach is acidic due to the presence of hydrochloric acid.
   b. Neutralization is carried out because the enzymes in the small intestine cannot work in an acidic medium.

Page 51

8. i. 40°C
   ii. The normal temperature of the human body is between 37 to 40°C which is the best temperature for enzymes to act in.
   iii. At low temperatures it takes longer for the egg white to be digested.
   iv. It would take too long for protein to be digested and be passed out with the faeces.
   v. Repeat the experiment to get more readings then average. Use narrower temperature bands e.g. 5°C

Page 52

9. i. a. Take a small amount of the solution in a test tube and add a few drops of iodine solution. If the colour changes from brown to blue-black, it shows that starch is present.
   b. Take a small amount of the solution in a test tube and add some Benedict's solution. Shake the test tube carefully. Heat the test tube gently in a beaker of water. If glucose is present, the Benedict's solution will change colour from blue to green to brick-red.
   ii. a. Glucose
   b. The glucose molecules are smaller than the holes in the membrane.
   iii. Starch molecules are larger than the holes in the membrane.
   iv. The small intestine.
   v. The blood

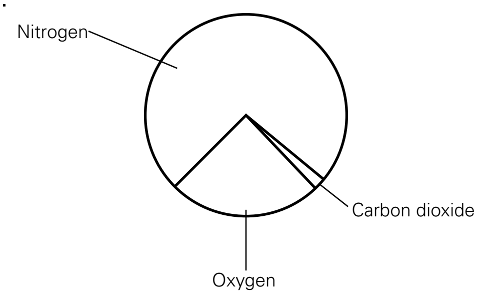
Chapter 9 Elements, compounds, and mixtures

Page 54

1. i. False ii. True iii. True
   iv. True v. False
2. i. a ii. b iii. a
   iv. c v. c

Page 55

3. i. a. nitrogen b. hydrogen
   c. argon d. oxygen
   e. carbon dioxide
   ii.

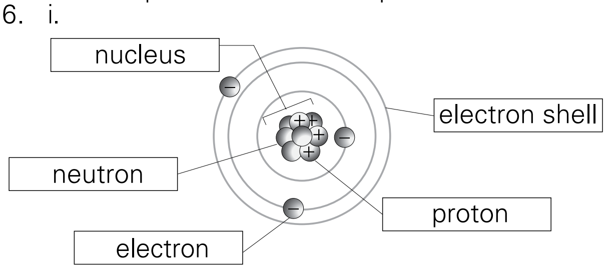


   iii. Air is liquefied by cooling. Each gas has a different boiling point. The liquefied air is warmed. As each gas vapourizes it is collected.
4.

Metals	Non-metals
difficult to melt	melt easily
high melting point	poor conductors of heat
make a noise when hit	dull appearance
shiny when polished	many are gases
hard solids	brittle or powdery

Page 56

5. i. a. (a) b. (b) c. (c)
   ii. An element contains only one kind of atom.
   iii. A mixture can be easily separated. A compound cannot be separated.
6. i.



ii. An electron has a negative (-ve) charge. A proton has a positive (+ve) charge.
iii. Neutrons have no charge.
iv. Electrons

Page 57

7.	aluminium	cooking foil
	americium	smoke alarms
	copper	electric wires
	chromium	shiny car parts
	mercury	thermometers
	silicon	computer chips
	xenon	car headlights
8.	sand	building
	baking powder	cooking
	lime	mortar
	ammonia	cleaning
	carbon dioxide	fizzy drinks
	methane	fuel

Chapter 10 The solar system

Page 58

1. i. False ii. False iii. True
   iv. False v. False
2. i. c ii. d iii. c
   iv. c v. c

Page 59

3. A solar eclipse happens when the **Moon** passes between the **Sun** and the **Earth**. Light from the **Sun** is hidden and the **Moon** appears to us as a black disc surrounded by a halo of bright light.
   A lunar eclipse happens when the **Earth** passes between the **Sun** and the **Moon**. The shadow of the **Earth** covers the face of the **Moon**.
4. **V**enus, **E**arth, **M**ars, **J**upiter, **S**aturn, **U**ranus, **N**eptune

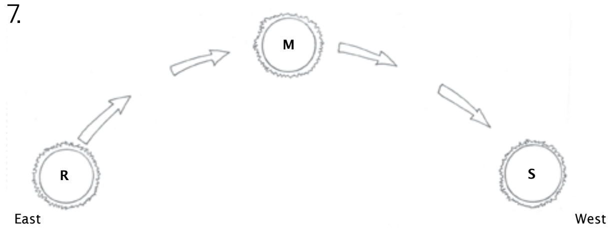
Page 60

5. i. a. Mercury b. Neptune
   ii. a. Jupiter b. Mercury
   iii. a. Mercury b. Neptune
   iv. Neptune
   v. The further the planet is from the Sun, the longer it takes to orbit it.
   vi. Because Neptune is very far away from the Sun.

Page 61

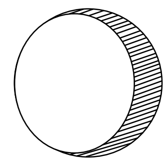
6. i. A, B and C ii. D and E
   iii. C iv. A
   v. E

7.



Page 62

8. i. The Moon does not give out its own light. It reflects light from the Sun.
   ii.



   iii. 1 iv. 5 v. 28 (27.3)
   vi. The Moon rotates once in the same time as it takes to complete one orbit of the Earth.

Chapter 11 The environment

Page 64

1. i. True ii. False iii. False
   iv. False v. False
2. i. b ii. d iii. c
   iv. d v. c
3. i. Environment is a scientific word for surroundings. It consists of all the living and non-living things that occur naturally in that area.
   ii. The living things in an environment.
   iii. The non-living things in an environment.
   iv. Any four from: fox, bird, squirrel, deer, tree, grass, flowering plants.
   v. Any four from: wind, rain, temperature, landscape, soil type.

Page 66

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

Page 67

5. i. Answer depends on the student but should include a reference to such things as;
good (forward) vision
speed
agility
strong jaws
ii. Answers depend on the student but should include a reference to such things as;
good all round vision
speed (for escape)
agility (for escape)
camouflage

Page 68

iii.

