SECOND EDITION

INTERNATIONAL SECONDARY SCIENCE

GRADE

6

TEACHER HANDBOOK

Pakistan Edition

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How to use your Teacher Handbook

Welcome to your **International Secondary Science** Teacher Handbook. This Teacher Handbook has been written to provide classroom support and teaching materials for PNC and Cambridge checkpoints.

Your Teacher Handbook includes a book of lesson plans as well as answers to all of the Student Book questions for your reference at any time.

The answers to the workbook questions are provided at the end of the handbook for your ease of reference.

Using your book

This book contains suggested lesson plans and answers to all of the questions in the Student Book. There is also information about students' prior knowledge.

There is one lesson plan for every unit in the Student Book, including Thinking and Working Scientifically, Science in Context, as well as Extension for the topic. Each lesson plan suggests activities for use in the classroom linked to the topics covered on the Student Book spread.

1.1 The building blocks of life

Student Book pages 2–3

1.1 Student Book answers

1. The building block of all living things.
2. A piece of equipment that uses light and lenses to magnify small objects.
3. Because most cells are too small to see with out eyes – they need to be magnified for us to observe them.
4. a. a piece of equipment which allows you to see very small objects, using light and lenses to magnify things. The order of the list does not matter:
   b. Eyepiece lens: The lens you look down/makes things look bigger
      Objective lens: Makes things look bigger
      Stage: Where you put your microscope slide
      |Clip: Holds your specimen in place on the stage
      Mirror/light source: Provides the light you need to see your specimen
      Focusing knobs: Turn these slowly to focus the microscope so you can see the specimen clearly
5. Any from: LM magnifies to ×1000, EM magnifies to ×1 million; EM larger than LM; EM much more expensive than LM.

Objectives

- Recognize cells as the basic unit of life that are organized into tissues, organs, systems and organisms.

Overview

This lesson introduces students to cells as the basic unit of organisms. This will be the first time many students will have met the idea of cells and microscopes – it is a great opportunity for developing wonder and excitement about what they are studying. Understanding cells is key to achieving well at IGCSE, so the foundations you build through this topic will be important both now and in the future. Students begin to develop key vocabulary to support their biology studies going forward through Stages 7–9 and on to IGCSE.

Activities

- Use the Student Book to introduce the idea of cells as the building blocks of living organisms and discuss the use of models in helping us to understand science (reference Thinking and working scientifically). Bring in any models you have that can help students understand the idea. Children's building bricks in different shapes, sizes and colours are useful.
- Carry on through the text to explain that all of the processes of life take place within cells – and then discuss ideas of size. Students may not realise that, because they cannot see things with their eyes, they still exist. Ask students to estimate sizes and look at rulers. Show them that there are 1000 mm in 1 m. Help them use their imaginations to imagine 1000 mm in a 1 mm.
- If available, ask students to examine everyday things through a simple magnifying glass to get a practical idea of magnification.
- Now give students real microscope and/or use using image in the spread, demonstrate the different parts of the microscope and describe what they do. Students familiarise themselves with the parts of the light microscope.
- Read through the section on the electron microscope with students – students just need to understand that these big, expensive machines give us even more magnification and clearer images of the details inside cells.
- **Fun fact!** To help students grasp the power of microscopes, tell them that a person magnified by the best light microscope would appear to be 2.5 km tall. The same person magnified by an electron microscope would be almost 1000 km tall!
- Students answer the questions at the end of the spread.

Extension

Students measure small objects with their rulers and calculate their size in mm and µm.

Homework

Workbook page 2.

Key words

cells; microns; light microscope; specimen; electron microscope.

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1.2 The cell story

SIC

Student Book pages 4–5

Prior learning

- Consider how scientists have combined evidence from observation and measurement with creative thinking to suggest new ideas and explanations for known phenomena

1.2 Student Book answers

1. Cells are the basic unit of life.
2. He bought fabric and made lenses so he could check his materials.
3. That a plant cell has a nucleus.
4. Theodore Schwann
5. Very few people had good microscopes with clear lenses. They couldn't see the cells Hooke and van Leeuwenhoek were describing and so wouldn't accept them. By the time Schwann proposed the cell theory, there were many good microscopes and communication between scientists was much easier. Cells were widely seen and accepted in all tissues so it was easy to agree that they are the basic units of life.

Objectives

- Discuss how scientific knowledge develops over time.

Overview

This lesson helps students to develop their understanding of Science in context. It summarises the early development of microscopes and looks at the role that these new technologies played in arriving at the cell theory. The content is delivered through the reports of two students. This is an excellent opportunity for students to consider the history of science and the impact of technology on our scientific understanding. In this instance, microscopes enabled us to see cells. Other examples include MRI scanners allowing us to see inside the human body, PCR machines enabling us to sequence DNA, or any local examples you may have of scientific discoveries.

Activities

- Ask students to think of concrete examples which make it easier to understand something. For example, it is easier for a small child to understand water flowing from a tap than to understand how electricity works – because we can see water. Then ask them to travel back in time over 400 years and imagine how hard it would be to accept that living organisms like people are made up of cells, when no-one had ever seen a cell.
- Introduce the students to Rameshwar and Karin and explain that they are going to look at the reports that these students have produced.
- Ask students to read through the section titled 'The history of the microscope'. Find examples of fabric magnified to show the threads, to explain why Anton van Leeuwenhoek wanted to produce a microscope, and any other examples of early drawings of cells you can find online.
- Ask students to consider how much easier it would be to visualise all living things as being built up of cells having seen the evidence from these early microscopes. Students read the information under the heading 'The cell theory' and answer questions 4 and 5 on page 45.
- Give students a collaborative exercise in which individual students or groups of students work on areas of the history of cells and develop visual resources to make a timeline which can be displayed in the classroom. You can provide large sheets of paper for their work, and arrows to link each time frame to the next. Some of the elements suggested are covered in the text.. Others are not and require information from other books or the internet. Select which students are given which tasks carefully. Each student or group of students should produce at least one, and no more than three, paragraphs of writing, and an image or drawing. Encourage them to identify the step forward in scientific knowledge and understanding resulting from the development they describe.

Extension

Each student produces their own timeline of microscopy with a minimum of seven dates and different instruments. Encourage them to identify the resulting step forward in scientific knowledge and understanding.

Homework

Workbook page 3.

Key word

cell theory.

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Each lesson plan begins with a reference to the pages of the Student Book that it covers and a summary of their objectives.

The *Overview* section of the lesson plan reviews what the suggested activities will cover to fulfil the learning objectives. Here you will also find advice and tips about common misconceptions, what you may need to review from the Primary curriculum framework or previous lessons, and suggested questions for a class discussion.

The *Activities* section of the lesson plan lists several different activities that can be used in the classroom. These activities include fun and engaging demonstrations, interesting practical ideas, group work suggestions, reading and research activities, and ways to explore a novel topic using models, games, class discussions or Internet research.

Lesson plans that are matched to Thinking and Working Scientifically and Science in Context units include activities that encourage students to use the skills they are learning about by planning and carrying out their own investigations, analysing data, and drawing conclusions individually or as part of a group.

Most of the lessons have suggested *Extension* activities to stretch your strongest students and help prepare them for the step up to Cambridge IGCSE®. Some of these could be carried out in class, whilst others could be set as homework.

Every content unit in the Student Book is matched to a page in the Workbook. At the end of each lesson plan the corresponding workbook page is suggested as *Homework*.

Finishing each unit are the answers for all of the questions in the Student Book for quick reference in the classroom.

Contents

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The cell story

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Student Book pages 4–5

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1.3

Animal and plant cells

Student Book pages 6–7

Prior learning

- Know the main differences between animals and plants

Objectives

- Relate the structures of some common cells (nerve, muscle, epithelium and blood cells) to their functions.
- Identify the structures present in an animal cell and plant cell as seen under a simple microscope and relate them to their functions (only cell membrane, cytoplasm, nucleus, cell wall, chloroplast, mitochondria and sap vacuole).
- Describe the similarities and differences between the structures of plant and animal cells.

Overview

In this spread, students are introduced to some key features of animal and plant cells. The aim is to ensure that they are familiar with both the structures and their functions, so that they can identify and describe them in diagrams, micrographs and as they look at them on microscope slides themselves. Remind students of the size of these cells – both their absolute sizes and the comparison between animal and plant cells. Also emphasise that cells are 3-D structures, not flat 2-D things like the diagrams on the page.

Activities

- Prepare for the lesson, by printing out the cells shown in **the spread** Print each one on a separate sheet of paper and mount it on card so that you can hold it up to the class OR prepare a presentation with one of the cell cards on each. Mix up the animal and plant cells that you will be using in the lesson.
- Ask students to remember and list the similarities and differences between animals and plants. Then introduce the idea that, just as animals and plants have similarities and differences, so do the different types of cells, which are the units of the organisms.
- Start by looking at the animal cell. Explain that this is a simple animal cell – similar to ones lining their mouths. Discuss with students the different structures of the cell and what they do. Ask them to indicate, by a show of hands, how many of these structures will also be found in plant cells.
- Read through the information on plant cells with students. Make sure they appreciate the size of the cell, and the features that are similar to and different from animal cells.
- Carry out an activity with the whole class. Show them the cells and ask them to write down whether each image is of animal or plant cells. They should explain their choice in each case. Then go through the cells, telling them whether they are plant or animal, pointing out features such as regular and irregular shapes, presence or absence of cell walls, etc. Students should mark their own work (or exchange with a partner) – discover how they got on by a show of hands.
- Ask students to complete Questions 1 and 2 at the end of unit.
- Once students have completed this activity, ask them to read the final section and then complete questions 3 and 4.

Homework

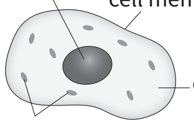
Workbook page 4.

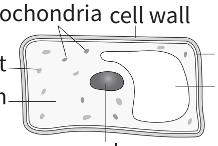
Key words

estimate, nucleus, genes, cell membrane, cytoplasm, mitochondria, respiration, cell wall, vacuole, cell sap, chloroplasts.

1.3 Student Book answers

1.





2. Order in table does not matter

Part of cell	Function	Animal, plant or both?
nucleus	Contains a set of plans to make new cells and controls everything going on in the cell	Both
cell membrane	Controls movement of substances into and out of the cell	Both
cytoplasm	Jelly-like substance where many of the chemical reactions of the cell take place	Both
mitochondria	Provide energy for the chemical reactions in the cell	Both
vacuole	Filled with cell sap, pushes against the cell wall to keep the cell firm and support the organism	Plants
cell wall	Tough outer layer which gives the cell strength. Vacuole pushes against it to keep cell firm and support organism	Plants
chloroplasts	Capture light energy for cell to make food	Some plant cells

3. Contains instructions to make a new cell; controls the chemical reactions going on in the cell
4. The cells of leaves and stem contain chloroplasts which capture the light energy needed for the plant to make food. Parts of the plant which don't get any light like the roots which grow underground don't have any chloroplasts.

1.4 Using a microscope

TWS

Student Book pages 8–9

Objectives

- Sort organisms through observation.
- Collect and record observations in an appropriate form.

Overview

This lesson helps students develop their skills in Thinking and working scientifically.

The text in the spread enables you to introduce your students to the practical use of the light microscope. They explain how to use a simple light microscope, how to calculate magnification and give clear instructions both for practising using a microscope and for looking at animal and plant cells, either using slides prepared by the students or using ready-prepared and stained slides. You could divide this lesson into two sessions which would leave your students with a good understanding of microscope techniques, or you could deliver a single very full lesson – preferably using pre-prepared slides for time management. Alternatively, you can use the Student Book alone without practical work if microscopes are not available.

Prior learning

- Sort living things into groups, using simple features

Extension

Students complete questions 1–4. They then investigate the use of different stains to show up different structures within animal and plant cells.

Homework

Workbook page 5.

Key word

stains.

Activities

- Start with a light microscope in front of you and ask students to name the parts from their earlier lessons. Now read through instructions for using a microscope. Students return to their labelled diagram of a microscope – and, add annotations explaining what each part of the light microscope is used for.
- **If microscopes are available for your students:** let them all practise using a light microscope. Give them time to get the microscopes set up to see how graph paper appears when it is magnified.
- Talk to students about drawing their observations – using pencil, and always showing the magnification. Work through the section on magnification and give students examples to try.
- Read the final section with students that explains the importance of stains. **If you do not have microscopes available:** show students a presentation of many different types of cells under the light microscope using different stains. **If no microscopes are available:** students should complete Q5, using the micrographs as if they were seeing them down the microscope and making observational pencil drawings from them.
- Students then complete questions 1–4 in any remaining lesson time.
- **If light microscopes are available: EITHER** give students prepared slides of human cheek cells and onion cells and ask them to observe and draw the cells using their light microscopes **OR** continue this work for another lesson, giving students the opportunity to make slides of their own cheek cells and of onion cells, which they then observe and draw. Make sure students understand how to calculate and record the magnification of the cells they observe and draw.

1.4 Student Book answers

1. Any suitable variation on: put stage at lowest position → put specimen on stage, secured by clips → put lowest power objective lens in place → look through eyepiece and turn coarse focus knob gently until the image comes into focus → adjust sharpness of image using fine focus knob → make a pencil drawing of a sample of cells. Include magnification.
2. total magnification = eyepiece lens magnification × objective lens magnification = 10 × 40 = ×400
3. Cells are often colourless. Adding stain makes it easier to see features of cells, e.g., nucleus, cytoplasm, cell walls.
4. Mitochondria are so small they cannot be seen at this level of magnification.

1.5 Seeing, drawing, and comparing cells

Student Book pages 10–11

Objectives

- Sketch the animal and plant cells and label key organelles in each.
- Compare and contrast an animal and a plant cell by preparing slides using onion peels and cheek cells.

Overview

This lesson helps students to develop their science skills. Students are introduced to the importance of making observations and recording observations via use of sketches. They can roleplay the working and discovery processes of earlier Biologists, who identified the similarities between wide range of organisms in the field and under laboratory conditions.

Prior learning
- Uses of microscope
- Parts of a microscope
- How to prepare and mount slides for observation

1.5 Student Book answers

1. Adding the stain makes it easier to see structures in the cell clearly.
2. Mitochondria cannot be seen as they are too small.
3. Students to state in their own words, based on the table in the spread.

Activities

- This lesson can be conducted in continuation with the previous lesson on use of a microscope.
- Begin the lesson by reviewing the main parts of the plant cell as studied in unit 1.3. Ask the students to sketch and label what they remember of a plant cell and keep the sketches to themselves.
- On a board or a poster provide a labelled plant cell sketch for reference.
- Remind students of the usage protocols for a microscope and divide them into groups.
- Follow the steps given in the students' book to begin observing and sketching plant cells, after appropriate staining. Encourage students to adjust the focus and magnification to get a clear view of the cells. Ensure the students sketch what they observe; remind them that though each student is responsible for their own sketches, they are to help each other out as group, when identifying cellular structures.
- Later the students can use prepared slides of human cheek cells and compare with the plant cell slides. Ask them to note down their observations and present findings in class.

Homework

Q3 from the student book spread, Workbook page 6.

Key word

cells, tissues, organs, organisms, organelles, cell wall, cell membrane, nucleus, cytoplasm, mitochondria, chloroplast, vacuole, nerve cells, muscle cells, epithelial cells, blood cells, microscope.

1.6 Specialised animal cells

Student Book pages 12–13

Objective

- Relate the structures of some common cells (nerve, muscle, epithelium and blood cells) to their functions.

Overview

Now that your students have grasped the cell theory that underpins biology and know the basic structures found in many cells, you are going to introduce the concept of specialised cells. There are several examples in the Student Book – and the more examples you find and explore with them, the better they will become at understanding the main principles. This is the ideal place to emphasise the importance of the relationship between structure and function, a key concept for future success at IGCSE.

Activities

- Use a quick quiz to recap the basic structures of animal and plant cells.
- Read the first part with your students and discuss the need for specialised cells in multicellular organisms. Ask students to name any specialised cells they have heard of. The response depends on your class. If students have lots of ideas, encourage and praise them. If they do not know any specialised cells, help them to work out that we need cells to move our bones, carry oxygen, etc.

Prior learning

- Sort living things into groups, using simple features

- Students answer questions 1 and 2.
- Read through the content on red blood cells. Explain the unique structure of red blood cells and how this relates directly to their function in the body. Students complete Q 3 to reinforce their learning on this point.
- If possible, prepare a short presentation to show students micrographs of several different types of specialised cells, e.g., striated muscle cells, fat cells, secretory cells, and discuss how their structures are related to their functions.
- If there is time, students can carry out some research to find more examples of specialised cells, relate their structure to their function and complete Q4 to reinforce their learning on neurones and ciliated cells.

Homework

Workbook page 7.

Key words

multicellular, specialised cells, function, plasma, red blood cells (rbcs), haemoglobin, biconcave, neurones (nerve cells), insulation, ciliated cells, cilia.

1.6 Student Book answers

1. An organism made up of more than one cell, usually millions or billions of cells
2. A cell specialised to carry out a particular function in an organism
3. a. To carry oxygen around the body

   b.

Feature	Function
Filled with haemoglobin	Carries oxygen
Small and flexible	Pass easily through small blood vessels to carry oxygen to the cells
No nucleus	Makes extra space for more haemoglobin to carry more oxygen
Biconcave	Gives them a big surface area pick up lots of oxygen

4. Neurones:
   - long structure to carry messages around the body
   - branches to connect to other neurones
   - insulation so electrical messages travel faster.

   Ciliated cells:
   - cilia which beat to cause movement
   - many mitochondria to supply the energy needed to make the cilia move.

1.7 Specialised plant cells

Student Book pages 14–15

Objective

- Relate the structures of some common cells (nerve, muscle, epithelium and blood cells) to their functions.

Overview

In this lesson, your students apply their understanding of the need for specialised cells in multicellular organisms, and reinforce the concept of the relationship between structure and function in specialised cells. You will introduce students to examples of specialised plant cells before discussing how to identify specialised features in unknown cells.

Activities

- Review the work from the previous lesson on specialised cells, asking students questions such as ‘What is a specialised cell?’, ‘Give me an example of a

Prior learning

- Sort living things into groups, using simple features

specialised animal cell', before looking at the text and discussing plants as multicellular organisms that also need specialised cells.

- Ask students to list some of the things that plants do, and then use these ideas to develop science-based ideas about the types of specialised cells plants might contain. Then read 'Cells as food factories' and 'Root hair cells' with students before they answer questions 1, 2 and 3.
- Students read through the section headed 'How to identify a specialised cell' and answer Q4 on page 53. Make sure students are aware that the principles discussed here apply to both plant and animal cells.

Extension

Students develop a small poster describing one example of a specialised animal cell and one of a specialised plant cell. Extra credit is given for researching and using different examples to those given in the Student Book.

Homework

Workbook page 8.

Key words

photosynthesis, palisade cells, chlorophyll, mineral salts, root hair cells.