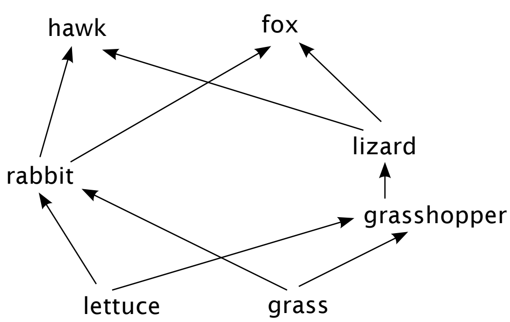
butterfly	bird
deer	lion
rabbit	fox
mouse	owl
fish	seal

Page 69

6. i. herbivore: slug
carnivore: thrush or cat
consumer: slug thrush or cat
ii. lettuce
iii. a green plant
iv. The flow of energy along the food chain.

Page 70

7. i.



ii. a. The number of lizards will reduce because with the grasshoppers dead, the lizards will not have any food. They will die of starvation.
b. Grass and lettuce plants will grow and reproduce more as the number of one of their consumers has been reduced.
c. With the grasshoppers dead, the rabbits would be able to get plenty of grass and lettuce to eat. Their number would increase, which means foxes would have more rabbits to prey on. Thereby the population of foxes will also increase.

8. i. For 60 years
ii. They have been living together quite happily in many areas of woodland.
iii. The red squirrels are unable to digest acorns.
iv. The squirrels are competing for food.
v. More coniferous woodland, especially pine trees, should be grown so that red squirrels can have their preferred diet.

Chapter 12 Solutions

Page 72

1. i. False ii. False iii. True
iv. False v. True
2. i. a ii. a iii. c
iv. c v. b

Page 73

3. When sugar dissolves completely in water a **solution** is formed. The solid sugar is called the **solute** and the water is called the **solvent**. Because it dissolves, sugar is described as **soluble**. Sand will not dissolve in water, it is described as **insoluble**.
4. i. evaporating ii. filtering
iii. sieving iv. filtering/sieving
v. sieving vi. filtering
5. Weigh a sample of lawn sand. Put it in a beaker, add water to it and stir. The fertilizer will dissolve in the water, and sand will settle at the bottom as sediment. When filtered, sand will be left on the filter paper and the solution will pass through. Heat the solution to dryness in a china dish. Dry the sand by heating it in a china dish. Weigh both the sand and the fertilizer thus obtained. If the manufacturer's claim is genuine, their weights should be equal.

Page 74

6. i. 2 ii. D
iii. a. B
b. Its components have separated into 2 spots which are similar to the homework pen.
iv. The ink dissolves in the solvent. The solvent rises up the paper carrying the ink with it. Individual pigments/colours do not move as fast as each other so get left behind as blobs. Each pigment /colour travels a different distance.
v. chromatography

Page 75

7. i. a. sodium chloride
      b. potassium nitrate
   ii. sodium chloride
   iii. approximately 40 g
   iv. 24°C

Page 76

8. i. Change state from solid to a gaseous.
   ii. To cool/condense the iodine vapour
   iii. a. Iodine crystals
        b. Iodine vapour condenses on the cold surface to form iodine crystals.
   iv. Ammonium chloride

Answers (Worksheets)

Chapter 1

Worksheet 1–1

1. Science is about obtaining knowledge by observation and experimentation and using that information to describe natural things.

2.

biology	the study of life and living things
chemistry	the study of matter and its properties
physics	the study of matter and energy and their interactions

3.

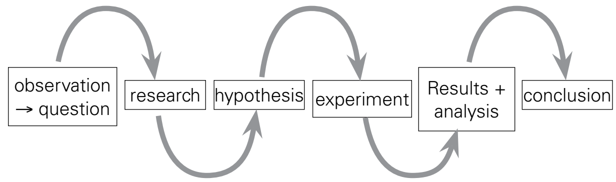
Chapter 1	Science skills	all three
Chapter 2	Life and living things	biology
Chapter 3	Acids and alkalis	chemistry
Chapter 4	Energy resources	physics
Chapter 5	Simple chemical reactions	chemistry
Chapter 6	Electrical circuits	physics
Chapter 7	The environment	biology
Chapter 8	Particles	chemistry
Chapter 9	Forces and their effects	physics
Chapter 10	Variation and classification	biology
Chapter 11	Solutions	chemistry
Chapter 12	The solar system	physics

4.

paleontology	the study of prehistoric life
oceanography	the study of the oceans
forensics	the science used to solve crimes
astronomy	the scientific study of space
ecology	the study of organisms and their environment
ethology	the study of animal behaviour
zoology	the study of animals
biochemistry	the study of chemical process in living things
genetics	the study of hereditary traits
botany	the study of plants
meteorology	the study of the atmosphere, including weather forecasting
pharmacology	the study of the effects of medicines

Worksheet 1-2

1.



a. An observation leads to a question. You need to research what information is already available that is relevant to your question. You need to form a hypothesis (based on your research).

b. You need to observe carefully, write down what you see, and measure to obtain your data.

c.

What are you measuring?	Which instrument do you use?	What units could you use?
length	ruler, tape measure	km, m, cm
volume	measuring cylinder	l, ml, cm^3
mass	scales, balance	g, kg
temperature	thermometer	degrees Celsius (°C), degrees Kelvin (K), degrees Fahrenheit (°F)
time	stop clock, stopwatch	s, min

d. Answers will depend on the dimensions of the pencil and paperclip. Please ensure units are included – most likely cm.

e. 29 ml

f. 0.30 gms

g. 1 m 12 sec

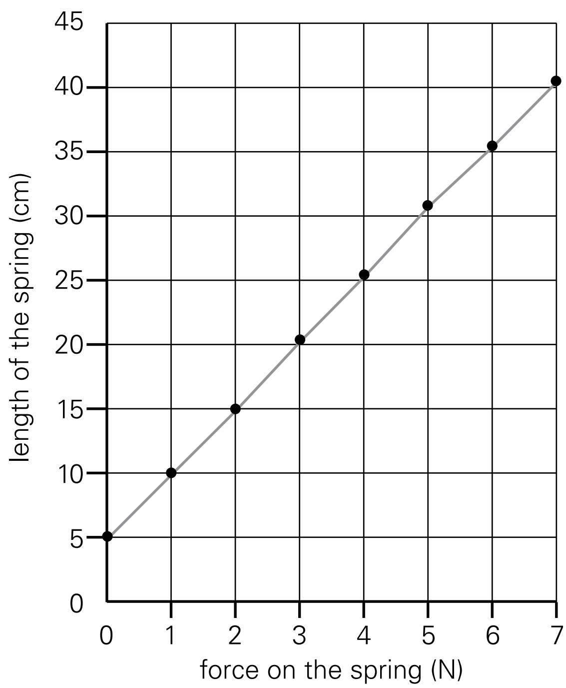
Worksheet 1-3

Answers depend on students

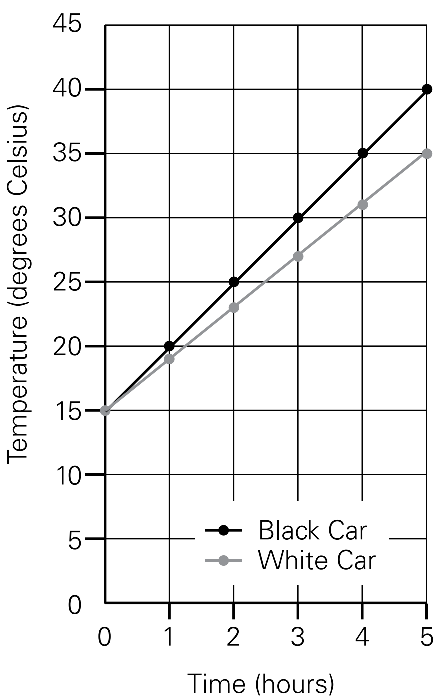
Worksheet 1-4

1. a.

The effect of different forces on the length of a spring



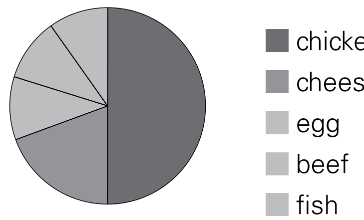
b. The effect of colour on a car's temperature over time



2. a.

sandwich	tally	total number
chicken	////	5
cheese	//	2
egg	//	1
beef	//	1
fish	/	1

b. Sandwiches sold



Worksheet 1-5

a. What is the effect of applying different forces on the length of a spring?

b. I expect that the spring becomes longer when a force/weight is put on the spring. I would expect that the extension of the spring will be more when the force/weight is bigger.

c. My conclusion confirms my hypothesis, which is that the spring extends more if more weight is applied.

d. If I did this experiment again, I would apply a heavier weight because I expect that at some point the spring will not extend any more.

e. Research question : Do black cars warm up faster than white cars when left in the sun?

f. Hypothesis : Since black absorbs light and white reflects light, I would expect the black car to warm up faster.

g. Conclusion : The results confirm the hypothesis and show that the black car warms up faster than the white car.

h. Reflection : I could include more different colours and/or I could check if these results would also be found if the cars were in the shade.

Chapter 2

WORKSHEET 2-1

1.

	characteristic of life
M	movement
R	release energy
S	sensitivity
G	growth
R	reproduction
E	excretion
N	nutrition

2. MRS GREN
3. a. movement, release of energy , reproduction (young giraffe), growth (young giraffe)
   b. movement (growing towards light), nutrition/feeding
   c. excretion of carbon dioxide, release of energy
   d. growth (from seed to plant), reproduction
   e. reproduction (pollination), nutrition (bee on nectar), movement or feeding , sensitivity (bee recognizes flower with nectar)

WORKSHEET 2-2

a. eyepiece lens
b. coarse focusing knob
c. objective lens
d. stage
e. mirror
f. turret
g. fine focusing knob
h. stage clips
i. diaphram
j. eyepiece lens, objective lens

WORKSHEET 2-3

1. a. Answers depend on students
   b. Answers depend on students
   c. green
2. a. nucleus b. cytoplasm
   c. cell membrane d. cell wall
   e. chloroplasts f. vacuole
3.

name of the structure
nucleus
cytoplasm
cell membrane
cell wall
chloroplast
vacuole

WORKSHEET 2-4

1.

picture	name of cell	function	structural adaptations
	pollen grain	reproductive cells	spikes so that the pollen sticks to the insect which carries it to the next flower
	red blood cell	carry oxygen around the body	round with a dent in the middle so that it has a large surface area which makes it faster to absorb or give off oxygen
	nerve cell	carry messages from one part of the body to another	long thin fibres so messages can be passed most quickly
	epithelial cell	cover surfaces	packed close together without any spaces between the cells so that everything entering or leaving the body is controlled by having to go through the cells

2.

name of the structure	description	example plant	example animal
cell	basic unit of life	root cell	skin cell
tissue	group of similar cells doing the same job	vascular tissue	epithelial tissue
organ	several tissues working together	leaf	stomach or lung
organ system	several organs working together to carry out large jobs	branch	digestive system
organism	something that is able to live on its own	palm tree	chicken

Chapter 3

WORKSHEET 3-2

a. 1000: 280 ppm
b. 1900: 290 ppm
c. difference: 10 ppm
d. 1900: 290
e. 2000: 370 ppm
f. difference: 80 ppm
g. The patterns are very similar.
h. Answer depends on students.

WORKSHEET 3-3

a. measuring : temperature
b. changing : type of food
c. staying the same : amount of food, distance between food and the water, starting temperature of the water
d.

independent variable	type of food
dependent variable	temperature
controlled variables	amount of food, distance between food and the water, starting temperature of the water

e. warmth/heat
f. nothing /no heat/very little heat
g. calorimeter

h. insulate the test tube/put a lid/cork on test tube
use a large beaker to put the food in and to hold the test tube

i. Weigh the food before and after and only use the amount actually burnt to calculate the energy.

Chapter 4

Worksheet 4-1

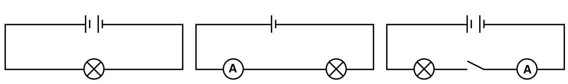
1. Answer depends on student's experiment.
2. Unsafe practices include:
    1. filling the kettle while still plugged in
    2. keeping a kettle and microwave near water
    3. putting a metal object into the toaster while it is plugged in
    4. many computers linked to a single socket
    5. wires on the floor (tripping)
    6. someone putting something into a socket
    7. coffee on the pc
    8. watering plant near the keyboard

Worksheet 4-2

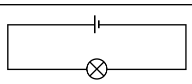
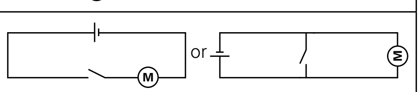
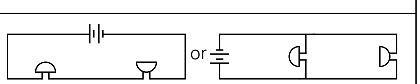
1.

	Explain why the bulb(s) will not light.
1.	complete circuit, bulb will light up
2.	incomplete series circuit : switch is open
3.	parallel circuit; one circuit is complete so that bulb will light, the other will not because the switch in that circuit is open so the circuit is incomplete
4.	complete series circuit; both bulbs will light up.
5.	complete circuit, bulb will light up
6.	parallel circuit; one circuit is complete so that bulb will light, the other will not because the switch in that circuit is open so the circuit is incomplete

2.