1.7 Student Book answers

1. Because they contain more than one cell
2. Cells found at the top of a leaf. Brick shaped so they pack in tightly. Many chloroplasts to trap as much light as possible.
3. Chloroplasts – because root hair cells grow in the soil where there is no light so they do not need chloroplasts which trap light for photosynthesis.
4. Cell A = animal cell – no cell wall or vacuole or chloroplasts. Not very active – very few mitochondria. Fat store as huge amount of fat in the middle. Cell B = plant cell – cell wall, vacuole and chloroplasts. Not a very regular shape and not very many chloroplasts so not in top layers of a leaf.

1.8 Modelling cells

TWS

Student Book pages 16–17

Objectives

- Identify cell structures including the cell membrane, cytoplasm, nucleus, mitochondria, cell wall, chloroplasts and sap vacuole
- Describe the similarities and differences between animal and plant cells
- Describe the strengths and limitations of a model

Overview

This lesson helps students to develop their skills in Thinking and working scientifically. It helps your students to discover the benefits and limitations of models in science in a very practical way. The concept of models is important through to IGCSE Biology and beyond, so this is a valuable foundation. This lesson gives students the opportunity to evaluate different model cells, to understand both how useful models are at helping us visualise things that we cannot normally see, and how difficult it is to create a simple model that does not reinforce misconceptions. Giving students the opportunity to create their own model of a cell, whether in class or as a homework project, reinforces that understanding.

Activities

- Begin your lesson by quickly revisiting with students the main features of animal and plant cells. Remind students of
  1. the difficulty of seeing cells even with a microscope
  2. the difficulty in visualising cells as three dimensional, not flat things like our diagrams
  3. the problems of visualising cells as jelly-filled with structures such as the nucleus and mitochondria suspended in the cytoplasm.
- Explain the idea of scientific models, as a physical way of representing things we cannot easily see – often because they are too small or too big. Explain how easily misconceptions are introduced by models – and the difficulty of overcoming those misconceptions in students. Use an example from childhood – for example, small children may be afraid of draughts because they do not know what they are, so imagine them to be monsters.
- There are many ways of using this lesson. Here are three suggestions:
- **EITHER:** Work through the text with your students, discussing the different models made by the students. Encourage students to look for strengths in each model and possible misconceptions they might cause by answering questions 1–4 at the end.
- Have a class vote for which is the best model, then students design their own model cell and, if there is time, make the model as a project in class or at home.
- **OR:** Divide the class into groups or pairs. Allocate one of the three models to different groups of students and give them 10 minutes to evaluate it. Encourage students to look for strengths in each model, and possible misconceptions they could cause, using the relevant question (1, 2 or 3) to structure their discussions.
- Students from the different groups state advantages or disadvantages of the model they have evaluated. Students vote for the cell model they think works best.

Extension

Students to write a brief report to be used for training teachers. They should explain the value of using models to help students visualise and understand cells. They should also explain some of the problems with using model animal cell and plant cells and the misconceptions they can cause.

Homework

EITHER complete the model cell planned and started at school, plan a model cell or make a model cell.

OR Workbook page 9.

Key word

misconception.

1.8 Student Book answers

1. a. It is simple; is has an irregular shape; it shows the nucleus of the cell and the cell membrane; any other sensible point.
   b. She hasn't labelled all the structures; it has an incorrect label – animal cells do not have vacuoles; it has got green structures inside it. If these are mitochondria, they should never be coloured green because that is the colour of chloroplasts. If they are chloroplasts, they are wrong because animal cells don't have chloroplasts; it doesn't give any idea of size.
2. a. Rafi's model is really good for showing how the plant cell wall is kept strong and rigid by the inside of the cell pressing against it. It shows the difference between the cell wall – the box – and the cell membrane – the balloon. It has models of the nucleus and the chloroplasts.
   b. It has no labels to explain what anything is except for the cell wall; it has air in the balloon instead of the jelly of the cytoplasm; the balloon does not fill the shape of the box; there are no mitochondria; there is no sense of scale; any other sensible point.
3. a. It gives an understanding of the size difference between animal and plant cells; shows the difference in shape between animal cells (irregular) and plant cells (regular); shows that plant cells have a strong rigid cell wall and animal cells do not; highlights that animal and plant cells have lots of features in common as nucleus, cell membrane and mitochondria are made of the same things and are labelled in both models; any other sensible point.
   b. The cytoplasm is flat and made of modelling clay – real cytoplasm is jelly-like and structures such as the nucleus and mitochondria are floating in it. These models make them look as if they sit at the bottom of the cell. Any other sensible points.
4. Students can make any choice they wish as long as it is clearly justified – for example, it can be useful to look at a poor model and correct the labels and suggest ways it might be improved.

1.9 Tissues and organs in animals

Student Book pages 18–19

Objective

- Recognise that cells are organised into tissues, organs and organ systems Rank the different levels of cellular organisation: cells, tissues, organs, organ systems and organisms.

Overview

In this lesson, you will introduce students to the concept that multicellular organisms are made up of specialised cells arranged as tissues which work together to carry out functions, and that these tissues are then organised within organs and then as organ systems. A solid understanding of these principles is fundamental to biology both for IGCSE and Advanced courses beyond. This lesson and the next give you time to reinforce these concepts for your students in both animals and plants.

Activities

- Use quick-fire questions or a planned quiz to discover how many different types of specialised cells your students recall.
- Introduce the idea that large, multicellular organisms need organisation to survive. Use an analogy which your students will be familiar with – perhaps a hospital, a factory, a hotel or even a school. If everyone tried to do all the jobs, it

Prior learning

- Use scientific names for some major organs of the body
- Identify the position of major organs of the body
- Explain how the functions of the major organs are essential

would be chaos – and nothing would be done very well. Ask students to list as many jobs as possible in a hospital, for example, doctors diagnose patients, prescribe drugs and do operations; nurses take care of patients, give them medicines and deliver babies; orderlies move patients around and make beds, cooks prepare food, cleaners make sure everywhere is clean .

- Read the first part with your students, introducing the levels of organisation in multicellular organisms. Explain how each level is built up of the previous one and explain how the function develops. Students answer Q1.
- Read the section headed 'Animal tissues' with students who then focus on the different types of cells making up tissues found in the human skin.
- Read the section headed 'Animal organs' with students, giving them examples and talking through shows a range of human organs.
- Read section headed 'Organ systems in animals' with your students, making it clear that in an organ system many organs work together to carry out a large-scale function in the body such as digestion or transport. Students complete the questions at the end.

Extension

Students **EITHER** chose an animal/human organ system and carry out some research into the organs and tissues that make it up and their functions **OR** develop a Human tissues, organs and systems word search.

Homework

Workbook page 10.

Key words

cells, tissues, organs, organ systems.

1.9 Student Book answers

1.

Level of organisation	Description
cell	Building block/basic unit of all organisms
tissue	Group of similar cells working together
organ	Several different tissues working together to carry out a particular function
organ system	Several different organs working together to carry out a particular function
whole organism	Combination of many different organs and organ systems working together to carry out all the functions of life

2. a. heart **b.** kidney **c.** liver

3. A tissue is made up of one type of specialised cells. An organ is made up of several tissues working together, so it would contain several different types of specialised cells.

4. a. To break down and digest the food taken in and remove undigested waste.

b. Most likely three: stomach – digests food; intestine – digest food/absorbs nutrients; liver – produces bile to help digest food.

1.10
Tissues and organs in plants

Student Book pages 20–21

Prior learning
- Know that plants have roots

1.10 Student Book answers

1. a. organ
   b. organ system
   c. specialised cell
   d. tissue
   e. organ
2. Palisade cell = specialised cell; palisade tissue – many palisade cells working together to trap light energy and carry out photosynthesis.
3. Flowers are plant reproductive organs – they contain all the tissues needed to make new plants BUT plants do not reproduce all the year round and flowers are only produced when needed.

Objective
- Arrange and rank different levels of cellular organizations – cells to tissues, organs and organisms.

Overview
In this lesson, you will reinforce the concept that multicellular organisms are made up of specialised cells arranged as tissues which work together to carry out functions, and that these tissues are then organised within organs and then as organ systems. Students apply what they learned in the last lesson on animal systems to tissues, organs and organ systems in plants. In this way, students will build the fundamental knowledge of plant biology that they need to succeed at the highest level in this course and in IGCSE Biology.

Activities
- Begin with a quick quiz on the importance of plants to people – ask students to list 10 different ways in which we use plants or products from plants. Write the list on the board.
- Remind students that plants are multicellular organisms that can become very large indeed. Ask students to give levels of organisation within a multicellular organism and then read the sections headed ‘Plant organ systems’ and ‘Plant organs’.
- Students **EITHER** draw a plant, adding flowers, into their own notes **OR** draw a flower/flowers onto the plant outline printout and then label and annotate the leaves, stem, roots and flowers before sticking it into their own notes.
- Read through the final section on ‘Plant tissues’ with students, relating the tissues to their function. Question students on how the position of each of the different tissues in the structure of the leaf is related to its function.
- Students draw and label in their notes before completing questions 1–3 at the end of the spread.

Extension
Students they describe the different levels of organisation in multicellular organisms and give both animal and plant examples.

Homework
Workbook page 1.

Key words
shoot system, photosynthetic system, root system, xylem, phloem

Student Book answers

1. a. Organism; organ system; organ; tissue; cell; nucleus **[3]**

b. plant organs: root and leaf; structure found in a plant cell: sap vacuole **[3]**

2. a. microscope **[1]**

b. Looking at specimens too small to be seen with the eyes alone **[1]**

c.

Part	Function
eyepiece	To look into the microscope and to magnify the specimen
objective lens	To magnify the specimen
stage	To put the specimen on so the light passes through it
coarse focus knob	To bring the specimen into focus
fine focus knob	To sharpen the image/improve the focus

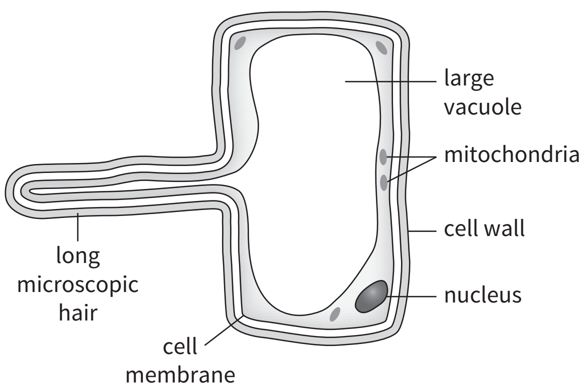
[5]

3. a. *Nucleus* A, *cell wall* B, *cell membrane* C, *cytoplasm* D, *mitochondria* E, *sap vacuole* F, *chloroplast* G, *nucleus* H, *cytoplasm* J, *cell membrane* K and *mitochondria* L **[10]**

b. Cell wall: supports the cell/protects the cell contents and gives the plant strength Sap vacuole: contains cell sap and presses against the cell wall to keep the cell firm and supported **[4]**

4. a. Specialised cell **[1]**

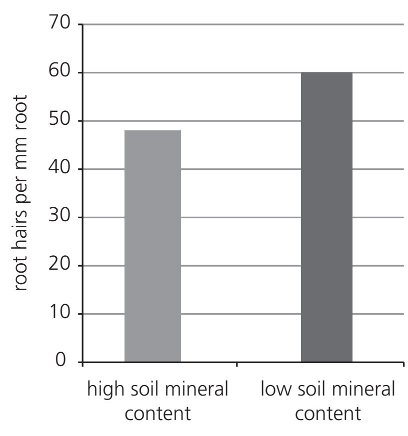
b.



[5]

c. They absorb water and mineral nutrients from the soil **[2]**

d.



5. In the 17th century Hooke and Van Leeuwenhoek began to see cells using microscopes made from lenses they made and polished themselves. They both made careful drawings of the cells they saw. People did not believe them because it was very hard to make a good microscope at that time. Without a microscope you couldn't see cells. By the 19th century, there were many more microscopes around so many more scientists could observe cells for themselves. This meant they were happy to accept the idea that cells are the basic unit of all living organisms, because they had seen that every living organism they examined under the microscope was made up of cells. [6]

6. **a.** Total magnification = eyepiece lens magnification × objective lens magnification = 10 × 40 so *Euglena* is magnified ×400 **[3]**

   b. Could be either as long as answer is supported by evidence, e.g., a plant – it has chloroplasts which trap light for photosynthesis, a process which happens in plants **[2]**

   c. Similarities with a general animal cell – one from: *Euglena* has a nucleus, a cell membrane, no cell wall and a nucleus Differences – one from: chloroplasts, flagellum to move around, eye spot or contractile vacuole **[2]**

7. Nerve cell: carries electrical messages around the body

   Root hair cell: absorbs water and mineral nutrients

   Muscle cell: contracts to move parts of the body

   Red blood cells: carries oxygen around the body

   Fat cell: contains a fat store to provide fuel for respiration when it is needed

   Palisade cell: carries out photosynthesis

8. **a.** iii

   b. i

   c. iii

   d. iii

2.1

Reproduction: a characteristic of life

Student Book pages 24–25

Prior learning

- the functions of different parts of plants: roots, stem/ trunk, leaves and flowers.

Objective

- Describe the different types of reproduction of plants.

Overview

This lesson helps students become familiar with the different types of reproductions in living organisms. The concepts are introduced using plant cells. The advantages and disadvantages of different types of reproduction are to be detailed.

Activities

- Begin the lesson by eliciting from the students the characteristics of all living things. Remind them that reproduction is a characteristic of all living organisms. Review the definition of reproduction and its role in ensuring continuity of life.
- Ask students to write down what they think is meant by the terms sexual and asexual reproduction. Although most students may recall these terms but 'don't know' is an acceptable answer if they do not remember.
- Read through and discuss page 24. If you find the students have a good grasp, you can also review the advantages and disadvantages of the same. You may choose to introduce which locally available plants (onions, potatoes, mint!) reproduce asexually.
- Read through and discuss page 25 topic of sexual reproduction and its advantages and disadvantages. You may choose to introduce which locally available plants (apple, chili, tomatoes!) reproduce sexually.
- Use the questions in the spread as an opportunity to check the understanding of the students verbally.

Homework

Questions from the student book spread. Also Workbook page 12

Key word

reproduction, asexual reproduction, sexual, pollination, fertilization.

2.1 Student Book answers

1. It is the life process by which all living organisms make more of themselves.
2. In reproduction, genetic information in the form of DNA is passed from parents to offspring.
3. Similarity: In both types of reproduction, genetic information from parent to offspring is passed in the form of DNA.

   Difference 1: In asexual reproduction offspring are identical to parents with no variation, which allows the best characteristics to display provided only if there is no change in the conditions. In sexual reproduction the DNA from both parents are mixed in any of the various combinations, allowing for adaptation to occur, which allows the species to adapt to changing conditions.

   Difference 2: Asexual reproduction requires only 1 parent. Sexual reproduction requires two parents.

2.2

Natural asexual reproduction in plants

Student Book pages 26–27

Prior learning

- an understanding of why plants are vital to sustaining life on Earth.

Objectives

- Describe the different types of reproduction in plants.
- Distinguish between artificial and natural asexual reproduction in plants. (Budding, grafting, Bulbs, Tuber, Runners, cutting, and layering).

Overview

This lesson is a good opportunity for students to review the different parts of plants. The concepts can be reinforced using a plant that reproduces asexually. Give your students the opportunity to grow their own individual asexually produced plants.

Activities

- Continue this lesson from the previous unit 2.1, especially through the use of examples of asexually reproducing plants.
- You can use alternatively choose to begin this lesson by reviewing the different parts of the plants. Explain that asexual reproduction uses parts of plants which are not usually associated with reproduction and have different other uses.
- Share an onion in class **(Ensure safety: remind students to wear gloves and goggles when handling a raw onion)**. Help students identify the primary function of an onion bulb as food storage. Help them peel back different layers and identify the bud in the center, which helps onion bulbs reproduce asexually.
- For the example of runners, you may choose to show mint plants or strawberry plants if available.
- For tubers, show budding potatoes and again help students identify their primary and secondary functions as food storage and asexual reproductive organs, respectively.
- Ask the students if they can answer the question 2 from spread and their reasons for the answers.

Homework

Questions from the student book spread. Also Workbook page 13.

Key word

asexual reproduction, natural propagation, bulbs, tubers, grafting.

2.2 Student Book answers

1. The use of different parts of the plant body for reproduction is called asexual reproduction.
2. Onions reproduce through bulb formation, composed of thick leaves arranged around a central bud, all on a short stem.
3. Potatoes (aloo) reproduce asexually by forming big, starch-filled underground tubers around the stem.

2.3

Sexual reproduction in plants

Student Book pages 28–29

Prior learning

- the stages in life cycles of common flowering plants.

Objectives

- Describe the different types of reproduction in plants.
- Compare and contrast asexual and sexual reproduction in plants.

Overview

This lesson helps students review the different reproductive parts of plants. They revisit the lifecycle concepts learned in primary classes. A good opportunity would be to encourage them to grow their own

individual plants from seeds all the way to fruit bearing stage. This can be a year ling project to reinforce concepts

Activities

- You can begin by asking the students what is sexual reproduction and its major advantage/disadvantage. Introduce the idea of a lifecycle.
- You can choose any local sexually produced plant and share its lifecycle; alternatively, use the lifecycle given in the students' book. Discuss the different stages in the sexual lifecycle of a plant (seed germination, seedling growth, adult plant, flowers, pollination, fertilization, seed formation, fruit, and seed dispersal).
- If possible, discuss each stage in detail using images and explain its contribution to the overall life cycle of the plant. Explain that some flowers are pollinated by animals such as insects, while others are pollinated by the wind.
- Ask the students to discuss and formulate a response to question 3 in the spread.

Homework

Q1 from the student book spread. Also Workbook page 14.

Key word

reproduction, sexual reproduction, cross pollination, fertilization.

2.3 Student Book answers

1. Students to research and provide the source for their research work.
2. **a.** flowers contain the reproductive organs of the plant, which produce the pollen grains or ovules or both.
   b. the movement of pollen grains to the ovules of the same flower or of flower of same plan type is essential for fertilization to occur.
   c. fertilisation occurs when the male and female gametes (pollen grains and ovules) meet, merge and form a new cell. This is the first step in seed formation.
   d. fruits ensure that seeds are dispersed as far as possible from the parent plant.
3. Students can refer back to spread 2.1 to help formulate their answers. Encourage them to present information in infographic format.

2.4

Artificial asexual reproduction in plants

Student Book pages 30–31

Prior learning

- an understanding of why plants are vital to sustaining life on Earth.

Objectives

- Describe the different types of reproduction in plants.
- Distinguish between artificial and natural asexual reproduction in plants. (Budding, grafting, Bulbs, Tuber, Runners,

Overview

This lesson continues from the unit 2.2. This is a good review and extension opportunity as the students should have firmly grasped the concepts of asexual reproduction. This unit is designed to encourage students to attempt some of the methods of artificial propagation of plants, themselves.