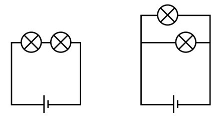


3.

A battery connected to a bulb.	
A battery connected to a motor and a switch.	
Two batteries connected to a buzzer and a bell.	

Worksheet 4-3

1. a. series circuit b. parallel circuit
2. a. yes b. no, less bright
   c. no d. yes
   e. yes f. yes
3.



Series Circuit Parallel Circuit

No, the bulbs in the series circuit will be less bright than those in the parallel circuit.

Worksheet 4-4

1.

	Ammeter	**Voltmeter**
What does it measure?	current (electrons running through)	voltage (the energy of the electrons)
Which units does it use?	ampere	volts
How is it placed in the circuit?	in series	parallel to a component
Does it matter where it is placed?	No, the current is the same everywhere in the circuit as long as all components are in series;– if they are in parallel, the current is divided over the parallel sections according to resistance.	Yes It must be in parallel and the sum of the voltage across all components is the same as the voltage provided by the battery. NB not all components have the same voltage!

2. a. ~~Series~~ / Parallel ~~Current~~ / Voltage
   b. Series / ~~Parallel~~ ~~Current~~ / Voltage
   c. Series / ~~Parallel~~ Current ~~/ Voltage~~
   d. ~~Series~~ / Parallel Current / ~~Voltage~~
3. a. the same (9A) everywhere in the circuit
   b. divided over the components (4V each)
   c. divided over the different loops (3A each)
   d. the same (12V) across each component

Worksheet 4-5

1. hotplate, electric heater, electric blanket, hair dryer, etc.

Worksheet 4-6

1. Lamps, electric heaters, air conditioners, fans, ovens, hair dryers, radio, TV, computer, iron etc.
2. Fuses which allow more electricity would be found in washing machine, microwave, iron, toaster, hair dryer and in circuits which have heaters or air conditioners. Circuits which will have lamps, computers, TV, radio will have fuses that allow less electricity.

Chapter 5

Worksheet 5-1

1. a. He did an experiment to test his idea.
   b. Does all the mass that the tree gains in five years only come from the minerals in the soil?
   c. Van Helmont concluded that the mass gained came only from the water.
   d. tree gained 164 pounds: 164 x 454 = 74,456 g = 74.456 kg
   e. soil lost 2 ounces : 2 x 28.35 g = 56.7 g
   f. Yes, because the mass of the tree increased much more than the mass of the soil decreased.
   g. No, because Van Helmont did not know that there were other places from which the tree could obtain mass (the air).
2. a. Dependent variable: which candles goes out first.
   b. Independent variable: the amount of air around the candle (or the size of the glass).
   c. Hypothesis: I expect candle C to continue to burn and candle B to go out sooner than candle A. A flame uses oxygen and once all oxygen is used up, it goes out.
   d. Results: Candle B went out first and candle A soon afterwards. Candle C continued to burn because the oxygen was not limited. Candle B was under the smaller glass so there was less air, so less oxygen than for candle A. This is the reason B went out before A.
   e. The function of candle C is to be the control. It has the same conditions as candles A and B, the only difference is the amount of oxygen available. It shows that this is the factor that extinguishes candles A and B.
3. carbondioxide + water → oxygen + biomass

Worksheet 5-2

a. the air in the airspaces and/or the waxy cuticle
b. bicarbonate provides carbon dioxide
c. Photosynthesis took place.
d. No, because photosynthesis needs light.
e. oxygen

Worksheet 5-3

1. because photosynthesis only takes in place in plants.
2. chlorophyll
3. The first test will show no starch anywhere in the leaf
4. The second test will show that the green part of the leaf now contains starch (indicating photosynthesis has occurred), while the non-green part has no starch because chlorophyll is missing in that part.
5. the mesophyll layer
6. the lower skin/epidermis
7. Because it needs to let as much light as possible through so that the light can reach the chloroplasts.
8.

stomata
chlorophyll
thin
large surface area
network of veins

9.

root hairs
large vacuole
living cells
network of veins

Worksheet 5-4

1.

use of glucose	main point
respiration	to release energy
storage (as starch, fats, oils)	to store energy
cellulose	needed to make new cell walls
joined with minerals	to make protein

2. Answers may include the following:
   - for oxygen
   - for clothes – cotton and linen
   - for bio-fuel
   - for building – wood
   - to keep warm – wood (fire)
   - to cook – wood
   - for shade
   - to stabilize land – plant roots can hold soil and reduce erosion and landslides
   - for decoration – gardens and flowers in vases
   - for medicines – e.g. morphine from poppies is still used to kill severe pain
   - for cosmetics – e.g. henna

Chapter 6

Worksheet 6-1

1. a.

Action	Observation	Concluding statement about solids
Try to press and squeeze the stone. What happens to its shape and volume?	Shape: <u>no change</u> Volume: <u>no change</u>	<u>Solids do not change their shape or volume when pressed. Solids cannot be compressed.</u>
Put the stone in different-shaped containers. Do the shape or the volume of the stone change?	Shape: <u>no change</u> Volume: <u>no change</u>	<u>Solids keep their shape and volume when put in different containers.</u>

b.

Action	Observation	Concluding statement about liquids
Measure 100 mL of water into different-shaped containers. Observe what happens to the volume and shape of the water when you place the water in different-shaped containers.	Shape: *changes to take the shape of the container* Volume: *no change*	*Liquids take the shape of their container but their volume does not change.*

c.

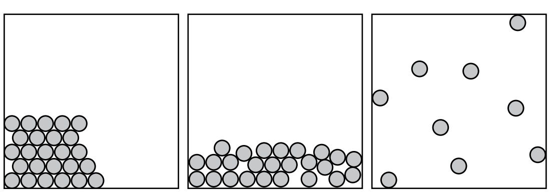
Action	Observation	Concluding statement about gases
Blow air in the balloon. Does its shape and volume change?	Shape: *changes to take the shape of the container* Volume: *changes to fill the container*	*Gases fill the volume of the container in which they are placed. They also take the shape of the container.*

d.

Action	Observation	Concluding statement about the sponge
Squeeze the sponge. Does its shape and volume change?	Shape: *it changes its shape when pressed and then goes back* Volume: *it changes its volume when pressed and then goes back*	*A sponge can be compressed because it is a flexible solid with many air holes. The air can shape its shape and volume but the flexible sponge will go back to its shape when released.*

2. a. properties b. fixed
   c. squashed d. fixed
   e. flow f. density, volume
   g. squashed h. volume
   i. flow, fixed j. dense, lower
   k. easy l. fixed
   m. fill n. dense, rise

Worksheet 6-2

1. a. This depends on the results
   b. Most likely they were close to the tissue.
   c. The scent spreads through the air via diffusion
2. 

solids liquids gases

3.