Activities

- Begin by introducing the idea that although plant asexual reproduction takes place naturally, human beings have found ways to make more plants to grow in their fields.
- Introduce the idea that artificial asexual reproduction involves people making parts of certain plants grow and form new independent plants, using these processes: taking cuttings, layering, grafting, and budding. Discuss each method in detail, using images or diagrams and explain how it is used to create new plants.
- Divide students into small groups and assign each group a method of artificial asexual reproduction in plants. Ask them to attempt question 3 and share their answers in class.

Homework

Questions from the student book spread. Also Workbook page 15.

Key word

reproduction, artificial propagation, cutting, layering, grafting.

2.4 Student Book answers

1. The process by which people make parts of certain plants grow and form independent plants.
2. **a.** Cutting; layering; grafting/budding
   b. All the above method use the stem to propagate new plants.
3. Students to work in teams to extract information from the spread and complete the table. You may suggest that they research further using various online resources.

2.5

Why is artificial propagation important?

Student Book pages 32–33

Prior learning

- an understanding of why plants are vital to sustaining life on Earth.

Objective

- Inquire how artificial propagation can lead to better quality yield in agriculture.

Overview

This lesson continues from the previous unit. The unit will help reinforce the commercial uses of asexual reproduction of plants and their importance in an agrarian economy.

Activities

- This lesson can be a continuation of the previous unit on artificial asexual reproduction.
- You can ask the students to review the main features and advantages/disadvantages of asexual reproduction. Ask them if they can suggest why farmers would want to further increase modes of asexual reproduction and plants which reproduce asexually. Remind them that asexually reproducing plants are very well adapted to certain environments and so farmers want to maximize the use of this ability.
- Banana crop can be used to illustrate how farmers choose to increase yield and size of the modern-day bananas. Share some images to demonstrate the difference between wild and cultivated bananas.
- Sugarcane crops can be used to illustrate the point about advantages gained from using artificial propagation in agriculture in Pakistan.
- Lead the discussion towards the development of scientific knowledge and its application for benefit of the humankind. Ask the students their opinions on whether such knowledge should be safeguarded or shared. Ask them if it is advantageous to only focus on preserving and growing high-yielding selected crops or if diversity should be ensured. Ask them to explain their reasons. This topic can be a project given as extension for further study later.

Homework

Questions from the student book spread. Also Workbook page 16.

Key word

reproduction, artificial propagation, cutting, layering, grafting.

2.5 Student Book answers

1. The process of producing new plants that are identical to the parent plant so all of the good features of the parent plant will also be there in the offspring giving increased yields in agriculture.

2. i. Produces new plants that are identical to the parent plant so all the good features of the parent plant will also be there in the offspring.

ii. The best plants can be propagated quickly, cheaply and reliably.

iii. Grafting allows the best characteristics of two different types of plant to be combined.

3. **a.** 61 tonnes/hectare

b. 104 tonnes/hectare

c. Initially the growth was slow or steady but since last 2 decades there is an increase of the approximately 50 tonnes/hectare per decade.

2.6
Review answers
Student Book pages 34–35

Student Book answers

1. **a.** Reproduction is the life process by which all living organisms make more of themselves.
   b. Reproduction is very important for the survival of the different types of living things.
2. **a.** DNA
   b. Nucleus
   c. DNA contains the instructions for making a new life.
3. **a.** Sexual and asexual
   b. Students to extract information from spread 2.1 and complete the table.
4. **a.** Natural asexual reproduction using bulbs
   b. A- protective outer layer; B- leaves full of stored food; C- bud; D- short stem; E- roots
   a. Any two from onions, fennels, and tulips.
   b. A- germination; B- sprout; C- seedling; D- tree; E- flower; F- tree with fruit; G- fruit with seeds.
   c. Pollination is process of transfer of pollen grain from the anthers to the stigma. Fertilisation is the name of the process in which the male and female gametes meet to form a new cell.
   Students to extract information from spread 2.1. Encourage them to present the information in form of a Venn diagram.
5. **a.** The one major difference is that artificial asexual reproduction requires human involvement. The similarity is that both types of asexual reproduction involve use of different parts of the plant body (other than flowers and reproductive organs) for propagation of the plant.
   b. Cuttings of the plant stem can be used to grow completely new plants; layering involves encouraging the plant stem to grow new roots by covering it with soil. And grafting and budding processes require attaching part of one plant stem to another different, rooted plant stem; in budding, only the bud from one plant is inserted into a new plant.
6. **a.** The yield per hectare can be increased significantly.
   b. I- soaking in organic liquid waste.
   Ii- soaking in water.
   c. Artificial propagation allows scientists to experiment into the best growing conditions for their crops by creating plants which are genetically identical to each other, and then testing their yield under different conditions.
7. **a.** The one major difference is that artificial asexual reproduction requires human involvement. The similarity is that both types of asexual reproduction involve use of different parts of the plant body (other than flowers and reproductive organs) for propagation of the plant.
   b. Cuttings of the plant stem can be used to grow completely new plants; layering involves encouraging the plant stem to grow new roots by covering it with soil. And grafting and budding processes require attaching part of one plant stem to another different, rooted plant stem; in budding, only the bud from one plant is inserted into a new plant.
8. **a.** The yield per hectare can be increased significantly.
   b. i- soaking in organic liquid waste.
   ii- soaking in water.

c. Artificial propagation allows scientists to experiment into the best growing conditions for their crops by creating plants which are genetically identical to each other, and then testing their yield under different conditions.

9. a. sexual
   b. tubers
   c. fertilization
   d. pollination
   e. dispersal of

3.1
The importance of digestion

Student Book pages 36–37

Prior learning
- the functions of the organs in the human digestive system such as mouth, oesophagus, stomach, small and large intestine.

Objectives
- State the importance of digestion in the human body and describe physical and chemical digestion.
- TWS Apply mathematical concepts to analyse data.

Overview
This lesson introduces students to the process of digestion, which is an essential life process. It helps in extraction of energy from the food, consumed by living things. Further, the students can

develop their thinking and working scientifically skills. Surface area analysis and application of mathematics as a science skill is practiced using worked example.

Activities
- Ask students to share what they understand by the word digestion - try to get everyone to contribute. Elicit that digestion is the process by which our bodies break down food into smaller molecules that can be absorbed and used for energy.
- Draw an infograph of the two types of digestion and along with a diagram of the digestive system, explain the physical and chemical digestive processes.
- Discuss with the students how the different types of compounds that make up their food. Explain that the different types of food (carbohydrates, proteins, fats) are broken down in different ways by the body.
- For the TWS session, let the students know that they will learn how to apply mathematical concepts to scientific ideas. Introduce the concept of surface area and how it relates to the digestive system: inner surface of the digestive organs have a bigger surface area to aid digestion.
- You may choose to divide students into pairs to work out the surface area to volume ratio of different surfaces. For extension, you can choose to use Q5 from the spread.
- Finish by reviewing with the class the rest of the questions in the spread.

Homework
Questions from the student book spread. Also Workbook page 17.

Key word
digestive system, alimentary canal, physical digestion, chemical digestion, enzyme, surface area.

3.1 Student Book answers

1. The process by which the food we eat is broken down into small, soluble, useful molecules that travel around our bodies in our blood to the cells that need them.
2. Carbohydrates, Proteins, and Fats and oils, are broken down into simple sugars (e.g. Glucose), amino acids, and fatty acids and glycerol respectively.
3. In order to convert large, often insoluble molecules, into smaller, soluble, useful molecules, capable of travelling around in our blood and entering cells which need them.
4. In physical digestion, food is broken down mechanically into smaller pieces. In chemical digestion, large insoluble molecules are broken down chemically into smaller, soluble molecules.

   SA= 6 x Area

   = 6 x (5 x 5)

   = 150 cm2

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3.2

The human digestive system

Student Book pages 38–39

Prior learning

- the human digestive system including the functions of the organs involved (mouth, oesophagus, stomach, small and large intestine), and enzymes.

Objectives

- Sequence the main regions of Alimentary Canal, its associated organs and describe the functions of different parts of the Alimentary Canal.
- Briefly describe the role of enzymes in digestion.

Overview

This unit continues from the previous unit, adding in further detail of the human digestive system. Reinforce the concept that in an organ system many organs work together to carry out largescale

function in the body such as in digestion.

Activities

- Begin by reviewing with the students the importance and types of digestion.
- Remind them of the concept that many organs work together in an organ system to carry out large-scale functions in the body, such as digestion. Refer back to the diagram of the human alimentary canal and review the different organs and their functions. You may choose to show a video or animation that shows the digestive process in action.
- Review the major organs of digestive tract and its role in digestion.
- Discuss the definition and role of enzymes in digestion. Divide students into groups for the Jigsaw Enzyme Action activity. Distribute to each group cut-out shapes representing different enzymes and substrates.
- Instruct the students to match each enzyme with its specific substrate, based on the shape of the enzyme's active site and the substrate. Ask them questions to elicit their reasoning and guide them to develop their knowledge of enzyme specificity and complementary binding.
- Once the students are done, have each group present their findings to the class, explaining their reasoning. facilitate discussions about enzyme action and how it relates to digestion.

Homework

Questions from the student book spread. Also Workbook page 18.

Key word

digestive system, alimentary canal, physical digestion, chemical digestion, biological catalyst, organs, enzyme, amylase

3.2 Student Book answers

1. Diagram is present in spread 3.2
2. Enzymes bind to large food molecules and speed up their breakdown into smaller molecules which can be used by our bodies.
3. These are the waves of muscle contraction that move the food all the way along the alimentary canal.

3.3

More about the digestive system

Student Book pages 40–41

Prior learning

- the human digestive system including the functions of the organs involved (mouth, oesophagus, stomach, small and large intestine), and enzymes.

Objective

- Conclude that blood transports the products of digestion to other parts of the body and the undigested products get egested/defecated.

Overview

This unit continues from the previous unit, adding further detail to the digestive process, such as the essential process of transport of food. Students should gain and understanding of the main organs associated with the system and how they work together to carry out the simultaneous transport and transformation of food through the digestive canal, resulting in waste products.

Activities

- Begin by reviewing the process of digestion through the alimentary canal. Explain to the students that they will learn more in detail about the transport of food through the digestive system.
- Continue from the previous lesson by getting into further detail, especially about the role of small intestine and associated organs.
- Review with the students the action of enzymes and provide further detail about the organs which produce enzymes which aid in digestion.
- Review the surface area activity from unit 3.1 and provide explanation linking it to the absorption of food in the small intestine.
- Review the lesson by discussing the questions in the spread. Alternatively, you can instruct the students to draw an infographic detailing the process of digestion through the alimentary canal, from ingestion of food to egestion of wastes.

Homework

Questions from the student book spread. Also Workbook page 19.

Key word

digestive system, alimentary canal, physical digestion, chemical digestion, absorption, organs, enzyme, amylase, egested, defecated, faeces

3.3 Student Book answers

1. Mouth -> oesophagus -> stomach -> small intestine -> large intestine -> rectum -> anus. Students can be asked to add associated organs, as an extra task.
2. Pancreas (makes enzymes to help break down carbohydrates, proteins, fats and oils), Liver (makes bile, a greenish-yellow liquid which helps the body digest fats and oils), Gall bladder (stores bile for when required).
3. Digestion is the breaking down of food into usable form. Egestion is the biological name for defecation, i.e. Passing out of waste and undigested materials from the body.

3.4 Modelling the alimentary canal (TWS)

Student Book pages 42–43

Prior learning

- the main regions of Alimentary canal, its associated organs and describe the functions of different parts of the alimentary canal.

3.4 Student Book answers

1. **a.** the bag is clear. Students to explain in their own words.
   b. the 'mixing' or squeezing motion may not accurately mimic the peristaltic motion.
2. **a.** how folding helps increase the surface area.
   b. the model is not 3D.
3. **a.** the motion is similar to the motion during peristalsis.
   b. cannot see what is happening inside the tube and the effect of increased surface area.
4. The answer depends on how young the students are and what we are aiming to teach. Model 1 is good to show the breakdown of food. Model 2 is good to demonstrate the effect of folding on increasing the surface area. And model 3 is a good way to demonstrate peristaltic movement.

Objectives

- Sequence the main regions of the alimentary canal and its associated organs.
- Describe the functions of different parts of the alimentary canal.
- Conclude that blood transports the products of digestion to other parts of the body.
- Describe the strengths and limitations of a model.

Overview

This thinking and working scientifically spread focusses on use of modelling, model building and analysis as discovery tools. It is designed to help your students to discover the benefits and limitations of models in science in a very practical way, building a valuable foundation for further studies.

Activities

- This lesson is designed to help students to discover the benefits and limitations of models in science in a very practical way. This lesson also helps students to review their learning and develop their skills in Thinking and working scientifically. The concept of models is important through to IGCSE Biology and beyond, so this is a valuable foundation.
- Begin the lesson by quickly revisiting with students the main features of the alimentary canal. Remind them of the main organs, the enzymes, and the process. Bring the students attention towards the peristalsis and elicit the student knowledge about its significance.
- Explain the idea of scientific models, as a physical way of representing things we cannot easily see – often because they are too small or too big. Also detail how easily misconceptions can be introduced by models – and the difficulty of overcoming those misconceptions in students.
- Review the three models detailed in the spread. You may instruct the students to self-divide into 3 groups and attempt a model each of their own choosing. Remind them to make observations and notes as they go along.
- Once the student groups have replicated the models, ask them if they were able to replicate the results. Encourage them to share their observations, conclusions and reasonings.
- Encourage them to consider question 4 of the spread, and how they would use the modeling exercise as a teacher. Ask them to share their reasonings and reservations.

Homework

Questions 1-3 from the student book spread. Also Workbook page 20.

Key word

digestive system, alimentary canal, physical digestion, chemical digestion, biological catalyst, organs, peristalsis.

3.5

Review answers

Student Book pages 44–45

Student Book answers

1. a Digestion breaks down food into small, soluble, useful molecules that can travel in blood to different cells of the body, to supply energy and provide the materials needed for growth and repair.
   b Encourage students to give the answer in tabular format, using the information provided in the unit.
2. a. Mouth: takes in food, mixes it with saliva and grinds it down into smaller pieces using teeth.
   b. Salivary glands: produce saliva, which wet the food and begin the process of chemical digestion.
   c. Oesophagus: the pipe which connects the mouth to the stomach.
   d. Stomach: a muscled bag which contains acid and enzyme that help break down proteins.
   e. Small intestine: makes enzymes to speed up the final breakdown of food and where the digested food is absorbed into your blood to be transported to other parts of the body.
   f. Large intestine: removes water from the undigested material back into the bloodstream.
   g. Pancreas: makes enzymes to help break down carbohydrates, proteins, fats and oils in the small intestine.
   h. Anus: the part of the rectum from where faeces pass out of the body.
3. a. Enzymes are biological catalysts which speed up the chemical digestion of food.
   b. Students can refer to spread 3.2
   c. Without enzymes, food would take too long to be broken down into usable, small molecules that the cells require.
4. a.

Label	Name	Association
A	Oesophagus	Part of the alimentary canal
B	Stomach	Part of the alimentary canal
C	Pancreas	Associated with the alimentary canal
D	Small Intestine	Part of the alimentary canal
E	Bile duct	Associated with the alimentary canal
F	Gall bladder	Associated with the alimentary canal
G	Liver	Associated with the alimentary canal

   b. Students can refer to the chapter or the answer to earlier question.
5. a. SA of a rectangle = L x W = 10cm2
   b. The final breakdown of food and the absorption of food into the blood stream.

c. The villi increase the surface area of the small intestine to allow the digested food to easily passes into bloodstream.

6. a. ii

b. i

c. i

d. ii

e. i

f. iv

g. i

4.1 The food we eat

Student Book pages 46–47

Prior learning

- Know that an adequate, varied diet is needed to keep healthy

Objectives

- Identify the constituents of a balanced diet for humans as including protein, carbohydrates, fats and oils, water, minerals (limited to calcium and iron) and vitamins (limited to A, C and D), and describe the functions of these nutrients.
- Recognise that a healthy diet contains a balance of foodstuffs.
- Identify the essential nutrients, their chemical composition and food sources.

Overview

In this lesson, you introduce students to the concept that animals, including people, eat food to get energy and nutrients. The important idea is that all the different foods we eat, in different countries and cultures, all contain the same basic food groups. There is a common misconception that the term diet applies to the food eaten when trying to lose weight. Make sure your students use the term correctly and understand that it means all of the food you take into your body.

Food tests provide plenty of opportunity for practical work by students or demonstrations by the teacher.

Activities

- Ask each student for their favourite food – try to get everyone to contribute.
- Ask students what they think when they hear the word 'diet'. Discuss the various answers you may get and read the first two paragraphs. Reinforce strongly that your diet is simply the food you eat every day.
- Question students about the different types of compounds that make up their food – have they heard of carbohydrates, proteins, etc?
- Read through the rest of the text with your students. Stop at the end of each category and have a Q&A session in which you ask students to give examples of foods rich in the different food groups, and their ideas about what they are needed for, to check that they understand the content. If possible, have examples of foods rich in the different categories with you to make the point. Students complete questions 1 and 2.
- Introduce your students to food tests used to identify the presence of different food groups, especially the two processes, using sodium hydroxide solution and copper sulfate solution OR using ready mixed Biuret solution. Ideally, your students should carry out these investigations themselves, developing practical skills and learning about food groups at the same time. If this is not possible, carry out the investigations as a demonstration. If that is not possible, read through and find a video online which demonstrates the protein test.
- Summarise the learning so far and ask students to be very aware of the food they eat before the next lesson – maybe even note it down.

Extension

Students investigate the main sources of protein in the food in their own culture and research the main protein sources in other cultures and then write a report on protein sources around the world.

Homework

Workbook page 21.

Key words

diet, carbohydrates, protein, amino acids, lipids

4.1 Student Book answers

1. The food you eat each day.
2. a. Carbohydrates, proteins, lipids/fats and oils, vitamins, minerals.
   b. Carbohydrates – energy; proteins – to build new cells/repair damaged cells; fats and oils – energy or energy store; vitamins – help chemical reactions take place in cells; minerals – to build different substances in the body.
3. Depends on what students ate – look for correct identification of foods containing the five main groups listed above.

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4.2

Carbohydrates, fats, oils, and energy

Student Book pages 48–49

Prior learning

- Know that an adequate, varied diet is needed to keep healthy

Objectives

- Identify carbohydrates and fats as constituents of a balanced diet and describe their functions in the body.
- Identify the essential nutrients, their chemical composition and food sources.

Overview

This lesson looks at the foods which contain the most energy, and the ways in which the body stores the energy it needs. Link this work on energy to aerobic respiration. It also provides more opportunities for students to carry out practical work with food tests for starch, glucose and lipids.