Are there big spaces between the particles in a solid?	no
Are there big spaces between the particles in a liquid?	no
Are there big spaces between the particles in a gas?	yes
When you compress a substance, do the particles get smaller?	no
When you compress a substance, do the spaces between the particles get smaller?	yes

Worksheet 6-3

1. a. will spread out
   b. faster
   c. faster
   d. This depends on results.
   e. This depends on results.
   f. Diffusion in a gas is much faster than diffusion in a liquid.

Worksheet 6-4

1. a. The can collapsed.
   b. from outside the can
   c. air
   d. air pressure
   e. When it was in cold water, the water vapour (gas) condensed into liquid water, taking up a lot less space. So the pressure inside the can became much smaller than the outside pressure, causing the can to collapse.

Worksheet 6-5

a. The rails must have been straight once, but now they are bent out of shape.
b. They got hot and expanded, but could only do this by changing their shape.
c. The little spaces allow the rails to expand without getting bent.
d. When placed in hot water, the mercury will warm up and expand. This means that the level in the small tube will rise and we can read from the scale how hot the water is.

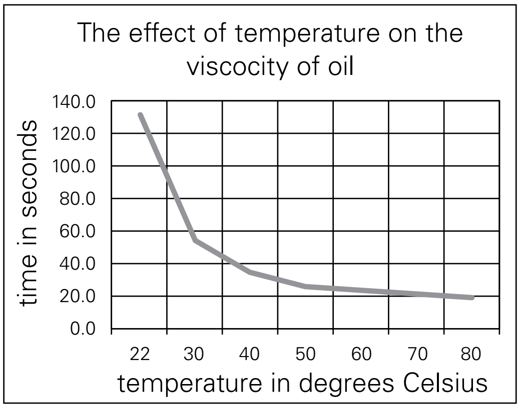
Worksheet 6-6

1. a. Research question: Does oil become more runny when it is warmer?
   b. Dependent variable: time (for the oil to run through the funnel); independent variable : temperature (of the oil)
   c. Most likely because the room was at 22 degrees C.

d.

131.3
54.7
34.7
25.3
22.0
19.7
18.7

e.



f. As the temperature increases, the time for the oil to run through the funnel decreases because it becomes more runny. In scientific terms: the viscosity of the oil decreases with increasing temperatures. As the oil gets warmer, the spaces between the particles increase and they can move past each other more easily, making the oil more runny.

Chapter 7

Worksheet 7-1

1. a. In first picture to the left, and in second picture downwards.
   b. A small push would move the eraser a short distance; a larger push would move it further.
   c. A force has a <u>direction</u> and a <u>size</u> (or magnitude).
2. a. Two teams are pulling on a rope. The team with the most force will pull the other team in their direction.
   b. The handkerchief will not move.
   c. Nothing, it still remains in the same place.
   d. No, it did not change speed, direction or shape.
3. a. The Moon's gravity is smaller than that on Earth.
   b. The Earth is bigger than the Moon.
   c. Yes, because Newton said that the force of gravity is bigger when the objects are bigger.
   d. Armstrong would have weighed more on Earth than on the Moon.
   e. Armstrong would have weighed nothing in space since there is no gravity. The scales would have shown zero.
4. a. Yes, the weight of the object is affected by the force of gravity.
   b. No, the mass of an object is independent of gravity.
   c. Weight is measured in Newtons (N)
   d. Mass is measured in kilograms (kg)
   e. We should discuss the mass because that tells us 'how much' there is.

Worksheet 7-2

1. a. ball sank
   b. boat floated.
2. a. big
   b. small
   c. sink
   d. small
   e. big
   f. float
3. volume of stone = 21.75 – 20.50 = 1.25 ml.
   density = 3.1 g/1.25 ml = 2.48 g/ml
   No because a sapphire has a density of 3.98 g/ml.

Worksheet 7-3

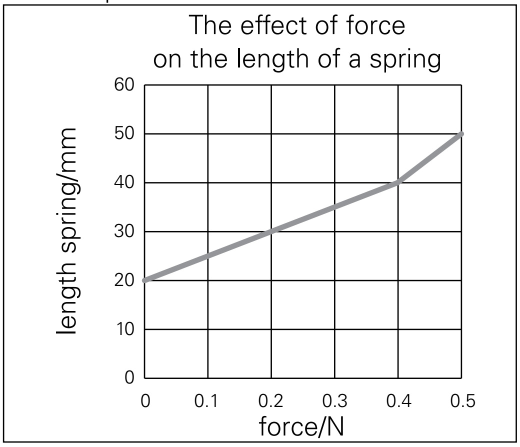
1. a. The plank bends.
   b. Assuming the person's mass is 75 kg, the force would be 750 N.
   c. At some point, the plank would break (and the people would get wet).
2. a. to be able to measure a range of forces accurately
   b. If you put too heavy a mass, the spring would be pulled out of shape and would not work anymore.
   c. If you put a very small weight, you would not be able to measure it accurately.

Worksheet 7-4

1. a.

mass in g	force in N	length in mm
0	0	20
10	0.1	25
20	0.2	30
30	0.3	35
40	0.4	40
50	0.5	50

b. The dependent variable is the length.
c. The independent variable is the force.