Activities

- Begin by asking students for examples of foods in their diet since the last lesson – ask them about food they have eaten that is rich in carbohydrates, or protein, or lipids, for example.
- Remind students that cells need energy to do work – from muscle cells contracting to building the chemicals needed for the body to function. Read through page 114 with students. Begin with carbohydrates – simple sugars like glucose, and starches. As in Unit 6.1, it is helpful to have some examples of the different foods to show students.
- Give students the opportunity to do a preliminary iodine test on starch solution, glucose solution and water. Then allow students to test a few different foods for starch, e.g. bread, potato, yam or breadfruit, and a piece of protein-rich food that does not contain starch (for example, egg white). As an alternative, demonstrate these investigations – research shows that good teacher demonstrations with plenty of class interactions are a very effective learning tool.
- Give students the opportunity to carry out the preliminary Benedict's test using glucose solution, starch solution and water. Then **EITHER** give students time to carry out the Benedict's test on different foods to see if they contain glucose **OR** demonstrate the Benedict's test on a number of different foods to see if they contain glucose.
- Read through the content on Fats and oils with students. students the opportunity to carry out a simple test to see how filter paper turns translucent when rubbed with a fat or oil.
- Discuss the need to store energy – we are not constantly taking in and digesting food, but our cells always need energy. Read through the final section with students. Emphasise the difference between the carbohydrate glycogen stores in the muscles and liver that give us a quick burst of energy when needed and the main energy store in our fat cells.
- Students answer questions 1–4a.

Extension

Students complete Q4b comparing glycogen and fat stores in the body.

Homework

Workbook page 22.

Key words

sugars, glucose, starch, glycogen

4.2 Student Book answers

1. Carbohydrates and lipids/fats and oils.
2. Similarity: both are carbohydrates.

   Differences: any two from – sugars are small molecules, starches are big molecules made up of lots of sugars; sugars are absorbed into the blood quickly, starches have to be digested before they can be absorbed; sugars for quick release energy, starch for slow release energy.
3. Seeds and nuts often contain large stores of fats and oils to provide energy for the new plant that grows. Animals eat them because they are a very energy-rich food.
4. **a.** Because they are not eating all the time so they need energy stores to release energy when they are not taking in food.

   b.

Glycogen	Fat
Carbohydrate	Lipid
Short-term energy store	Long-term energy store
Stored in the muscles and liver	Stored in fat cells under the skin and around body organs
Provides rapid instant energy when blood sugar levels fall	Provide energy over time if not enough food is eaten to supply our energy needs

4.3

Measuring the energy in food – managing variables

TWS

Student Book pages 50–51

Objectives

- Plan a range of scientific investigations.
- Decide what equipment is required to carry out an investigation.
- Use symbols and formulae to represent scientific ideas.
- Apply mathematical concepts to analyze data.

Overview

This lesson helps students to develop their skills in Thinking and working scientifically.

Students will learn how we measure the energy stored in food and the units used: kilojoules and kilocalories. These are the SI units and the traditional units, still widely referenced on food packaging. You will explain how to measure the energy stored in food using a very simple calorimeter. Engage your students in a discussion about the different variables involved and how they can be controlled. You could give them a version of this practical to do themselves, demonstrate the technique yourself or use only the Student Book to generate the same discussion. There are also demonstrations available online.

This is a valuable opportunity to raise the problem of controlling all the variables when working with biological systems. Living things vary – for example, you can measure the same mass of date and peanut – but each date and peanut will be different from the next as a result of genetic and environmental variation. This means that in biology some variables cannot be completely controlled. This is one way in which biology differs from physics and chemistry.

Activities

- Bring a selection of food packaging into the lesson and let students look at the energy values of the different food and the different units used. Ask for ideas about why this might be, then read the first section with students.Now look at the section headed ‘Making a fair comparison’. Ask different students to read out each comment and then have a brief class discussion on the value of the statement.
- **EITHER** carry out a demonstration **OR** use an online demonstration.
- Students complete questions 1 and 2.

Extension

Give students Q3 to complete.

Homework

Each student to make a record of the food they eat for at least one day before the next science lesson – ideally they record this for three days – and bring their records to the next science lesson.

Workbook page 23.

4.3 Student Book answers

1. Place a measured volume of water in a test tube/boiling tube → weigh a food sample → record the water temperature → set the food sample alight and use it to heat the water → record the maximum water temperature reached → weigh any food left → subtract the final mass from the initial mass to find out how much of the food burned → subtract the initial temperature from the maximum temperature to find the temperature rise → substitute data into this formula:

   temperature rise per gram (°C/g) = measured temperature rise (°C) ÷ mass of food used (g)

   → ***repeat twice more and find the mean → repeat the whole process with a second type of food so you can compare the amount of energy in the two foods.***

   Also acceptable if students say weigh the same mass of two different foods and use the same amount of each rather than weighing before and after burning.
2. Volume of the water, mass of the food sample, any other sensible point.

   Additional variables: e.g. control the energy loss to the environment, use oxygen rather than air to ensure same amount available for burning, any other sensible point.
3. Total mass of date burned = 30 − 5 = 25 g

   Temperature rise from heating with date = 25 − 20 = 5 °C

   Temperature rise per gram = 5/25 = 0.2 °C per gram

   Total mass of peanut burned = 1.2 – 0.2 = 1 g

   Temperature rise from heating with date = 20.4 – 20 = 0.4 °C

   Temperature rise per gram = 0.4/1 = 0.4 °C per gram

   Peanuts had more energy per gram as dates.

4.4 A balanced diet

Student Book pages 52–53

Prior learning

- Know that an adequate, varied diet is needed to keep healthy

Objective

- Recognise that a healthy diet contains a balance of foodstuffs.

Overview

This unit focuses on the concept of a balanced diet in terms of a variety of food intake. A common misunderstanding is that the diet must be balanced every day. Emphasise that very few people have a perfectly balanced diet every day, but that over weeks or months the diet must be balanced to avoid health problems. You also introduce the importance of water and fibre in the diet. Neither are nutrients but both are needed for a healthy body.

Activities

- Ask students what is needed in a healthy diet – they should remember the main food groups they have met so far – carbohydrates, proteins, lipids (fats and oils), vitamins and minerals. Then look at the unit in the Student Book and read the section on a balanced diet.
- Ask lots of questions to make sure that students understand the principle of a balanced diet and recognise that different people will need different balances of foods at different life stages, e.g. if they are growing fast, if they are pregnant, if they do a very physical job, if they are training for a sports event.
- Look at the food pyramid as an example of a balanced diet. Make the point very clearly that most people do not eat a balanced diet every day, but that over time the diet must be balanced to be healthy.
- Ask students to get out their record of the food they have eaten. If students have recorded their food over several days, suggest they redraw and extend the table so they can see how their diet balances over several days. Students analyse their diets and look at possible changes they might make. Remind them again that a balanced diet happens over time, not on a single day – **be sensitive to the circumstances of individual students, especially if you are doing this lesson during Ramadan or you have students affected by conditions such as diabetes in your class.**
- Students read through the section 'What else do we need?' to the end of the second bullet point. Question them on the importance of water and fibre in the diet.
- Comment on the difficulty of educating people about the importance of a balanced diet. Ask them to design a 'Healthy food plate' – using the circle as a plate but also as a pie chart to show people what proportions of different types of food are needed to make a balanced meal. Their food plate must be bright and interesting and carry simple information for people to understand and use.
- Leave time at the end of the lesson to introduce the ways in which diet can affect human health (students can complete their food plate for homework). Read through the final paragraph, carefully considering the data in the graph. If time, students answer questions 1–3.

Extension

Students answer Q4.

Homework

Workbook page 24.

Key words

balanced diet, fibre, cellulose

4.4 Student Book answers

1. A balanced diet contains a wide variety of foods that give you the energy you need to replace the energy used by your cells to carry out the functions of life, and the nutrients your body needs to grow and repair itself.
2. A balanced diet contains more carbohydrates, fruits and vegetables than anything else. It should contain fibre in the wholegrains and fruits and vegetables. Protein should be the next biggest constituent of the diet to replace cells, etc. There should only be a small percentage of fats and oils, and sweet or fatty treats.
3. In a cold country: needs more energy to keep warm and hence more high energy food. Loses less water as sweat to cool down, so less water in their balanced diet.

   In a hot country: needs less energy rich food, as no issues with keeping warm, but more water, as lose sweat to keep cool.
4. The risk of dying of colon cancer over 25 years drops from about 1.5% to about 0.5% with an increase in the fibre content of the diet from 20 g per day to 60 g per day. It falls in relation to an increase in fibre in the diet.

4.5

Diet, growth and development

Student Book pages 54–55

Prior learning

- Know that an adequate, varied diet is needed to keep healthy

Objectives

- Recognise that a healthy diet contains a balance of foodstuffs.
- Identify and describe essential nutrients deficiency disorders.
- Correlate diet and fitness.

Overview

In this lesson, you introduce students to the concept of deficiency diseases – as always when discussing health related issues, sensitivity is needed. Help your students to recognise that substances such as vitamins are needed in tiny amounts compared with carbohydrates, proteins and lipids, but they are nevertheless very important to the healthy working of the body. This spread focuses both on what vitamins and minerals are important for and the deficiency diseases that result if they are lacking in the diet. It is very impressive for students if you bring 2 chicken bones to the lesson – one normal one and one that you have stored covered in vinegar for around 5 days. The vinegar removes the calcium and so the bone is bendy – you can use it to show how important it is for bones to take up the calcium they need.

Activities

- Quiz students to find out what they know about vitamins and minerals with questions such as 'What is a vitamin?', 'What is a mineral?', 'Name a vitamin and tell us what it does in your body', 'What foods are rich in vitamins?' etc.
- Read through with students looking at the information on the role of vitamins in the body. Bring in some examples – citrus fruits, carrots or sweet potatoes, eggs. Look up stories about the discovery of vitamins and their importance to tell to students – for example, the use of citrus fruits to prevent scurvy on long sea voyages, the problems of rickets in countries where there is little sun, etc.
- Talk about importance of minerals such as calcium and iron in the diet. Link calcium to vitamin D and help students understand that vitamin D is needed for the bones and teeth to take up the calcium they need to stay strong. If you have prepared a chicken bone with the calcium removed, demonstrate it to students now – they will be amazed to see how flexible the bones are without calcium.

- Students work through questions 1–3.

Key words

deficiency disease, Vitamin A, night-blindness, Vitamin C, scurvy, Vitamin D, rickets, calcium, iron, anaemia.

Extension

Students answer Q4 on the role of certain vitamins and minerals in aerobic respiration.

Homework

Workbook page 25

4.5 Student Book answers

1. A disease caused by a lack or deficiency of a particular nutrient in the diet.
2.

Deficient substance	Role in the body	Food containing this nutrient	Name and symptoms of deficiency disease
Vitamin A	Supports healthy eyes	Egg yolks, fish liver oils, dairy products, carrots	Night blindness: poor vision in dim light
Vitamin C	Helps cells stick together/ aerobic respiration	Citrus fruits	Scurvy: gums bleed, skin peels, legs swell, cellular respiration stops
Vitamin D	Helps bones absorb calcium	Egg yolks, cream, fish, liver, oils	Rickets: soft, bendy bones, weak bones, crumbing teeth
Calcium	Makes bones and teeth strong	Dairy products	Rickets: soft, bendy bones, weak bones, crumbing teeth
Iron	Needed for haemoglobin in red blood cells	Red meat, egg yolks, liver, apricots, green leafy vegetables	Anaemia: not enough haemoglobin in red blood cells (rbcs), not enough rbcs = not enough oxygen – feel tired and weak.

3. Your body needs calcium to maintain strong, hard, healthy bones and teeth. It also needs vitamin D to absorb calcium from your digestive system. A diet low in calcium will cause rickets. But a diet high in calcium but low in vitamin D will still cause rickets because the body cannot absorb the calcium it needs.
4. Scurvy because it is a lack of vitamin C and vitamin C is needed for the reactions of aerobic respiration. Anaemia because it is a lack iron which is needed to make the haemoglobin which brings the oxygen needed for aerobic respiration to the cells. They are both very serious because aerobic respiration releases the energy needed for all the processes of life in your cells. If they cannot take place, you will eventually die.

4.6

Starvation, stunting, obesity, and health

Student Book pages 56–57

Prior learning

- Know that some foods can be damaging to health e.g. very sweet and fatty foods

Objective

- Correlate diet and fitness.

Overview

This is another lesson that requires sensitivity – you may have students who are either underweight or obese in your class. No student should be made to feel uncomfortable during the lesson – but it is still important that students recognise the health problems linked to both conditions. This content is important for success at IGCSE Biology and understanding the links between diet and health is important for producing healthy and scientifically literate citizens of the future.

Activities

- Students list possible reasons why some people around the world do not have enough to eat. Put their answers together in a list on the board and then read the first two paragraphs with your students. Discuss these reasons and recognise that, for most people, not having enough to eat is not a lifestyle choice – it is imposed on them. Remind students of the deficiency diseases they met in the previous lesson and explain that people who are starving are at risk of these deficiency diseases and many more.
- Explain that starvation is a problem for millions of people – but many more people around the world are affected by obesity than by being underweight. Obesity as a result of eating too much is a lifestyle choice for many people – but some people have other problems which mean they become obese very easily.
- List the main factors that increase the risk of obesity: eating more food than needed, eating food high in carbohydrates and fat, and lack of activity/exercise. Discuss them with your students. Aim to build understanding that obesity is a multifactorial problem and that societal changes have an impact on it as well as individual choices.
- Work through the BMI calculation with students. To avoid the chance of causing distress, it is better to do calculations with theoretical students – see Q4 later. students understand the concept of risk, the increased risk of health issues with increasing obesity and that being underweight also increases the risk of disease.
- Finally, ask students to look at Q4. All the students in the question have the same body mass. This exercise reinforces the concept that it is our level of obesity, not our absolute mass, that affects our risk of disease.

Extension

Give students to look at how different behaviours affect how we eat, and to think of actions at both the societal level and the individual level that would help make more people healthy eaters.

Homework

Workbook page 26

Key words

obese, diabetes, high blood pressure, heart disease, heart attack, cancer, arthritis

4.6 Student Book answers

1. Obesity is carrying too much fat on our body and having a BMI over 30.
2. People are eating more, especially food high in carbohydrates and fats; people are exercising less as fewer people do physical jobs and more people drive rather than walk.
3. Any three from
   - Diabetes: blood sugar levels are hard to control. This causes tiredness and eventually blindness and even death.
   - High blood pressure: obesity is a common cause of high blood pressure. This stresses your heart and blood vessels and causes heart disease and strokes.
   - Heart disease: fatty material builds up in the blood vessels – you may have a heart attack.
   - Cancer: at least 13 different cancers are more common in overweight and obese people.
   - Arthritis: strain on the skeleton leads to wear and pain in the joints.
   - Deficiency diseases: fatty, sugary foods are often low in vitamins and minerals leading to deficiency diseases.
4. **a.** **i.** BMI = 70 ÷ (1.83 × 1.83) = 70 ÷ 3.35 = 20.9. Range 18–24.9.
   ii. BMI = 70 ÷ (1.50 × 1.50) = 70 ÷ 2.25 = 31.1. Range 30–39.9.
   iii. BMI = 70 ÷ (1.65 × 1.65) = 70 ÷ 2.72 = 25.7. Range 25–29.9.
   b. Jamil is in the healthy weight range so he is likely to be healthiest. Moeed is overweight and Yasmin is obese – the higher your BMI, the more it is likely to affect your health.

4.7 The problems of wasting and obesity in Pakistan (TWS)

Student Book pages 58–59

Prior learning

- Essential nutrients' deficiency disorders.
- a healthy diet contains a balance of foodstuffs.
- Correlate diet and fitness.

Objective

- Investigate issues which involve and/or require scientific understanding.

Overview

This lesson helps students to develop their skills in Thinking and working scientifically.

It takes students through the process of extracting and displaying information graphically, identifying trends, developing a hypothesis, planning an investigation, analysing results and drawing conclusions. The questions encourage students to extend their investigations based on their results and determine ways in which the investigation could be improved.

Activities

- Begin by reminding students that this lesson in Thinking and working scientifically, is designed to guide them through conducting investigations and collecting and analysing datasets.
- It is preferable if the data and graphs in the spread can be projected or shown via a large screen so that everyone can see them without opening their Student Books. Talk about the information in the first figure, comparing BMI rates across Pakistan. Discuss the relationship between BMI and being over- or under-weight. Explain that Body Mass Index (BMI) is a tool used to determine an individual's weight status by considering their weight and height. It is calculated by dividing a person's weight in kilograms by the square of their height in meters.
- Further explain that although BMI is an easy and inexpensive way to screen for weight problems, it does not directly measure body fat. For example, an

4.7 Student Book answers

a. Being healthy weight means that a child is at the correct weight and height range for their age. A stunted child is less than the correct height range, whereas a wasting or wasted child is less than the correct weight range for the age. An obese or overweight child is above the weight range compared to their height.

b. Students should be encouraged to attempt to create the bar chart themselves.

c. Lead a class discussion on this topic. You may refer to TWS spread 4 at the beginning of the book. The correct data display is important to summarize challenges and findings, and to discover possible solutions to the issues of diet and nutrition.

athlete may have a higher BMI due to increased muscle mass rather than increased body fat.

- Bring the focus back on the nutritional status' and discuss what each term (healthy, overweight, underweight, wasted, stunted, obese) means. Review the data given in the book and ponder the possible reasons for this.
- Facilitate a class discussion based on the dataset on page 59 of the spread. Ask them to try and answer part c of the question box and give their reasonings. Encourage them to use the information given on pages xii and xiii (TWS spread 4) when formulating their answers.

Homework

Q1b from the student book spread. Also Workbook page 27.

Key word

healthy diet, balanced, food stuff, nutrients, essential nutrients, food source, food habit, budget.

4.8 Some major digestive disorders

Student Book pages 60–61

Objective

- Briefly describe some major digestive disorders.

Overview

This lesson will require sensitivity on your part – some students may have lost close loved ones due to cancer, of the alimentary tract or otherwise. No student should be made to feel uncomfortable during the lesson – but it is important that students recognise the health problems linked to the alimentary canal. Understanding the links between sanitary lifestyle, diet and health is important for producing healthy and scientifically literate citizens of the future. This lesson also covers many of the objectives of science in context, as it looks at risk and the way scientific knowledge and human behaviour interact.

Activities

- Discuss this lesson with sensitivity, as, with all health issues, some students will have family experience of these problems.
- This lesson is a good lead-up to developing the students understanding of science in context. Begin by reviewing the concepts of infectious and non-infectious diseases. Explain to the students that infectious diseases are caused

Prior learning

- Difference between contagious and non-contagious diseases.
- Essential nutrients' deficiency disorders.
- a healthy diet contains a balance of foodstuffs.

by microorganisms known as pathogens, which can spread from one person to the other through various means. Non-infectious diseases can be due to number of other factors and include such deadly diseases such as cancer.

- Ask the students what possible symptoms they would expect in a person suffering from a disease of the alimentary canal.
- Discuss the symptoms and underlying reasons for infectious diseases of the alimentary canals, such as Diarrhoea and Ulcers. elicit the differences between the two, and also the similarities.
- Review the different types of cancer that can occur in different parts of the alimentary canal. Discuss their similarities and differences.
- Finish the lesson by having a class discussion on the questions given in the spread. Ensure that all students participate.

Homework

Questions from the student book spread. Also Workbook page 28.

Key word

healthy diet, balanced, food stuff, nutrients, essential nutrients, proteins, carbohydrates, fats, minerals, vitamins, fiber, deficiency disorders, food source, food habit.

4.8 Student Book answers

1. For proper breakdown of major food groups and proper absorption of the nutrients.

2. **a.** Diseases caused by pathogens which can spread from one person to the other through various means.

b. Students' answers should include reference to water contamination with faecal bacteria E.coli and its effect on peristalsis.

c. i. Prevent contamination of surfaces and food and drink with faecal matter;

ii. Ensure no cross contamination occurs between foods and/or dirty surfaces;

iii. Make certain that the food and drink entering our body is not contaminated.

3. **a.** Cancer formation is affected by the genetic material inherited and lifestyle factors such as smoking and the amount of fibre and other factors in the diet.

b. Oral, gastric, and Colorectal.

c. Students can create a bar graph using the data in the last paragraph in the unit.

4.9

Health and inequality

SIC

Student Book pages 62–63

Objectives

- Discuss issues which involve and/or require scientific understanding.
- Describe how people develop and use scientific understanding.
- Discuss how the uses of science can have a global environmental impact.

Overview

This lesson helps students to develop their understanding of Science in context. They look at inequality of access to food and education through the work of two students. This content helps your students to recognise that scientific understanding is required to tackle some of the biggest issues of our time. The evidence presented demonstrates that there is no need for people to have health issues as a result of too much or too little food – but equality of access to scientific understanding of the situation through education is crucial so that everyone has the opportunity to make informed decisions about their life.

Homework

Workbook page 29

Key words

inequality of access

Activities

- Read through the introductory section with students and ask: 'When scientists know so much about the impact of lifestyle choices on health, why are so many people still affected by diseases caused by their diet, or their habits such as smoking?'
- Students read through the work of Rameez and Mariam and answer questions 1–3.
- Encourage students to work in groups, although they could work individually, to develop a short news report about the importance of scientific understanding in enabling both people in power, and ordinary individuals, to evaluate problems and make healthy decisions. Students record their reports in the style of an audio or video news broadcast. If possible, enable students to watch each other's presentations and discuss which are the most effective at getting the message across.

4.9 Student Book answers

1. 45%–36% animal feed and 9% biofuels.

2. Any 3 valid reasons, e.g.

- Difficult to grow crops in some parts of the world, e.g. too hot, too dry. Solution: develop plants that grow in difficult conditions/improve farming methods.
- Only 55% of the crops grown are used to feed people directly – 36% is fed to animals to produce meat. Solution: people eat less meat, so more crops are available to feed people.
- 9% of crops grown are used to produce biofuels. Solution: stop using food which could be eaten to produce biofuels.
- Around 33% of all food produced is wasted or spoiled in storage. Solution: reduce food waste and improve food storage.
- Any other sensible suggestions.

3. Look for students referencing evidence and investigations, e.g. into different types of crops. Also look for reference to the role of education in both growing food and in understanding the importance of a balanced diet for healthy growth and development of children and for overall health. A good answer should have at least **6** well-made points.

4.10
Review answers
Student Book pages 64–65

Student Book answers

1. a. A balanced diet contains a variety of foods that supply the energy you need for your cells and the nutrients your body needs to grow and repair itself. **[2]**
   b. Carbohydrates provide both rapid energy and slow release energy sources, e.g. rice, bread (any example of carbohydrate rich food is acceptable). **[4]**
   c. Proteins are important to build new tissues, repair damaged tissues and replace old tissues, e.g. meat, fish, beans (any example of protein food is acceptable). **[4]**
   d. Lipids/fats and oils are important as an energy source and to produce insulating layer under the skin/protective layer around organs and cell membranes, e.g. butter, olive oil, cheese (any 2 examples of high fat food are acceptable). **[4]**
2. a. 50 g of fat. **[1]**
   b. Cheese contains 50% fat. Fat is very high energy food – it contains a lot of calories. When people want to lose body mass, they must reduce the amount of energy they take in. So reducing cheese would quickly cut a lot of energy from the diet. **[1]**
   c. i. 15 g more fat in meat than in fish. **[1]**
      ii. It is low in fat (relatively low in calories) and high in protein. **[2]**
3. a. Potato chips would supply most energy per gram as they have a much higher percentage of fat in them, and fat is a rich energy source. **[2]**
   b. If you record the temperature of a sample of water, then burn a food sample and use it to heat the water and measure the rise in temperature, this will give you a measure of the energy contained in the food. **[4]**
   c. Size of food sample (e.g. the same each time); the volume of the water heated; the distance of the flame from the tube; any other sensible points. **[2]**
   d. Not all the food burns away; some of the energy is lost as light and by heating the air. **[2]**
4. a. Lacking vitamin A. It is needed for healthy eyes and deficiency means you cannot see well in dim light. **[3]**
   b. Lacking iron. Iron is needed to make haemoglobin that carries oxygen to the cells for aerobic respiration which provides the cells with energy. With too little iron, a person makes fewer red blood cells so their skin is pale and they lack energy/feel tired/are breathless as they try to get more oxygen. **[4]**
   c. Lacking vitamin C. This is needed for cells to stick together. Lack causes scurvy where skin breaks up, gums bleed and teeth are lost. **[3]**
   d. i. Lack of calcium or lack of vitamin D. **[2]**
      ii. Calcium is found in milk and dairy produce. As the patient drinks lots of milk it is unlikely that the cause of her rickets is lack of calcium. Vitamin D comes from the diet but is also made in the skin when out in the sun. You need vitamin D to absorb calcium from the diet into the body. The patient stays indoors most of the time so doesn't get sun on her skin. This suggests the cause of her weak bones is lack of vitamin D not lack of calcium. **[5]**
5. a. BMI = Body Mass Index; calculated: BMI = mass/(height)^2 **[2]**
   b. BMI over 30 is obese. Obesity increases the risk of developing many different diseases. **[2]**

c. Any three from:

Diabetes: a lot of body fat makes blood sugar levels hard to control. This causes tiredness and eventually blindness and even death.

High blood pressure: obesity is a common cause of high blood pressure. This stresses your heart and blood vessels and causes heart disease and strokes.

Heart disease: fatty material builds up in the blood vessels – you may have a heart attack.

Cancer: at least 13 different cancers are more common in overweight and obese people.

Arthritis: strain on the skeleton leads to wear and pain in the joints.

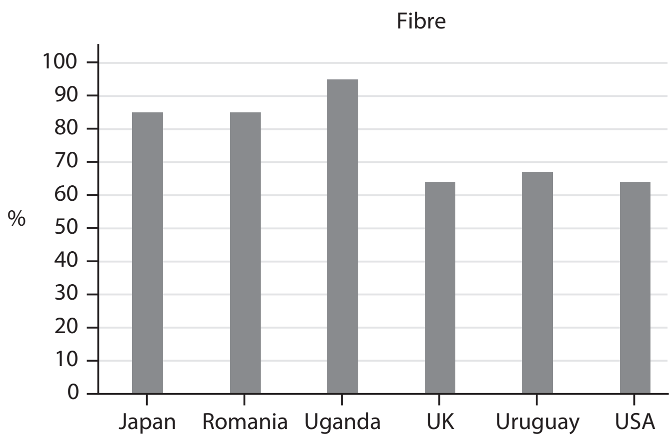
Deficiency diseases: fatty, sugary foods are often low in vitamins and minerals leading to deficiency diseases. **[6]**

[1]

6. a. Material in your food which cannot be digested e.g. cellulose/plant cell walls. **[2]**

b. USA and Uruguay. **[2]**

c. Title: Chart to show the percentage of high-fibre foods eaten in different countries Vertical axis label: % high fibre food in the diet



[10]

d. They do support the hypothesis – countries with very high fibre intake such as Uganda generally have a lower incidence of bowel cancer than countries with a low fibre intake. **[2]**

7.

	Diarrhoeal diseases	Alimentary canal cancers
similarities	both cause diarrhea as a symptom and affect the alimentary canal	
	both can lead to weight loss and even malnutrition	
	both are relatively common in Pakistan	
differences	result of bacterial infections	result of cells growing in an uncontrolled way
	acute but short-term	chronic, i.e. long-term

8. a. tissues **[1]**

b. amino acids **[1]**

c. glycogen **[1]**

d. fats **[1]**

e. cellulose **[1]**

5.1 The particle model

Student Book pages 66–67

Homework

Workbook page 30, and questions from the students book as well.

Key words

material, substance, particle, particle model, property

Objectives

- Explain the particle theory of matter.
- Describe the structure of matter in terms of particles (i.e., atoms and molecules).

Overview

This lesson introduces the simple particle model, which explains changes of state, as well as properties such as density and hardness. A more complex particle model, involving atoms and atomic structure, explains chemical change. Students meet this model later in the course.

The lesson begins with a brief introduction to chemistry. Students then carry out two practical tasks. In the first, they observe and record properties. In the second, they use the particle model to suggest explanations for differences in properties between pairs of materials. Finally, students work in pairs to reinforce definitions of key words.

Activities

- Ask students the question *What is chemistry?* Tell students that chemistry is the study of matter (stuff), and how and why it changes. Point out that chemistry is involved in almost everything, including staying alive, cooking, and making plastics and medicines.
- **Practical activity:** Students describe the properties of five materials, including their appearance and whether or not they flow.
- Explain that everything is made from particles and that the particle model describes the arrangement and movement of particles in a substance. Tell students that the properties of a substance depend on five factors, as listed in the Student Book.
- **Practical activity:** Students compare pairs of materials. For each pair, they deduce the answer to a question about the mass, movement, or separation of their particles, or how strongly the particles hold together. The purpose of this activity is to get students thinking, as a precursor to taking these ideas further in next lesson.
- Give the definitions of *material* (the different types of matter that things are made from) and *substance* (a material that has one type of matter, with identical particles). In pairs, tell one student to give the definition of one of the five key words in this lesson. The other student in the pair identifies the word that has been defined.

Extension

Ask students to discuss in pairs, or to write down, to predict whether each of the following is the same/different for ice (water in the solid state) and steam (water in the gas state):

- what their particles are like
- how their particles are arranged
- how far apart the particles are
- how strongly their particles hold together.

5.1 Student Book answers

1. Substance – a material that has one type of matter; material – the different types of matter that things are made from; property – what a substance is like and what it does; particle model – describes the arrangement and movement of particles in a substance.
2. For example: shiny, grey, shape stays the same unless you apply a force.
3. How strongly the particles hold together.
4. Gold particles are heavier than silver particles.

5.2
The states of matter

Student Book pages 68–69

Prior learning

- Matter can be solid, liquid, or gas.

Objective

- Explain the particle theory of matter.

Overview

In this lesson, students learn about the arrangement, movement, separation, and attraction of the particles in the three states of matter, and take the roles of particles to model these. Students then examine samples of substances, decide which state each is in, and discuss how the particle model explains the physical properties observed.

A common misconception is that solids, liquids, and gases are different types of matter. To avoid students picking up this idea, this course emphasises that any one substance can usually exist in three states, depending on temperature. The particles do not change in each state; only their arrangement and behaviour changes.

Activities

- Display some ice, liquid water, and steam (from a boiling kettle), and ask students what they have in common. Elicit that they are water in its three states of matter – solid, liquid, and gas. Tell students that most substances can exist in three states, and that the state of a substance depends on temperature.
- Display diagrams of the particle arrangements of a substance in its three states. Describe the arrangement, movement, and separation of the particles in each state.
- Tell students they will now take the role of particles to model the solid, liquid, and gas states. If possible, do this activity outside or in a big hall. First, students arrange themselves as the particles in a solid (close together, in rows, shaking to represent vibrating). Second, students act as particles in liquid (close together, moving around each other in a defined space, representing the bottom of a container). Third, students act as particles in gas (moving fast in all directions, throughout the whole container).
- **Practical activity:** Give students the definition of the term *physical properties.* Students then examine samples of substances and decide whether each is in its solid, liquid, or gas state. In pairs, they discuss how the particle model explains the physical properties observed and record their answers in writing.
- Students complete the questions from the unit to reinforce their learning.

Extension

Show students some hard-to-classify materials, such as sand, toothpaste, and foam. Students work out the state (or states) of each, and justify their decisions.

Homework

Workbook page 31.

Key words

states of matter, physical properties.

5.2 Student Book answers

1. Solid, liquid, gas
2. Difference – solid, does not flow; liquid, does flow. Difference – solid, shape stays the same unless you apply a force; liquid – takes the shape of the bottom of its container; Similarity – both can only be compressed a tiny bit.
3. Arrangement – not in a pattern; movement – move around randomly, sliding over each other; separation – touch each other.
4. Particles in a liquid are held together more strongly than particles in a gas.

5.3 Using the particle model

Student Book pages 70–71

Prior learning

- A substance has different physical properties in its three states.
- The particles have different arrangements, movement, and separation in the three states.

Objectives

- Explain why gases and liquids take the shape of their container but solids do not, in terms of the particle theory of matter.
- Discuss, using the particle model, why liquids and gases can flow easily, but solids cannot.

Overview

In this lesson, students use the particle model to explain some of the physical properties of substances in the solid, liquid, and gas states. The main activity is a group activity, in which students create posters or short plays to communicate their learning.

In the final part of the lesson, each group presents their poster or play to another group for peer assessment.

Activities

- Remind students about the arrangement, movement, and separation of the particles in the three states using an animation from the Internet or marbles/dried beans in a jar. Tell students that a space that has no particles is called a vacuum, and that most of outer space is close to being a vacuum.
- Divide students into groups of three. These are *home groups.* Within home groups, each student is allocated one question from the spread. Students doing the same question then get together in new groups of three or four. These are *expert groups*. Each expert group tackles its question using information from the Student Book, and group members plan how to teach their home groups what they have learnt. Students might like to use physical models, such as marbles or dried beans, to support this task.

  Students return to their home groups, and teach the other members of the group what they have learnt.
- Students remain in home groups. They create posters or short plays to show what they have learnt about how the particle model explains the three properties (shape, flow, and compression) in questions A, B, and C.
- Home groups present their posters or plays to one other group. The other group peer assesses.

Extension

Ask students to make a poster or use a physical model to explain why 1 g of steam (water in the gas state) has a bigger volume that 1 g of liquid water.

Homework

Workbook page 32.

Key word

vacuum.

5.3 Student Book answers

1. Particles are greatly separated and can move around very freely.
2. The particles are in fixed positions and hold together strongly.
3. The particles move around.
4. Substance does not flow in solid state because the particles are in fixed positions; substance flows in liquid and gas states because the particles can move around.

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5.4
Diffusion

Student Book pages 72–73

Prior learning
- Particle model of matter

Objective
- Apply the particle model to explain diffusion.

Overview
The lesson defines and explains diffusion along with the factors that affects diffusion such as temperature, particle size, and state. It is explained on the basis of particle model.

The activities give visual view of diffusion and factors affecting it. The simulation will solidify the concept and also help students to get a real view of diffusion.

Activities
- Recall the particle model by asking following questions.

  What is matter made up of?

  Do particles stay at one place?
- Introduce diffusion by putting a drop of food colour in water and encourage the students to observe how the colour spreads slowly in water.
- Explain diffusion further with the help of student book.
- Ask students to give their own examples from daily life and ask them to guess at least one factor which affects diffusion.
- Following online simulation can be utilized to explain different factors affecting diffusion.

https://phet.colorado.edu/sims/html/diffusion/latest/diffusion_en.html

Homework:
Students to answers the questions given in the spread. Also Workbook page 33.

Key word
Diffusion, Particles, Region.

5.4 Student Book answers

1. It is the movement of particles from an area with higher number of particles to an area with lower number of molecules.
2. Because the particles gain energy at higher temperature.
3. Because particles of solids can not move freely from one place to another.

5.5

Evidence for the particle model

Student Book pages 74–75

Prior learning

- Particle model of matter
- Diffusion

Objectives

- Apply the particle theory of matter to explain diffusion.
- Interpret the evidence for the existence of the particles in matter by observing daily life. Examples (adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water).

Overview

The lesson proves the existence of particles in matter and that they are moving. The students will be shown some live examples to prove particle model. Each group of students will come up with the best possible explanation of how the example is the evidence for the model.

Activities

Divide students into groups. Perform the following activities and assign each group with the explanation that how this proves the particle model of matter.

- Fill up a balloon with air.
- Show Brownian movement in dust particles when sunlight strikes them.
- Fill up the syringe with air and push it then cover the nozzle with finger.
- Make a solution of salt and water.
- After class discussion involving students, explain each evidence with the help of the book.

Homework:

Students to answers the questions given in the spread. Also Workbook page 34.

Key word

Brownian motion, Pollen grains, Evidence.

5.5 Student Book answers

1. **a.** Particles will be away from each other, spread throughout the syringe.
   b. Particles will be much closer now.
2. Because salt has broken down into tiny particles and is spread evenly giving the water salty taste.
3. Brownian motion is the rapid movement of particles when in liquid. Adding salt to water proves the presence of particles as salt particles are not visible but water tastes salty.

5.6 Some changes of state

Student Book pages 76–77

Prior learning

- Evaporation is the change from the liquid to the gas state.
- Condensation is the change from the gas to the liquid state and is the reverse of evaporation.
- The boiling point of water is 100 °C.

Objective

- Explain the changes in states: melting, freezing, evaporation, condensation and sublimation using the particle model of matter.

Overview

The lesson starts by observing wax and water in different states, and with a reminder about the arrangement, movement, and separation of the particles in these states. Students then consider changes of state involving liquids and gases. They measure the boiling point of water, and display their results in a line graph. Next, students use the particle model to explain boiling, evaporating, and condensing. There is also an opportunity to make conclusions from data.

Activities

- Burn a candle. Elicit that wax exists in three states – solid, liquid, and gas. It is the gas that burns. Tell students that this lesson focuses on changes of state involving liquids and gases.
- **Practical activity:** Ask students if they remember the boiling point of water (100 °C) and remind them that, when water is boiling, it is present in two states – liquid and gas. Students then do an experiment to confirm the boiling point of water, and display their results as a line graph.
- Students read the sections on *evaporating* and *boiling* in the Student Book. Student pairs discuss differences between evaporating and boiling, and use ideas about particles to explain these changes.
- Students read the section on *condensing* in the Student Book. They draw a diagram to show what happens to the particles when a substance condenses. If students need help, remind them that condensing is the reverse of evaporating.
- Tell students that different substances have different boiling points. Ask them to work in pairs to make up questions for each other based on the data in the table in the *Thinking and working scientifically* box in the Student Book.

Extension

As a class, act out evaporating and condensing, with each student taking the role of one particle.