Worksheet 7-5

1. a. The tyres of the racing bikes are very narrow.
   b. The tyres of the cross country bike are much wider.
   c. Yes. A wider tyre means more friction. This will slow down the competitor but also reduce his chances of slipping and falling.
2. a. The friction increases.
   b. The speed of the car would reduce because the driver is no longer pushing the accelerator (so no more force to make the car move) and at the same time, the friction (of the brakes on the wheels) increases a lot.
   c. It is easy to do and students may feel their hands becoming a little warm.
   d. It is much more difficult and hands become very warm.
   e. It would be easier and less warm since the oil reduces the friction.
   f. Because oiling the brakes would reduce the friction and the brakes would not work anymore.
3. a. Thinking time and braking time or thinking distance and braking distance.
   b. 50 km = 50000 m
      1 h = 60 x 60 seconds = 3,600 s
      50 km/h = 50,000 m/3,600 s = 13.9 m/s
   c. 100 km/h is twice 50 km/h so it is 2 × 13.9 m/s = 27.8 m/s. In 2 s, the car will cover 2 x 27.8 m = 55.6 m.
   d. 50 km/h = 13.9 m/s. Thinking time is 1.5 sec so average thinking distance is 1.5 x 13.9 m = 20.85 m
   e. Answers for factors affecting braking distance would include: the brakes (type and maintenance), tyres (pressure and tread or profile), the car's mass, the road surface, etc

Chapter 8

Worksheet 8-1

1. i. a. carbohydrates b. fats
      c. proteins d. minerals
      e. vitamins f. roughage/fibre
   ii. roughage/fibre
   iii. water
   iv. because all chemical reactions in the body take place in solution
2.

nutrient *which kind*	**mainly used for**	**food rich in**	**test**
carbohydrates			
glucose	for energy (immediately)	fruit, juice, energy bars, salad dressing	Benedict's test
starch	for energy (after digestion)	rice, wheat (bread, pasta), corn, potatoes, beans	iodine test
fats	for energy	fish (salmon), butter, oil, nuts, avocado	ethanol test
protein	for building muscles for enzymes	beans, meat, cheese	Biuret test
minerals			
calcium	for strong bones	dairy products, green leafy vegetables	
iron	for red blood cells (which transport oxygen)	liver, beef, spinach	
vitamins			
vitamin C	for growth and repair	(citrus) fruit, green leafy vegetables	
vitamin D	to absorb calcium	salmon, butter made by skin under UV light	
roughage/fibre	to make gut work	whole wheat products, bran, lentils, broccoli	
water	(important but has no nutritional value)		

Worksheet 8-2

An example of what a menu could look like.

Day 1				
Breakfast	Snack	Lunch	Snack	Dinner
whole wheat toast with butter and jam (carbohydrates, fats, fibre) orange juice (vitamins, minerals)	peanuts (carbohydrates) apple (vitamins, minerals)	vegetable curry (vitamins, minerals, fibre) vegetable fried rice (carbohydrates, fats) grilled chicken (protein, fats)	some raw vegetables (e.g. cauliflower or capsicum) (vitamins, minerals, fibre)	piece of fish (protein, fats) baked potato (carbohydrates) carrots and peas (fibre, vitamins, minerals)
Day 2				
Breakfast	Snack	Lunch	Snack	Dinner
bowl of yoghurt with fresh fruit and cereal (carbohydrates, fibre, fats, Ca and vit D)	small piece of cheese few crackers (protein, fats, carbohydrates)	salad (protein, fibre, minerals, vitamins, fats) bread (carbohydrates)	mixed nuts (fats, carbohydrates) milk (vitamins, minerals)	lamb chops (protein, fats) roasted potatoes (carbohydrates, fats) broccoli (fibre, vitamins, minerals)
Day 3				
Breakfast	Snack	Lunch	Snack	Dinner
scrambled egg (protein, fats) whole wheat toast (carbohydrates, fibre) juice (vitamins, minerals, fibre)	energy bar (carbohydrates) banana (carbohydrates, vitamins, minerals)	lentil soup (protein, fibre) grilled cheese sandwich (whole wheat) (protein, fats, carbohydrates, fibre)	fruit salad (vitamins, minerals, fibre)	spaghetti (carbohydrates) minced beef (protein, minerals, vitamins, fibre)

Worksheet 8-3

a. two servings per container
b. 5 g sugar per serving
c. Each serving is 10% of the daily carbohydrates so you would need 10 servings = 5 containers.
d. One serving of sodium is 28% so, 10 servings would be 280% which is almost three times what you need.
e. No. The food is very rich in fat and sodium compared to other nutrients. It can be part of a balanced diet but no food alone is a balanced diet.

Worksheet 8-4

parts of the digestive system	digestive juice produced	substrate	enzyme	product
mouth	saliva	starch	amylase →	maltose
oesophagus	no digestion; moves food through peristalsis			
stomach	gastric juice	proteins	protease →	amino acids
small intestine	bile	produced by liver; stored in gall bladder emulsifies fats		
	pancreatic juice and intestinal juice	starch	amylase →	maltose
		protein	protease →	amino acids
		fat	lipase →	fatty acid + glycerol
		carbohydrates	carbohydrase →	glucose
appendix	stores good bacteria			
large intestine	absorption of water storage and egestion of faeces			

Worksheet 8-5

1. a.

	raw egg	boiled egg
colour	egg white is transparent, yolk is yellow	egg white is white, yolk is yellow
what it feels like	feels like jelly	rubbery

b. No, it becomes a cold boiled egg. It remains rubbery and the egg white remains white.
c. Protein

2. a. Protein in egg changes (denatures) when exposed to high temperature.
   b. Protein in fish changes (denatures) when exposed to acid.
   c. Enzymes in an apple change when exposed to high temperature because they no longer work. If they had worked, they would have turned the apple brown.
   d. Enzymes in an apple change when exposed to acid because they no longer work. If they had worked, they would have turned the apple brown.
   e. Protiens, high, acid

Chapter 9

Worksheet 9-1

1.

	gas	liquid	solid
keeps it shape	×	×	✓
takes shape of container	✓	✓	×
cannot be compressed	×	✓	✓
volume becomes smaller under pressure	✓	×	×
particles close together	×	✓	✓
particles far apart	✓	×	×
particles vibrate but remain in position	×	×	✓
particles move around a bit	×	✓	×
particles move around freely	✓	×	×

2. Hydrogen Oxygen Sodium
   Potassium Calcium
3. Mg Mn
4. Electron cloud, Nucleus
5.

symbol	name	no. of Protons
Li	Lithium	3
B	Boron	5
N	Nitrogen	7
Ne	Neon	10
Mg	Magnesium	12

5.

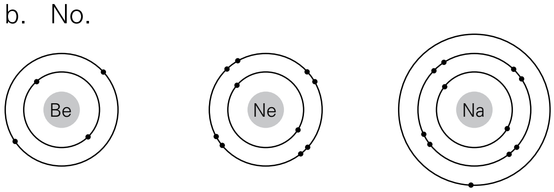
symbol	name	no. of electrons
Li	Lithium	3
C	Carbon	6
O	Oxygen	8
F	Fluorine	9
Na	Sodium	11

Worksheet 9-2

1. a. protons (p) and neutrons (n)
   b. proton (p)
   c. in the electron cloud
   d. no charge/neutral
   e. They keep the nucleus together; if there were only positive particles, they would repel each other and the nucleus would fall apart.
2.

name of the sub atomic particle	charge of the particle	mass (in a.m.u.)
proton (p)	+1	1
(n)	0	1
(e)	-1	0.0005

3. a. Lithium has 3 electrons.
   b. No.
4.



Worksheet 9-3

1. a. An element is a chemical substance that cannot be broken down into anything simpler because it is made up of only one type of atom.
   b. A compound is formed when different atoms combine chemically and form a new substance.
   c. A mixture is the result of mixing two or more elements which do not chemically combine.
   d. An atom is the smallest part of an element that can exist and take part in a chemical reaction.
   e. A molecule is made up of two or more atoms chemically joined together.
2.

	A	B	C	D	E	F	G	H	I	J
Which of the squares contain atoms?	✓	×	✓	×	×	×	✓	✓	×	×
Which of the squares contain molecules?	×	✓	×	✓	✓	✓	✓	✓	✓	✓
Which of the squares represent an element?	×	×	✓	×	×	×	×	×	×	✓
Which of the squares represent a compound?	×	✓	×	×	×	×	×	×	✓	×
Which of the squares represent a mixture?	✓	×	×	✓	✓	✓	✓	✓	×	×

3.

process	physical change?	chemical change?
boiling water	✓	
boiling an egg		✓
mixing iron powder and sulphur powder	✓	
heating a mix of iron and sulphur powder		✓
setting off fireworks		✓
burning paper		✓
mixing salt and sand	✓	
dissolving salt in water	✓	
filtering a mixture of salt, sand, and water	✓	
peeling, cutting, and mixing different fruits into a fruit salad	✓	
mixing hydrogen gas and oxygen gas	✓	
igniting a mixture of hydrogen gas and oxygen gas		✓

Worksheet 9-4

1. a. Elements are first arranged by increasing atomic number (= number of protons in the nucleus).
   b. Elements with similar properties are placed in group, under each other.
   c. A chemical symbol is either one (capital) letter or one (capital) letter followed by a small letter. The letters chosen usually refer to the (Latin) name of the element as it was at the time the symbol was allocated. This may or may not be similar to the current name of the element.
   d. The 21 elements at the top right of the periodic table are non-metals.
   e. All the other elements are metals.
2. a. Answer depends on student's response.
   b. No, because pure substances have only one type of particle (elements and compounds) and air is a mixture. The air may smell clean and fresh but scientifically cannot be considered "pure".

Chapter 10

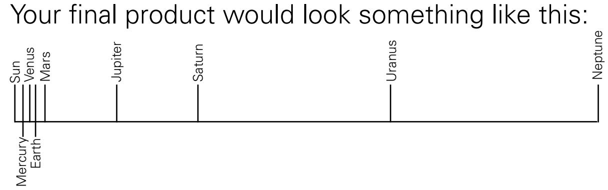
Worksheet 10-1

1. a. Distance between Neptune-Sun = 4,500,000,000 km
   b. in meters = 4,500,000,000,000 m
   c. $$\frac{4{,}500{,}000{,}000{,}000 \text{ m}}{20 \text{ m}} = 225{,}000{,}000{,}000$$
   d. Diameter Earth in Solar System = 12,750 km
   e. in meters = 12,750,000 m
   f. Diameter of Earth in classroom model = $$\frac{12{,}750{,}000 \text{ m}}{225{,}000{,}000{,}000} = 0.000\ 057 \text{ m}$$
   g. The diameter of Earth in the model would be 0.000 057 m = 0.057 mm
   h. Assuming your string is 20 m, your scale would be 1 m in the classroom is 225,000,000,000 m in the solar system.

The distances would then be as follows:

	distance to the sun in the solar system/m	distance to the sun in the classroom/m
Mercury	60,000,000,000	0.27
Venus	108,000,000,000	0.48
Earth	150,000,000,000	0.67
Mars	230,000,000,000	1.02
Jupiter	780,000,000,000	3.47
Saturn	1,400,000,000,000	6.22
Uranus	2,900,000,000,000	12.89
Neptune	4,500,000,000,000	20.00

Your final product would look something like this:



You might want to remind students that in this model, Earth would be a fraction of the size of a pin.

2. a. Answer depends on students.
   b.

Which planet is closest to the Sun?	Mercury
Which planet is is the furthest from the Sun?	Neptune
On which planet would your night be the longest?	Venus
Which planet is the largest?	Jupiter
Which planet is the smallest?	Mercury
On which planet would you have the most birthdays?	Mercury
On which planet would you be unlikely to even live one year?	Neptune
On which planet would you be able to wash?	Earth (the only one with water)
On which planets would you be able to breathe oxygen?	Mercury and Earth
Which planet is the warmest?	Venus
Which planet is the average temperature of your freezer at home?	Mars (-23°C)
Which planets have no moons?	Mercury and Venus
Which planet has the most moons?	Uranus

Worksheet 10-2

1. a. Luminous objects give out their own light.
   b. Non-luminous objects do not give out light of their own. (They may reflect light.)
   c.

luminous	**non-luminous**
fire fly	diamond
flame of a candle	ice cube
light bulb	mirror
stars	Moon
Sun	Venus
traffic light	

2. a. A day is a complete rotation of Earth.
   b. When your part of the Earth is facing the Sun, you have daylight. At night, your part of the Earth is facing away from the Sun.
   c. It takes one year for the Earth to orbit the Sun. This is 365.25 days.
   d. We calculate 365 days in a year but add one extra day every four years and call it a leap year.
   e. The extra day of a leap year is 29 February.

Chapter 11

Worksheet 11-1

1. a. Camels do not live on the North Pole because it is too cold and/or there is no food for them.
   b. Sharks do not live in the desert because they cannot get oxygen from the air.
   c. Abiotic factors are the physical, non-living part of the environment
   d. Biotic factors are all other living things in the environment
   e. An eccoystem is formed by biotic and abiotic factors

2.

Abiotic factors	Biotic factors
water rocks sunlight soil	trees shrubs/bushes weeds grass

3. a. Camels can live in deserts because they are adapted to the circumstances. Students only need to give ONE adaptation.
   Examples of the adaptations are:
   - camels can go a long time without eating or drinking.
   - camels allow their body temperature to rise so they do not loose water by sweating
   - camels can produce very concentrated urine to reduce water loss
   - camels' big feet mean they do not sink into the sand
   - camels' thick lips allow them to eat prickly plants
   - camels have hairs in their ears to keep the sand out, long eyelashes to protect their eyes from sand and can close their nostrils to keep sand out of their noses.

   b. Adaptations are special features developed to help animals or plants cope with the conditions in which they live.