Homework

Workbook page 35.

Key words

changes of state, evaporating, evaporation, boiling, boiling point, condensing, condensation

5.6 Student Book answers

1. Condensing
2. Sublimation.
3. Both involve a change of state from liquid to gas; evaporation happens at any temperature but boiling happens at the boiling point; in evaporation, particles leave the liquid surface but, in boiling, bubbles of the substance form everywhere in the liquid. In boiling, these bubbles rise to the surface and escape.
4. Use the table in the spread. Encourage students to display information in an infographic.

5.7 Investigating boiling temperatures

TWS

Student Book pages 78–79

Prior learning

- Draw line graphs to present results.
- Identify patterns from results.
- Use results to draw conclusions.

Objectives

- Describe how to collect evidence to test a hypothesis.
- Draw a graph to present data.
- Describe patterns in results.
- Make conclusions by interpreting results informed by reasoning.

Overview

This lesson helps students develop their skills in Thinking and working scientifically.

This lesson takes students through one process for doing a scientific investigation. Students start by discussing a selection of questions – which could be answered scientifically? This leads to the point that scientific questions are those that the collection of evidence can help to answer. The lesson then focuses on one question – why does water boil at different temperatures in different places? Students use the evidence to test a hypothesis and to make a conclusion. They finish by sequencing some steps of a scientific investigation.

Activities

- Student pairs discuss the questions which could be answered scientifically? Make the point that scientific questions are those that the collection of evidence can help to answer.
- Tell students that water boils at different temperatures in Karachi a city by the sea, and Shimshal a city in the mountains (use local examples, if possible). Ask students to suggest a scientific question based on this evidence, for example *Why does water boil at different temperatures in different places?*
- Tell students that a hypothesis is a possible explanation that is based on evidence. Give one hypothesis for the different boiling points in Karachi and Shimshal – boiling point depends on altitude.
- Ask students how they could test the hypothesis above. Students plot a line graph of boiling temperature vs altitude.
- Students check that the evidence displayed on their line graph supports the hypothesis, and make a conclusion based on the evidence. They also identify the anomalous result in the table.
- Students make a flow chart to show the steps they took to make their conclusion.

Extension

Students consider possible improvements to the investigation by reading the section *Suggesting improvements* in the Student Book and by answering question 5.

Homework

Workbook page 36 and the questions in the spread.

5.7 Student Book answers

1. A possible explanation that is based on evidence and that can be tested further.
2. 69 °C
3. As altitude increases, the boiling temperature of water decreases.
4. 92 °C
5. Ask everyone to use the same type of thermometer, because different types of thermometer might give slightly different readings for the same temperature.

5.8

More changes of state

Student Book pages 80–81

Prior learning

- Melting is the change of state from solid to liquid.
- Freezing is the change of state from liquid to solid.
- Freezing is the reverse of melting.

Objective

- Explain the changes in states: melting, freezing, evaporation, condensation and sublimation using the particle model of matter.

Overview

This lesson explains changes of state involving solids, as well as providing an opportunity for students to practise making conclusions from data. It starts by getting students to consider particles – how do their arrangement, movement, and separation change on melting and freezing? Students find the melting point of stearic acid by plotting heating and cooling curves. There is then a short demonstration in which students learn that melting temperatures give information about the purity of a substance. The lesson ends with a short activity in which students make conclusions from data to predict the states of different substances at different temperatures.

Activities

- Lead a discussion to elicit how particle arrangement, movement, and separation change on melting and freezing. As a class, students act out melting and freezing, with each student taking the role of one particle.
- Students follow the guidance to plot heating and cooling curves for stearic acid. They use their graphs to find its melting point.
- Explain that melting temperatures indicate the purity of a substance – if a substance has a sharp melting point, it is pure. If a material melts over a range of temperatures, it is not pure. Illustrate this point by inserting a thermometer into solid butter (a mixture) and heating gently to melt. The stearic acid that students melted in the practical activity is a pure substance. Melting point data also help identify substances – students read about this the Student Book.
- Tell students that – together – melting point and boiling point data can be used to predict the state of a substance at a given temperature. Show students how to use the number line to predict the state of silver at different temperatures. Students then answer question 3 on this page.
- Each student makes up two quiz questions to summarise learning from the lesson. In groups of four, students take turns to ask their question to others in their group.

Extension

Students write the melting point (−7 °C) and boiling point (60 °C) of bromine on a number line. They predict its state at −10 °C, 20 °C, and 100 °C. They repeat this activity for a few other elements, using melting and boiling point data from a data book or the Internet.

Homework

Workbook page 37 and the questions from the Students' book.

Key words

melting, freezing, melting point

5.8 Student Book answers

1. **a.** Melting
   b. Freezing
2. Movement – before, move around, sliding over each other; after – vibrate on spot. Arrangement – before, arrangement changes all the time; after – in a pattern. Separation – particles touch each other before and after.
3. **a.** Solid
   b. Liquid
   c. Gas
   d. Solid

5.9

Models in science

TWS

Student Book pages 82–83

Prior learning

- Use the particle model to explain observations.

Objectives

- Define the term model in science.
- Consider strengths and limitations of the particle model.

Overview

This lesson helps students develop their skills in Thinking and working scientifically.

The lesson starts with a discussion about toys, as an analogy for scientific models. Next, students use dried peas to represent the particle model, and discuss which observations this representation can and cannot explain. Students then read about the strengths and weakness of the particle model itself, and create posters to communicate some of these. The lesson ends with peer evaluation of the posters.

Activities

- Show students some toys, such as a doll, a model car, and a model house. Ask student pairs to discuss how the toys are similar and different to the real things they represent, as well as the advantages of playing with these toys rather than real people, cars, or houses.
- Explain that a model in science is an idea that explains observations and helps in making predictions. Like the toys discussed, models in science have similarities and differences to reality. Models in science may be represented in different ways – as diagrams, as physical models that can be touched, or even as mathematical equations.
- Tell students that they will now use dried beans to represent the particle model. Encourage them to discuss which of the observations listed the bean representation of the particle model can and cannot explain.
- Students then read about the strengths and limitation of the particle model. Then, in pairs, they make a poster to summarise some strengths and limitations of the model. Emphasise that this activity is about the particle model itself, not about the bean representation of the model.
- Student pairs join together in groups of four to peer evaluate their posters. Encourage students to focus on the content of the posters, rather than what they look like.

Extension

Students design alternative representations of the particle model, using items other than dried beans. Challenge them to design representations that explain observations that the bean representation cannot explain.

Homework

Workbook page 38 and the questions from the Students' book.

Key word

model.

5.9 Student Book answers

1. An idea that explains observations and helps in making predictions.
2. You can pour a substance when it is liquid because its particles move all the time, sliding over each other. In the solid state, the particles are in fixed positions.
3. Particles are not all spheres and particles are not solid.
4. It does not explain all observations perfectly; predictions made with the model are not always accurate.

5.10

Review answers

Student Book pages 84–85

Student Book answers

1. **a.** Solid and liquid **[2]**
   b. Liquid **[1]**
   c. Liquid and gas **[1]**
2. **a.** Particle model **[1]**
   b. Evaporation **[1]**
   c. Substance **[1]**
   d. Physical properties **[1]**
3. **a.** C **[1]**
   b. D **[1]**
   c. Melting **[1]**
   d. Evaporating / boiling **[1]**
   e. Sublimation **[1]**
4. Gas, vibrate on the spot, close together, solid, liquid, move around and slide over each other, a little, gas, much, move around from place to place **[10]**
5. **a.** Tungsten **[1]**
   b. Chlorine **[1]**
   c. Chlorine **[1]**
   d. Two from iodine, osmium, tungsten **[1]**
   e. Liquid **[1]**
   f. Liquid [1] gas **[1]**
   g. Evaporating / boiling **[1]**
6. From top – C, B, A **[1]**
7. **a.** Increases **[1]**
   b. Decreases **[1]**
   c. Decreases **[1]**
8. **a.** Z **[1]**
   b. Y **[1]**
9. **a.** Heat the liquid **[1]**
   b. Diagram as in the question, but with lesser particles in liquid form and with a few particles spaced out in the space above the liquid **[1]**
10. A substance cannot diffuse in the solid state. Its particles are in fixed positions. **[1]**

    If a gas is in a container with no lid, it escapes from the container – the particles move around in all directions **[1]**

    A liquid takes the shape of the bottom of its container – the particles move around, sliding over each other **[1]**

    You cannot pour a solid – its particles are in fixed positions **[1]**
11. Brownian movement, gases and solutions all provide evidence for the particle theory of matter.

    Brownian movement, also called diffusion in liquids and gases, is the continuous and random motion of small solid particles in a liquid or gas. This motion is caused by the collisions of the particles with the molecules of the liquid or gas, which shows that matter is made up of tiny particles that are always moving and interacting with each other.

    Gases have no definite shape or volume and can expand or contract to fill any container. The particle theory of matter explains that they are composed of a large number of small, fast-moving particles that are far apart and have negligible attraction or repulsion between them. However, when compressed the particles of the gas are able to come closer together, as evidenced by the ‘’empty’’ syringe experiment.

The particle theory of matter explains the formation and behavior of solutions by providing evidence that the solute particles (the substance that dissolves) are small enough to fit between the solvent particles (the substance that does the dissolving). This is proved by the solute particles remaining behined once the solvent evaporates. **[3]**

6.1

Elements and Compounds

Student Book pages 86–87

Prior learning

- The different types of matter that things are made of are materials.
- Every material has its own properties.
- A substance is a material that has one type of matter.

6.1 Student Book answers

1. A substance that cannot be split into other substances.
2. For example: iron – tools, platinum – computer hard drives; silver – jewellery.
3. Hydrogen, Helium, Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen, Fluoride, Neon.

Objectives

- Describe the structure of same thing. matter in terms of particles (i.e., atoms and molecules).
- Recognize the names and symbols for some common elements (first 10 elements of periodic table) and recognize their physical properties.

Overview

The lesson begins with a look at materials – how many can students see? What are their properties? Students are then introduced to elements as substances that everything is made of, and that cannot be split up. They examine the properties of as many elements as possible, and find them on the periodic table. There is also an optional research activity, in which each student finds out facts about an element of their choice.

Activities

- Students list the materials they can see, and describe their properties. Make sure they give properties of the materials, not objects made from them.
- Explain that every material is made from one or more substances called elements. Elements cannot be split into other substances. Each element has its own type of particle, and its own properties. There are about 100 elements.
- Tell students that the periodic table lists all the elements. The elements on the left of the stepped line are metals, and the elements on the right of the line are non-metals. They will learn more about the periodic table in future lessons.
- Students examine real samples of as many elements as possible, note their properties, and find them in the periodic table. Make the point that every element has unique properties.
- Finish the lesson by asking each student to describe to a partner the properties of one element that they examined.

Extension

Students use the internet to research one element each. They make small posters for display.

Homework

Workbook page 39 and the questions in the spread.

Key words

periodic table, element, metal, non-metal

6.2 Metal and non-metal elements

Prior larning

- Physical properties are properties that you can observe or measure without changing the material.
- In the periodic table, metals are on the left of the stepped line.

6.2 Student Book answers

1. Six from: high melting points, high boiling points, shiny when first cut, sonorous, good conductors of thermal energy, good conductors of electricity, malleable, ductile, strong
2. Beryllium is the only metal.
3. **a.** Yes, it shiny.
   b. It is a soft solid at room temperature.
4. Element X is a metal as it fulfills three major characteristics of metals. Due to its high melting point it will be able to conduct heat easily. It is also a good conductor of electricity and similar to other metals is sonorous.

Objective

- Categorize elements into metals and nonmetals (first 10 elements) based on their physical properties.

Overview

The lesson starts with an opportunity to elicit students' prior knowledge of metals and their properties. There is also a short matching activity to ensure that students understand the meanings of words describing properties. Students then do a practical activity to explore the properties of metals (and non-metals) in more detail. The lesson continues with a card sorting activity to reinforce the properties of metals. It concludes with a brief discussion about how the uses of metals are linked to their properties.

Activities

- Display samples (as big as possible) of one or two metal elements. Ask student pairs to describe the appearance of the metals and to suggest any other properties they are likely to have. The purpose of this activity is to elicit students' prior knowledge of the physical properties of metals.
- Student to build knowledge of vocabulary that describes properties.
- Students test the following properties for a selection of elements: thermal and electrical conduction; hardness; appearance. They list the physical properties that are typical of metals.
- Students sort cards to reinforce their knowledge of typical metal properties.
- Finish the lesson by describing uses of different metals, Students note down one or two properties that explain why metals are suitable for each of these uses.

Extension

Students use the Student Book, and the internet, to explain in more detail how the properties of some metal elements are linked to their uses.

Homework

Workbook page 40 and the questions in the spread.

Key words

malleable, ductile

6.3
Chemical symbols

Student Book pages 90–91

Prior learning

- There are about 100 elements.
- The elements are listed in the periodic table.

6.3 Student Book answers

1. Be, B, C, F, He, H, Li, Ne, N, O.
2. Hydrogen, Helium, Beryllium.
3. Mg, Al, Si, P, Cl, Ar, K, Na.
4. Beryllium, Nitrogen, Carbon, Oxygen.

Objectives

- Recognize the names and symbols for some common elements (first 10 elements of periodic table) and recognize their physical properties.
- Identify that compounds are substances that contain two or more different types of atoms.

Overview

This lesson introduces chemical symbols. To start, students suggest reasons for elements having symbols. They then practise writing chemical symbols correctly, before playing games using symbol and name cards. Students then use the periodic table to help them make up quiz questions about element names and chemical symbols. Finally, students swap with others and answer the quiz questions.

Activities

- Tell students that each element has its own chemical symbol. Ask student pairs to suggest why, and elicit that they are shorter to write and internationally understood. Read the Student Book and look at the Chinese periodic table.
- Students practise writing chemical symbols correctly by listing the first 20 elements and their symbols (see Student Book page 41). Emphasise the correct use of lower and upper case letters.
- Students play games by creating their own element name and symbol cards.
    - o For memory game: spread out the cards, face down, on the table. The first player turns over two cards. If they are a pair (element and symbol) the player keeps them and has another turn. If they are not a pair, the next player has a turn.
    - o For snap: deal out the cards. Hold them face down. Players take turns to quickly turn over one card. When players spot a pair, they shout *snap*. First person to shout wins the pile.
- Students make up quiz questions on element names and chemical symbols, for example *Name four elements whose symbols start with S; name two elements named after countries*. Students swap quizzes and answer questions.

Extension

Memorise the chemical symbols of the first 20 elements of the periodic table, from hydrogen to calcium.

Homework

Workbook page 41 and the questions in the spread.

Key word

chemical symbol

6.4
Atoms

Student Book pages 92–93

Prior learning

- An element is a substance that cannot be split into other substances.
- Everything is made up of tiny particles.

6.4 Student Book answers

1. Atom – the smallest part of an element that can exist; element – a substance made from one type of atom; model – an idea that explains observations and helps in making predictions.
2. Properties – red–brown and shiny; no.
3. a. Shows that atoms of different elements are different.
   b. Atoms do not have straight edges; atoms are smaller than the bricks.

Objectives

- Describe the structure of matter in terms of particles, including atoms.
- Describe the strengths and limitations of a model for atoms.
- Explain how the properties of an element are the properties of many atoms of the element, not a single atom of the element.

Overview

This lesson begins with an exposition of key knowledge about elements. Students read the Student Book and complete a grid to record key points. Next, students manipulate and compare two ways of representing atoms – with toy bricks and with dried beans. They discuss what each representation of the model can – and cannot – explain, before identifying their strengths and weakness and deciding which representation is more useful. The lesson ends with a quick quiz.

Activities

- Start by displaying a sample of the element silicon, if possible. Tell students that the element is used to make the tiny electric circuits in electronic devices.
- Display the magnified picture of the surface of silicon. Elicit that the circles are tiny atoms, which are actually spherical.
- Students then discuss things that students find interesting, or that they do not understand.
- Tell students that, since atoms are so small, it can be helpful to represent them with objects such as toy bricks or dried beans. Student pairs then discuss how to use beans and toy bricks to represent atoms. They then identify strengths and weaknesses of the two representations. Finally, they compare the two ways of representing atoms and decide which is more useful, and why.
- Finish the lesson by asking a few quiz questions. For example: What is an atom? How many types of atom are there? What shape is an atom?

Extension

Students devise their own way of representing atoms. They think about what it can be used to explain, and what it cannot explain. They identify the strengths and weaknesses of the model.

Homework

Workbook page 42, and the questions in the spread.

key words

atom, element

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6.5

Molecules

Student Book pages 94–95

Prior learning

- Everything is made up of tiny particles.

Objectives

- Describe the structure of matter in terms of particles (i.e., atoms and molecules).
- Describe molecules as a combination of atoms (e.g., H_2O, O_2 & CO_2).
- Differentiate that some elements are made of atoms and some elements exist as molecules and have different properties to a single atom of the element.

Overview

In this lesson plan students will learn about molecules, including their structure, types, and the distinction between simple and giant molecules. Students will explore the fundamental concept of molecules as the building blocks of matter and learn about different types of molecules, such as simple and giant molecules, and molecules of metallic compounds. Additionally, they will delve into the characteristics and examples of simple and giant molecules, understanding their significance in various aspects of daily life.

Activities

- Engage the students by asking them about things they encounter every day (e.g., water, air, sugar) and discuss what these substances have in common. Guide the discussion towards the concept of molecules. Give example of Sulphur ring.
- Explain that molecules are the building blocks of matter and are made up of atoms. Use the periodic table to discuss different elements and their symbols.
- Discuss the structure of a molecule, illustrating it on the board with a simple diagram (e.g. hydrogen , fluorine and water molecule).
- Explain that molecules consist of atoms, represented by chemical symbols (e.g., H for hydrogen, O for oxygen),
- Introduce the distinction between simple and giant molecules. Explain that simple molecules are small and composed of a few atoms, while giant molecules, also known as macromolecules or polymers, consist of thousands or millions of atoms bonded together.
- Give examples of simple molecules (e.g., water, carbon dioxide) and giant molecules (e.g., proteins, DNA) and discuss their unique properties and applications.
- Engage students in a hands-on activity where they work individually or in small groups. Provide them with paper and pencils and ask them to choose a simple molecule and a giant molecule to draw and label their structures.
- Encourage students to identify and discuss the distinctive characteristics of each molecule.

Extension:

To extend the lesson, students can conduct research on the role of specific molecules in various scientific fields, create presentations on the significance of molecules in everyday life, or explore real-life applications of giant molecules in industries such as materials science or biotechnology.

Homework:

Workbook page 43 and the questions in the spread.

6.5 Student Book answers

1. A molecule is a particle made up of two or more atoms, strongly joined together.

2. **a.** 8, b. 2

3. Since nitrogen element exists in nature in form of a small molecule with very low melting point, which is why it exists as gas at room temperature. Carbon however, exists as a giant molecule, and is therefore a solid at room temperature.

4. **a.** -272, -219.

b. Helium.

5. It is a gas at room temperature.

6.6

Discovering the elements

SIC

Student Book pages 96–97

Prior learning
- An element is a substance that cannot be split into other substances.
- Everything is made of one or more elements.

6.6 Student Book answers

1. Sulfur, gold, and carbon exist naturally on their own.
2. Zinc, phosphorus, arsenic, bismuth, platinum
3. Two from: francium, hafnium, rhenium, technetium, astatine, radon

Objectives

- Describe how people developed scientific understanding.
- Describe some factors that influenced when elements were discovered.

Overview

This lesson helps students develop their understanding of Science in context.

This lesson is about the discovery of elements, focusing on factors that influenced when different elements were first found. The lesson begins with an opportunity for students to speculate about which elements were discovered earliest. It continues with a group activity, in which students work together to find out about the elements discovered in different time periods. Student groups then create posters to summarise and display what they have learnt.

Activities

- Tell students that some elements were discovered thousands of years ago. Others were discovered this century. Ask student pairs to speculate which elements were discovered earliest. Why do they think these elements were first found so long ago?
- Divide students into groups of three. These are *home groups*. Within home groups, each student is allocated one question from the spread.
- Students doing the same question then get together in new groups of three or four. These are *expert groups*. Expert groups tackle the questions using information from the Student Book, and plan how to teach their home groups what they have learnt.
- Students return to their home groups, and teach each other what they have learnt.
- Students remain in their home groups. They create posters or dramas to show what they have learnt about the discovery of elements.
- Home groups present their posters or dramas to one other group. The other group peer assesses.

Extension

Use the internet to find out more about the discovery of particular elements. See https://www.rsc.org/periodic-table and https://www.webelements.com/ or search for *periodic table RSC* and *web elements*.

Homework

Workbook page 44.

6.7 Compounds

Student Book pages 98–99

Prior learning

- An element has one type of atom only.

6.7 Student Book answers

1. Compound – substance made up of atoms of two or more elements, strongly joined together; molecule – a particle made up of two or more atoms strongly joined together.
2. An element has one type of atom; a compound has two or more types of atom strongly joined together.
3. **a.** A
   b. B and D
4. Their particles are different.

Objectives

- Explain that compounds are formed by different types of elements joining together chemically forming a new substance (.e.g. Burning magnesium or steel wool in air/oxygen).
- Distinguish between elements and compounds.

Overview

This lesson introduces compounds. It begins with a demonstration to show that the properties of a compound are very different from those of the elements it is made up of. Students then play 'who am I?' to guess the names of elements and compounds, and make molecule models. At the end of the lesson, students work out whether molecule pictures represent elements or compounds.

Activities

- If possible, display three substances – sodium, chlorine (in a gas jar), and sodium chloride (as table salt). Tell students that sodium chloride is made up of atoms of two elements, sodium and chlorine, strongly joined together. Sodium chloride is an example of a compound. Give a second example of a compound, calcium phosphate. Use of the Student Book to describe how the properties of the compound are different from the properties of the elements whose atoms it is made up of. Give the definition of the term *compound.*
- Student pairs play 'what am I?' One student states the properties and uses of an element or compound, the other student uses information from the Student Book and the first activity, as well as general knowledge, to choose the name of the element or compound from the answer card. Answers: A – water; B – hydrogen; C – oxygen; D – carbon monoxide; E – carbon dioxide; F – chlorine.
- Tell students that all the elements and compounds in the previous activity exist as molecules, and that a molecule is a particle made up of two or more atoms strongly joined together. If the atoms in a molecule are of the same element, the substance is an element. If the atoms in a molecule are from two or more elements, the substance is a compound. Student pairs then make molecule models of water, hydrogen, oxygen, carbon monoxide, and carbon dioxide, using the pictures in the Student Book to help them. If molecular model kits are not available, toy bricks can be used, or dried fruit and toothpicks. At the end of the activity, point out that not all compounds are made up of molecules.
- Finish the lesson by revisiting the definition of compound and answering question 3 of the Student Book.

Extension

Make up some more questions like question 3 in the Student Book, using drawings of molecules encountered in this lesson. Give your questions to another student to answer.

Homework

Workbook page 45 and questions 1, 2 and 4 of the spread.

Key words

compound, molecule

6.8 Naming compounds

Student Book pages 100–101

Prior learning

- A compound is a substance made up of atoms of two or more elements, strongly joined together.

Objectives

- Write compound names.
- Deduce the elements in a compound from the compound name.

Overview

The lesson begins with an introduction to the idea that the name of a compound gives clues about the elements whose atoms are in it. For example, a name ending in *–ate* shows that the compound includes oxygen atoms. Models are used to help students understand how to name compounds made up of atoms of non-metal elements only. Students then to practise naming compounds and making deductions from names.

Activities

- Show students four compounds – sodium chloride, copper oxide, copper sulfate, and copper carbonate. They guess which elements make up the compounds. Explain that the compounds whose names end in *–ide* include atoms of one metal element and one non-metal element; compounds whose names end in *–ate* include atoms of oxygen.
- Display molecular models of compounds made up of atoms of non-metals only, including carbon monoxide, carbon dioxide, sulfur dioxide, and sulfur trioxide. Explain how the compounds are named, including that *mon-* at the beginning of a word means 1, *di-* means 2, *tri-* means 3, *tetra-* means 4, *penta-* means 5, and *hexa-* means 6.
- Students answer the questions on page 49 of the Student Book. Ask students to check each other's answers in pairs before giving the correct answers.

Extension

- Students create flow diagrams to explain how to name compounds.
- Students make up their own questions on naming compounds, and give to a partner to answer.

Homework

Workbook page 46, and the questions in the spread.

6.8 Student Book answers

1. **a.** Copper sulfide
   b. Sodium chloride
   c. Copper sulfate
2. **a.** Magnesium and oxygen
   b. Potassium and chlorine
   c. Potassium, sulfur, and oxygen
3. **a.** Calcium chloride
   b. Copper oxide
   c. Calcium nitrate
4. **a.** Carbon monoxide
   b. Sulfur dioxide
   c. Nitrogen dioxide

6.9

Chemical formulae

TWS

Student Book pages 102–103

Prior learning

- The name of a compound is deduced from the names of the elements whose atoms are in it and the ratio of the numbers of atoms of each element.

6.9 Student Book answers

1. a. CO
b. CO_2
2. a. NO
b. SO_2
3. P_2O_5 and $CaSO_4$
4. 13 carbon atoms, 21 hydrogen atoms, 1 nitrogen atom, and 3 oxygen atoms

Objectives

- Use symbols and formulae to represent scientific ideas.
- Write chemical formulae for elements and compounds.
- Make deductions from formulae.

Overview

This is a lesson that helps students develop their skills in Thinking and working scientifically.

The lesson starts with a video clip and description to exemplify one way in which chemical formulae are useful. Next, molecular models are used to help explain how to write chemical formulae. Students then carry out matching activities and written exercises to practise writing and interpreting chemical formulae. The lesson ends with a task in which students make deductions about a medicinal drug from its formula.

Activities

- If possible, show a video of a controlled explosion involving TNT, for example, to demolish a building or in mining. Also show students a paracetamol tablet. Tell students that both substances are compounds that are made up of atoms of carbon, hydrogen, nitrogen, and oxygen. TNT and paracetamol have different properties because their molecules have different numbers of the atoms of the four elements (see Student Book page 50).
- Display molecular models of oxygen, carbon dioxide, carbon monoxide, and water and write the chemical formula of each (O_2, CO_2, CO, and H_2O). Point out that a chemical formula uses chemical symbols and numbers to give the relative number of atoms of the elements in a substance.
- Students practise writing formulae correctly and making deductions from formulae.
- End the lesson by displaying the chemical formula of dexamethasone: $C_{22}H_{29}FO_5$, which exists as molecules. The drug is used in the treatment of several diseases, including some COVID-19 hospital patients. Ask students to make as many deductions as possible from the formula. (Possible responses: it is a compound; it is made up of atoms of four elements – carbon, hydrogen, fluorine, and oxygen; its molecules have five oxygen atoms for every one fluorine atom; there are a total of 57 atoms in one molecule.)

Homework

Workbook page 47, and the questions in the spread.

Key word

chemical formula

6.10

Elements and compounds in daily life

Student Book pages 104–105

Prior learning

- the chemicals and elements we study in chemistry are present in our day to day life and some are essential to our very life.

6.10 Student Book answers

1. aluminium - making utensils; nitrogen - its liquid form is used to store delicate biological samples; carbon - many uses, for example, graphite the soft form of carbon is used as pencil lead.
2. salt and sugar.
3. encourage students to retrieve answer from the spread.

Objective

- Explore the common elements and compounds in our daily life-(carbon, nitrogen, hydrogen, aluminium, water, common salt, sugar).

Overview

Students will explore common elements and compounds found in our daily lives, focusing on carbon, nitrogen, hydrogen, aluminium, water, common salt, and sugar. They will learn about the properties, uses, and significance of these substances, developing an understanding of their role in everyday materials and substances.

Aluminium

- Begin the lesson by asking students if they have ever wondered about the substances that make up the materials they encounter daily.
- Explain that aluminium is a lightweight metal widely used in various industries and everyday items.
- Discuss the properties of aluminium, such as its strength, durability, and resistance to corrosion.
- Provide examples of aluminium-containing materials, such as aluminium foil, beverage cans, and building materials like window frames.

Carbon

- Present carbon as one of the most abundant elements on Earth and an essential component of living organisms.
- Discuss the properties of carbon, such as its ability to form long chains and bond with other elements.
- Provide examples of carbon-containing substances found in daily life, such as graphite, diamonds, and organic compounds like carbohydrates and proteins.

Nitrogen

- Explain that nitrogen is an element that makes up a significant portion of the Earth's atmosphere.
- Discuss the importance of nitrogen in living organisms, particularly its role in protein synthesis and plant growth.
- Give examples of nitrogen-containing substances, such as ammonia (NH3) and fertilizers, and explain their significance in agriculture.

Hydrogen

- Introduce hydrogen as the lightest and most abundant element in the universe.
- Discuss the properties of hydrogen, such as its flammability and its role as a component of water (H2O).
- Emphasize the importance of water as a vital substance for all living organisms.
- Divide students into small groups and provide them with chart paper and markers.
- Instruct each group to create a chart listing everyday materials and substances that contain the elements and compounds discussed in the lesson.
- Encourage students to categorize the materials based on the elements or compounds they contain (e.g., carbon-based materials, aluminium-containing materials).

- Have each group present their charts to the class, sharing the materials they identified.
- Recap the main points of the lesson, emphasizing the properties, uses, and significance of the common elements and compounds discussed.
- Discuss how an understanding of these substances enhances our knowledge of the world around us.

Extension:

To extend the lesson, students can conduct further research on other elements and compounds found in daily life, create posters or presentations showcasing the applications and importance of these substances, or conduct experiments to observe their properties.

Homework:

Workbook page 48 and the questions in the spread.

6.11 Making compounds

Student Book pages 106–107

Prior learning

- A compound is a substance made up of atoms of two or more elements, strongly joined together.

Objective

- Explain that compounds are formed by different types of elements joining together chemically forming a new substance (.e.g. Burning magnesium or steel wool in air/oxygen).

Overview

Students will understand that compounds are formed when different types of elements chemically combine. They will learn how to write word equations to represent chemical reactions and explore the safe procedures for burning magnesium.

Activity

- Begin the lesson by discussing the concept of compounds, explaining that they are formed when different elements combine chemically.
- Engage students in a discussion about examples of compounds they may be familiar with (e.g., water, table salt) and their composition of elements.
- Introduce the idea that chemical reactions involve the rearrangement of atoms to form new substances.
- Discuss how compounds are formed when elements join together through chemical bonding.
- Emphasize that compounds have different properties than the individual elements they are composed of.
- Conduct a demonstration of burning magnesium to show compound formation.
- **Use safety goggles and have a well-ventilated area for the demonstration.**
- Show students a piece of magnesium ribbon and ignite it using a flame.
- Allow students to observe the reaction, noting the bright white light and the formation of a white powder (magnesium oxide).

- Discuss how magnesium (element) combines with oxygen (also an element) to form a new compound (magnesium oxide).

Homework:

Workbook page 49 and the questions in the spread.

6.11 Student Book answers

1. a change that makes new substances, by rearranging and joining the atoms differently.
2. the atoms are rearranged and join together differently.
3. Magnesium Oxide.
4. **a.** carbon and oxygen.
   b. carbon dioxide.
   c. Carbon (solid) + Oxygen (gas molecule) ----> Carbon Dioxide (gas molecule)

6.12 Investigating a chemical reaction

Student Book pages 108–109

Objectives

- When planning a scientific enquiry, use scientific knowledge to:
- Make a hypothesis and prediction
- Choose equipment.
- Work safely
- Collect and recordmeasurements
- Make a conclusion
- Suggest improvements enquiry

Overview

This is a lesson that helps students develop their skills in Thinking and working scientifically.

The lesson starts with a demonstration to show that, when iron burns in air, the mass of solid product is greater than the mass of solid reactant. Students then do their own investigations into the mass change when magnesium burns in oxygen. They compare their results with those of other groups, and suggest improvements to the investigation.

Activities

- Demonstrate the investigation shown in the Student Book, emphasising the investigation stages described in the Student Book (planning, carrying out, and analysing the evidence). You need about 4 g of iron wool and a metre ruler, metal if possible. If the ruler is wooden, cover the end in foil before heating.

Prior learning

- In a chemical reaction, the total mass of reactants is equal to the total mass of products.

- Students investigate the mass change involved in the combustion reaction of magnesium.
- Gather together results from all groups. Most students should have found (correctly) that the mass of product was greater than the mass of magnesium at the start. Some students may have found that the mass of product was less, most likely because some magnesium oxide escaped (as white powder) on opening the lid.

Homework

Workbook page 50, and the questions from the spread.

6.12 Student Book answers

1. A possible explanation that is based on evidence and that can be tested further.
2. **a.** Iron wool can cut skin; iron wool catches fire easily.
   b. Wears eye protection, wears gloves to avoid cuts from iron wool, keeps spare iron wool in a jar with a closed lid.
3. Make a hypothesis, make a plan, make a prediction, decide what equipment to use and how to work safely, carry out the investigation, write a conclusion, suggest improvements and carry them out.

6.13 Review answers

Student Book pages 110–112

Student Book answers

1. **a.** Element [1] **b.** Model [1] **c.** Atom [1]
   d. Chemical symbol [1] **e.** Compound [1] **f.** Molecule [1]

2. [8]

Element name	Chemical symbol
beryllium	Be
boron	B
chlorine	Cl
fluorine	F
potassium	K
silicon	Si
sodium	Na
sulfur	S

3. **a.** He [1] **b.** Ar [1]
   c. Ne [1] **d.** B [1]
4. More than one [1]; different from [1]; are always the same [1].
5. **a.** B and C [1] **b.** A and D [1]
   c. It shows that every element has its own type of atom and a compound is made of more than one type of particle [1]
   d. It is different from the particle it represents because atoms do not have straight edges and are much smaller than toy bricks. [1]

6.

Compound	Names of elements in compound
calcium oxide	calcium, oxygen
sodium chloride	sodium, chlorine
magnesium sulfide	magnesium, sulfur
iron sulfate	iron, sulfur, oxygen
calcium carbonate	calcium, carbon, oxygen
silver nitrate	silver, nitrogen, oxygen

[6]

7. **a.** Nitrogen dioxide [1] **b.** Nitrogen monoxide [1]
c. Sulfur trioxide [1] **d.** Magnesium sulfate [1]
e. Sodium chloride [1] **f.** Calcium carbonate [1]
g. Beryllium oxide [1]

8. **a.** 3 [1] **b.** 2 [1]
c. **i.** Yellow /green [1] **ii.** OF_2 [2]

9.

Name of substance	Formula	Element or compound?
nitrogen	N_2	element
carbon dioxide	CO_2	compound
sulfur	S_8	element
argon	Ar	element
magnesium oxide	MgO	compound
copper sulfate	$CuSO_4$	compound

10. **a.** SiO_2 [1]
b. A compound [1] because it includes atoms of two/more than one element [1]

11. **a.** i [1] **b.** ii [1] **c.** i [1]
d. i [1] **e.** i [1] **f.** i [1]
g. ii [1]

7.1

Mixtures

Student Book pages 112–113

Prior learning

- Solid substances can be mixed, and it is often possible to separate them again.

7.1 Student Book answers

1. A mixture contains two or more substances that are not joined together.
2. For example: paints, medicines, deodorants, alloys
3. **a.** homogeneous
   b. homogeneous
   c. heterogeneous
   d. homogeneous
4. **a.** 4
   b. nitrogen, N_2 and oxygen, O_2
   c. carbon dioxide, CO_2 and sulfur trioxide, SO_3

Objectives

- Demonstrate that mixtures are formed when two or more substances mix with each other without making a new substance.
- Identify and explain examples of common mixtures from daily life.
- Identify different types of mixtures.

Overview

The lesson begins with a short practical demonstration and activity of mixing and separating rice, salt, and sugar. Students then learn about the characteristics of mixtures, and that many of the products we use every day are mixtures. The lesson ends with an opportunity for students to interpret particle diagrams representing mixtures.

Activities

- Demonstrate mixing uncooked rice and salt. Ask students whether you have made a mixture or a compound. Elicit that the rice and salt are not joined together, so you have made a mixture.
- Students do the practical activities to learn that it is often easy to separate the materials in a mixture.
- Elicit the other three characteristics of mixtures, (the substances are not joined together; the substances keep their own properties; you can change the amounts of the substances).
- Tell students that mixtures can contain elements, mixtures, or both. Point out that many useful things are mixtures, with exactly the right amounts of substances to make things like paints, medicines, and deodorants. Students read Student Book.
- Explain how particle diagrams can be used to model mixtures, using the examples in the spread. Students check their learning by answering Student Book question 3.

Extension

Provide packets of products that display their ingredients, for example, toothpaste and food products. Students deduce whether the products are mixtures of elements, compounds, or both.

Homework

Workbook page 51 and questions 1, 2 and 4 from the spread.

Key word

mixture

7.2

Comparing elements, mixtures, and compounds

Student Book pages 114–115

Prior learning

- An element is a substance that is made from one type of atom.
- A compound is a substance made up of atoms of two or more elements, strongly joined together.
- A mixture contains two or more substances that are not joined together.

Objective

- Describe differences between elements, mixtures, and compounds.

Overview

The lesson begins with a reminder of the definitions of the terms *element, mixture*, and *compound*. Students then carry out an experiment to explore the properties of the elements iron and sulfur, as well as a mixture of the two elements. Next, students make a compound – iron sulfide – and compare its properties to those of iron, sulfur, and a mixture of iron and sulfur. Finally, students use information from the Student Book to ask each other questions about the differences between elements, mixtures, and compounds in general.