Worksheet 11-2

This task can have many correct answers. Some ideas are suggested below but many other solutions may also be feasible. Some of the islands have two alternative descriptions but still other ideas are possible. Students may embellish on the description of the habitat but may not really change it. For example, they cannot decide to grow trees when the description specifically states there are no trees.

Island ONE
Rabbits will learn to climb trees as there is no food on the ground (too dark) and their paws will change to make this easier. In the trees, they will build nests for their young so they are safe from the foxes. They will have fewer young as it is difficult to find enough food for them.

1. Their tails will grow longer so they can use them for balance and holding on to branches.
2. Rabbits will develop a skin flap between front and back paws so they can glide from one tree to the next.

Island TWO

1. Rabbits start eating seaweed. They will eventually eat snails and mussels from the rock pools during low tide and their claws will change to help them collect and crush the shells. The fur on their bodies will grow longer since shelter is lacking but the fur on their paws remains short so it dries faster. They will have fewer young and when they are born, they are ready to move around with their parents.
2. Rabbits will start eating seaweed and eventually go into the sea to collect it fresh. They will grow skin between their toes so their paws can act as flippers which make them faster under water. Their fur will become oily so they dry quickly. They will grow some spikes on their backs to make them less attractive prey for the small sharks.

Island THREE

1. Rabbits become nocturnal (when birds sleep), develop bigger eyes and ears and darker fur. Food is plentiful and they will breed rapidly to compensate for the many young which are attacked by birds or eaten by foxes.
2. Rabbits grow much bigger and aggressive so they can chase off the birds. They grow bigger

teeth, suited for attacking and bigger claws. They could develop a taste for bird eggs.

Island FOUR
Rabbits will live underground and/or under the snow. They will never go out so they no longer need to see and will not have eyes. They will eat the available grass and will dig tunnels through the snow. Their fur will grow thick to protect them from the cold. Since they are completely sheltered, they will live long lives and reduce the number of young.

Worksheet 11-3

1. a.

producer	a living thing that makes its own food
consumer	a living thing that eats other living things
herbivore	an animal that eats plants
carnivore	an animal that feeds on other animals
omnivore	an animal that eats both plants and animals
decomposer	an organism that breaks down dead plants and animals.

   b. a carnivore
   c. consumer

2.

predators	prey
built for speed	live in groups
sharp teeth and claws	built for speed
camouflage to avoid being seen by prey	defences such as poison or stings
eyes to the front of the head to judge size and distance well	camouflage to avoid being seen by predators
	eyes to the side of the head to get a wide field of view

3. a. Phytoplankton → Zooplankton → Fish → Seagull → Leopard seal → Killer whale
   b. Phytoplankton → Zooplankton → Fish → Leopard seal → Killer whale
   c. Phytoplankton → Krill → Fish → Seagull → Leopard seal → Killer whale
   d. Phytoplankton → Krill → Fish → Leopard seal → Killer whale
   e. Phytoplankton → Krill → Blue whale
   f. Seaweed → Crab → Squid → Penguin → Leopard seal → Killer whale
   g. Seaweed → Crab → Squid → Penguin → Killer whale
   h. Seaweed → Crab → Squid → Elephant seal → Killer whale

4. a. 22 000 kJ b. 2000 kJ c. 3000 kJ
   d. 1000 kJ e. 125 kJ

Worksheet 11-4

a. The rabbits would get hungry and some would starve.
b. No, because the rabbits would eat lettuce instead of grass.
c. The population of slugs would decrease because they would compete more with rabbits for food (lettuce).
d. The thrush population would decrease because there would not be as much food (slugs).
e. No there would be fewer thrushes and rabbits so the sparrowhawk would eat more blue tits and chaffinches. With more roses, there would be more greenfly so more blue tits so they might become the sparrowhawks most important food source.

Chapter 12

WORKSHEET 12-1

1.

term	definition
soluble	a substance which will dissolve
insoluble	a substance which will not dissolve
solution	the mixture of a liquid and a solid
suspension	the mixture of an insoluble solid and a liquid where small particles float around the liquid
sediment	the insoluble particles which have settled at the bottom of the suspension
solvent	the liquid in which the solute is dissolved
solute	the solid which is dissolved in the solvent
saturated solution	when the maximum amount of solute is dissolved in the solvent
unsaturated solution	when less than the maximum amount of solute is dissolved in the solvent
concentrated solution	a solution containing a large amount of solute relative to the amount of solvent
dilute solution	a solution containing a small amount of solute relative to the amount of solvent
filtration	the separation of an insoluble solid from the liquid by pouring the mixture through filter paper
filtrate	the liquid which passes through the filter paper
residue	the solid which does not go through the filter paper
evaporation	changing a liquid into gas to separate it from a mixture
sublimation	changing a solid into a gas to separate it from a mixture
distillation	separating the solvent from a solution or mixture of liquids which have different boiling points
chromatography	a method for separating dissolved substances from one another

2.

<table>
<tr><td colspan="3">dilute solution or
~~concentrated solution~~</td><td colspan="3">~~dilute solution or~~
concentrated solution</td></tr>
<tr><td colspan="2">~~solute or~~
~~solvent or~~
solution</td><td colspan="2">solute or
~~solvent or~~
~~solution~~</td><td colspan="2">~~solute or~~
solvent or
~~solution~~</td></tr>
<tr><td colspan="3">solution or
~~suspension~~</td><td colspan="3">~~solution or~~
suspension</td></tr>
<tr><td colspan="3">~~chromatography or distillation or evaporation or~~ filtration</td><td colspan="3">~~chromatography or~~ distillation ~~or evaporation or filtration~~</td></tr>
<tr><td colspan="3">~~chromatography or distillation or~~ evaporation ~~or filtration~~</td><td colspan="3">chromatography ~~or distillation or evaporation or filtration~~</td></tr>
</table>

Worksheet 12-2

1. a. independent variable: the temperature
   b. dependent variable: the amount of colour dissolved (seen by how much of the chocolate of the bunties becomes visible)
   c. controlled: the amount of water, the colour of the bunties (important, some colours dissolve better than others), the number of bunties used, how much the water is moved (not—keep it on a table or lab bench)
   d. Yes
   e. because more chocolate is visible on the buntie in the hot water and/or more colour was dissolved
   f. the particles of the solute need to move in between the particles of the solvent
   g. at higher temperatures, the particles move faster so the solute particles get in between the solvent particles faster

NOTES

NOTES