Activities

- Give the definitions for element, mixture, and compound but do **not** tell students the words that are being defined – ask students to work these out for themselves.
- Students to explore the properties or iron, sulfur, and a mixture of the two elements.
- Students to make the compound iron sulfide from its elements. They then compare the properties of iron, sulfur, and iron sulfide.
- To conclude, students study the table on Student Book page 115, which summarises the differences between elements, mixtures, and compounds. In pairs, students take turns to ask each other questions about the information in the table.

Extension

Students answer all the questions in the spread.

Homework

Workbook page 52.

7.2 Student Book answers

1. Both are a single substance; both cannot be split up/separated by physical means.
2. Element – one type of atom, compound – two or more types of atom; element has own properties, properties of compound different to properties of the elements in it.
3. Compound – cannot easily be split up, mixture – can easily be separated; compound – atoms of its elements are joined together, mixture – the substances in it are not joined together.
4. **a.** B
   b. C
   c. D
   d. A

7.3

Comparing pure substances and mixtures

Student Book pages 116–117

Prior learning

- An element is a single substance.
- A compound is a single substance.

Objectives

- Differentiate between pure substances and mixtures on the basis of their formation and composition.
- Define the terms pure substance and purity
- Describe how to show that a substance is pure
- Make a conclusion from a graph
- Describe one application of science

Overview

The lesson begins with a discussion about the meaning of the word *pure* in science, in the context of vaccines. Students then carry out an investigation, including plotting a cooling curve, to find out if butter or margarine is a pure substance. The lesson concludes with consolidation questions from the Student Book.

Activities

- Ask students whether they – or family members – have had vaccinations. Tell students that the substance that is present in the largest amount in a vaccine is water. Elicit that water used for vaccines must be pure. Give the definition for *pure substance*, as in the Student Book. Outline the difference between the scientific and everyday meanings of *pure.*
- Students look at the graph on the left of Student Book page 117. Remind them that this is a cooling curve, and that cooling curves can be used to find out whether or not a substance is pure, or whether it is a mixture of substances.
- Students follow the guidance to plot a heating curve for butter or margarine. conclude that butter is impure – it is a mixture of substances.
- To finish the lesson, students answer questions 1, 2, and 3 to consolidate learning from the lesson.

Extension

Students answer questions 3 and 4 of the spread.

Homework

Workbook page 53 and questions 1-2 from the spread.

Key words

pure substance, purity

7.3 Student Book answers

1. Pure substance – consists of one element or compound only;
2. It is a mixture of water and mixed impurities, such as minerals, salts, etc.
3. 70 °C
4. Encourage students to use the table on page 116, but to display the answer in form of a Venn diagram or a fishbone diagram.

7.4

Inside mixtures: Solutions

Student Book pages 118–119

Prior learning

- Recognise that some materials can dissolve in water.

7.4 Student Book answers

1. Solution: a mixture formed when a solute dissolves in an solvent. Soluble: substances that can dissolve in a given solvent, usually water. Insoluble: substances that cannot dissolve in a given solvent, usually water.
2. Solute = sugar
   Solvent = water
3. Water is known as universal solvent because many substances can dissolve in it.
4. They contain particles of more than one substance that are not joined together; the amounts of substances can easily change; the substances in the solution can be easily separated; the substances in the solution keep their own properties.

Objectives

- Demonstrate the process of solution formation, using water as a universal solvent.
- Define the terms solution, soluble, and insoluble.
- Explain why a solution is a mixture.
- Evaluate a model for a solution.
- Make a prediction and conclusion.

Overview

The lesson begins with a demonstration of dissolving salt in water, and a matching activity to reinforce the meanings of key words. Students then observe a second demonstration to show that mass is conserved when a substance dissolves in a solvent. The next activity involves students using rice and dried beans to model the particles when a solute dissolves in a solvent. The lesson concludes with paired discussion in which students evaluate the rice and bean model by considering its strengths and weaknesses.

Activities

- Demonstrate dissolving one spatula measure of salt in water. Use the words solvent, solute, solution, dissolve, and soluble. Student pairs can match these words – and others – to their definitions.
- Demonstrate that mass is conserved when a substance dissolves by pouring water into a beaker and measuring the mass. Add a known mass of salt and stir to dissolve. Show that:

  mass of solution = mass of solute + solvent

  Students record the results in their notebooks.
- Students model dissolving using rice and dried beans.
- Finish the lesson by asking student pairs to discuss the strengths and weaknesses of the beans and rice model. Take feedback from a few pairs.

Extension

Devise a different way of modelling what happens to the particles in dissolving.

Homework

Workbook page 54 and the questions in the spread.

Key words

dissolve, solution, solvent, solute, soluble, insoluble

7.5

Inside mixtures: Alloys

Student Book pages 120–121

Prior learning
- Properties of metals.

7.5 Student Book answers

1. Alloy – a mixture of a metal with one or more other elements; steel – alloys of iron.
2. An alloy is classified as a mixture, because it is a mix of a metal with one or more other elements. Also, an alloy has properties different from the elements in it.
3. The alloy is about 6 times harder than pure aluminium, the alloy is about 70 times stronger than pure aluminium.
4. Bridges, buildings, ships, and cars need to be strong, so low carbon steel is a suitable material to make them from; low carbon steel is easily shaped, which makes it particularly suitable for ships and cars.
5. An iron alloy has different sized atoms in it (in addition to its iron atoms) so the layers of atoms cannot slide over each other easily. This makes iron alloys stronger and harder than pure iron.

Objectives

- Describe an alloy as a mixture of a metal with one or more other elements.
- Compare the physical properties of alloys and the elements in them.
- Explain how the uses of alloys depend on their properties.

Overview

This lesson is about alloys. It begins with an opportunity for students to share what they already know about alloys. It continues with a group activity, in which students work together to answer four questions: What are alloys? What are steels? Why are the properties of alloys different from those of the elements whose atoms are in them? What is bronze?

Activities

- Student pairs discuss what they already know about alloys, including common alloys such as steel. Ask a few pairs to feed back.
- Divide students into groups of four. These are *home groups*. Within home groups, each student is allocated one question from the spread.
- Students doing the same question then get together in new groups of three or four. These are *expert groups*. Expert groups tackle the questions using information from the Student Book, and plan how to teach their home groups what they have learnt.
- Students return to their home groups, and teach each other what they have learnt.
- Students remain in home groups. Ask them a few questions – perhaps to tackle as a group test – to check learning from the previous activity.

Extension

Students research shape memory alloys, such as nitinol. Typing *shape memory alloy* into a search engine yields useful websites.

Homework

Workbook page 28, questions from the spread.

Key words

alloy, steel

7.6

Inside mixtures: The air

Student Book pages 122–123

Prior learning

- Air is a mixture of different elements and compounds.

Objective

- Justify why air is considered as a mixture of gases.

Overview

Students will understand why air is considered a mixture of gases and explore the composition and properties of the gases present in the atmosphere. They will learn about the various gases present in air, their individual boiling points, and how these points support the classification of air as a mixture.

Activities

- Begin the lesson by asking students to share what they know Oxygen cylinders in hospitals.
- Discuss the concept of air as a mixture and explain that air contains different gases. Review the major gases present in the Earth's atmosphere, including nitrogen, oxygen, carbon dioxide, and trace gases like argon and water vapor.
- Display visual aids, such as pictures or diagrams, to help students visualize the composition of air.
- Emphasize that these gases are not chemically bonded and exist as separate entities.
- Introduce the concept of boiling points as the temperature at which a substance changes from a liquid to a gas. Present a boiling point chart of common gases, including nitrogen, oxygen, carbon dioxide, and water vapor. Discuss the boiling points of each gas, emphasizing that they vary based on their molecular structure and interactions.
- Engage students in a discussion about how the boiling points of different gases support the idea that air is a mixture.
- Explain that since the gases in air have different boiling points, they do not boil at the same temperature.
- Use the boiling point chart to compare the boiling points of nitrogen, oxygen, carbon dioxide, and water vapor.
- Discuss how, during the process of fractional distillation, the components of air can be separated based on their boiling points.

Activity: Boiling Point and Cooling Chart

- Divide students into small groups and provide them with chart paper and markers.
- Instruct one group to create a chart illustrating the gases found in air and their corresponding boiling points and other group to explain change of state when air is cooled.
- Encourage them to use different colours or symbols to represent each gas.
- Have each group present their boiling point and cooling charts to the class, explaining the significance of the different boiling points in supporting the idea that air is a mixture.
- Explain that companies separate gases from the air for their use.

Extension:

To extend the lesson, students can research and present on other properties of the gases present in air, explore how fractional distillation works in separating gases, or investigate the role of air as a mixture in atmospheric phenomena such as weather and air pollution.

Homework

Workbook page 56.

7.6 Student Book answers

1. water, oxygen, argon, nitrogen.
2. Students can suggest their own list of answers: any from: respiration, combustion, burning, rusting.
3. oxygen −183; nitrogen −196.
4. Cooling the air shows that it is a mixture because the different substances in the air change state at different temperatures.

7.7 Separating mixtures: Filtration and evaporation

Student Book pages 124–125

Prior learning

- Mixtures can be separated into its constituents easily as they retain their individual properties.

Objective

- Demonstrate ways of separating mixtures, including by filtration and evaporation.

Overview

Students will understand different methods of separating mixtures, specifically focusing on filtration and evaporation. They will explore how these techniques are applied to various mixtures and their practical significance in everyday life.

Activity

- Begin the lesson by asking students if they have encountered mixtures in their daily lives and what they know about separating them.
- Introduce the concept of separating mixtures and explain that different techniques are used based on the properties of the components.
- Share the lesson objective of exploring two common methods of separation: filtration and evaporation.

Filtration

- Explain the process of filtration as a method of separating solid particles from a liquid.
- Present a visual demonstration of filtration using a funnel, filter paper, and a water and sand mixture.
- Guide students through the steps of filtering the mixture, emphasizing that the sand particles will be retained on the filter paper, while the water passes through as the filtrate.

Evaporation

- Introduce the process of evaporation as a method of separating a soluble solid from a liquid.
- Explain that when a mixture of a soluble solid and a liquid is heated, the liquid evaporates, leaving the solid behind.
- Perform a demonstration of evaporation by heating a solution of saltwater in a heat-resistant container.
- Observe the formation of salt crystals as the water evaporates.

Practical Applications

- Engage students in a discussion about the practical applications of filtration and evaporation in everyday life.
- Discuss examples such as water purification, coffee-making (filtration), and salt production (evaporation).
- Encourage students to think of other situations where these separation techniques are utilized.

Activity: Real-Life Examples

- Divide students into small groups and provide them with chart paper and markers.
- Instruct each group to research and list real-life examples of filtration and evaporation in various industries and household activities.
- Have them present their findings to the class.
- Summarize the main points of the lesson, emphasizing the techniques of

7.7 Student Book answers

1. residue.
2. sand and small stones.
3. we can obtain salt from the salt solution by using the process of evaporation.

filtration and evaporation as common methods of separating mixtures.

- Reinforce the practical significance of these separation techniques in various contexts.
- Encourage students to reflect on how an understanding of these methods enhances their knowledge of the world around them.

Extension:

To extend the lesson, students can investigate other methods of separating mixtures, such as distillation and chromatography, or conduct experiments with different mixtures to practice the techniques of filtration and evaporation.

Homework

Workbook page 57

7.8 Separating mixtures: Distillation

SIC

Student Book pages 126–127

Prior learning

- Seawater is not a pure substance. It is a mixture of water and salt.

Objectives

- Demonstrate way of separating mixtures by distillation.
- Explain how to obtain pure water from salty water by distillation.
- Describe some benefits and problems of desalination

Overview

This is a lesson that helps students develop their understanding of Science in context.

The lesson begins with a discussion about water sources, including desalination. Following a demonstration of the distillation of inky water, students carry out their own distillation experiments in simple apparatus. Finally, there is a discussion about the benefits and disadvantages of desalination.

Activities

- Ask student pairs to discuss where drinking water comes from. Elicit that it may come from rivers, lakes, or underground. In regions with a poor supply of water from these sources, drinking water may be obtained from the sea. This is desalination.
- Remind students that they can obtain salt from seawater by evaporation. Ask how they can obtain pure water from seawater. The next activity shows how.
- Use the apparatus shown the book to demonstrate obtaining pure water from a mixture of ink and water by distillation. This mixture has been chosen since it is easy to see that ink-free water is produced. Tell students that a version of distillation is used in some methods of desalination.
- Students follow the guidance to obtain pure water from ink solution. The apparatus is a simplified version of that used in the demonstration.
- Finish the lesson with a discussion about desalination. Ask student pairs to discuss its advantages and disadvantages, and to decide whether – overall – desalination is of value. Student Book page 129 supports this activity.

Extension

Students write a story from the perspective of a water particle during the distillation of seawater.

Homework

Workbook page 58 and the questions in the spread.

Key words

desalination

7.8 Student Book answers

1. **a.** water and sodium chloride
   b. The seawater is boiled. Water in the gas state (steam) evaporates from the seawater. The steam travels through the condenser. It cools and condenses into pure, liquid water. The pure water drips into the beaker. The salt remains in the flask.
2. A substance is pure if it consists of one element or compound only.
3. Benefits – makes drinking water for many people, even if the only source of water is the sea. Problems – some people do not like its taste, it does not contain dissolved calcium compounds, it needs huge amounts of electricity, may kill sea plants and animals where very salty water returns to the sea.

7.9 Separating mixtures: Chromatography

Student Book pages 128–129

Prior learning

- A mixture contains two or more substances that are not joined together.

7.9 Student Book answers

1. To separate substances, to identify substances, to find out if a substance is pure.
2. **a.** Red and yellow
   b. One
   c. Red, yellow, and blue

Objectives

- Demonstrate way of separating mixtures by chromatography.
- Describe how chromatography separates and identifies substances in a mixture.
- Describe a useful scientific enquiry.

Overview

This lesson shows how chromatography can be used to separate mixtures of dyes from pens and leaves. It begins with a scene-setter – how can you tell whether green marks on a criminal's T-shirt are from grass, spinach, or cassava leaves? To solve this problem, students first try out the technique of chromatography to separate the dyes from ink samples. They then plan and do an investigation in which they use chromatography to answer the question posed at the start of the lesson.

Activities

- Display a piece of cloth with green stains on it. Tell students that police need to know whether the stains are from grass, spinach, or cassava leaves? Set the challenge – students will use chromatography to identify the source of the green stains.
- Students to experience chromatography by making chromatograms of ink samples, ideally from felt-tip pens.
- Students plan and do an investigation to identify the source of the green stains introduced in activity 1. Discuss the results as a class – how sure can you be that the conclusions are correct? – each group needs a strip of chromatography paper with a spot of juice extracted from spinach on the pencil line.

- Students read about some uses of chromatography, focusing on the study described on page 2 of the Student Book. Finish the lesson by discussing the benefits of this study.

Extension

Use the Internet to find out about further uses of chromatography.

Homework

Workbook page 59 and the questions from the spread.

Key words

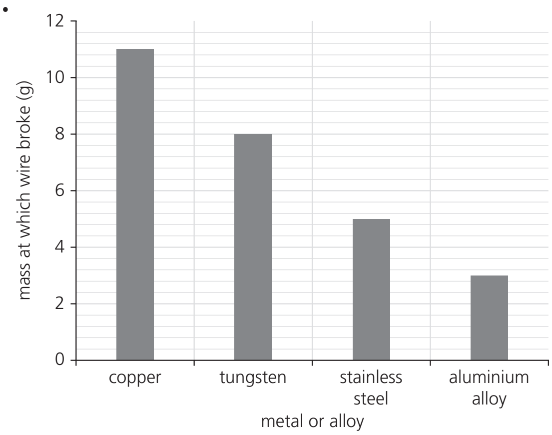
chromatography

7.10 Review answers

Student Book pages 130–131

Student Book answers

1. **a.** alloy **[1]**
   b. a solution **[1]** **d.** a solvent **[1]**
   c. pure **[1]**
2. More than one **[1]**
   similar to **[1]**
   can vary **[1]**
3. **a.** filtering **[1]**
   b. distilling **[1]**
   c. chromatography **[1]**
   d. evaporating **[1]**
4. b, d, f, a, c, e. **[4]**
5. **a.** 20%
   b. 99%
   c. Carbon dioxide and Argon.
6. **a.** The metal or alloy **[1]**
   b. For example, length of wire / thickness of wire **[2]**
   c. **i.** Copper and tungsten **[1]**
   ii. Copper **[1]**
   iii.



7. a. D **[1]** b. E **[1]** c. A **[1]** d. C **[1]** e. B **[1]**
8. a. heterogenous **[1]** b. homogenous**[1]** c. solute **[1]** d. insoluble **[1]** e. alloy **[1]**

8.1

What is energy?

Student Book pages 132–133

Objective

- Recognize energy as a physical quantity.

Overview

This introductory lesson focuses on the need for food or fuel to make things like movement possible. Students learn about the energy content of food in joules and kilojoules. They consider how much food is needed to fuel certain activities. They link the energy stored in food to the energy stored in fuels.

In the next lesson students will learn that the energy stored in fuels and food originates from the Sun.

Activities

- Ask students to list as many activities as they can that they do each week, and then to put them in order from those requiring the most energy to those requiring the least energy. Elicit the idea that your body needs energy just to keep warm and to breathe. Ask them where this energy comes from.
- Introduce the idea of energy in food being measured in joules or kilojoules. Use a balance to measure the smallest piece of chocolate that will register (0.1 g is equivalent to approx. 2000 J), and use this to demonstrate why we use kJ rather than J. If appropriate discuss the link with calories/kilocalories (1 Cal = 1 kilocalorie = 4.2 kJ).
- Students complete an investigation into the energy content of food by measuring the temperature rise of a certain volume of water when a fuel is burnt, **(Safety: ensure students wear goggles and notify you of allergies.)** They evaluate the investigation.
- Students work out how long they would have to complete different activities to 'burn off' the energy in food.
- Introduce fuels as energy stores like food. Discuss the similarities between fuels and food and how they are used.

Homework

Workbook page and questions from the sprad.

Key words

energy, fuel, joule, kilojoule, coal, oil

8.1 Student Book answers

1. Three of: coal, oil (petrol, diesel), wood, food, (natural gas, nuclear).
2. Two of: breathing, keeping your body warm, movement, heart beating.
3. 1 kJ = 1000 J, so
   200 kJ = 200 000 J
4. So their bones, muscles, and brains can grow bigger
5. 100 g of chocolate contains 1500 J, cycling uses 25 J/minute

   number of minutes =
   1500 J/(25 J/min) = 60 minutes, or one hour

8.2

Asking questions: Energy

TWS

Student Book pages 134–135

Objectives

- Recognise that there are many ways to find answers to questions in science.
- Understand how to decide if a question can be answered with a fair test investigation.

Overview

This is a lesson that helps students develop their skills in Thinking and Working Scientifically.

In this lesson students learn about the type of questions that science can answer and the different ways in which they can be investigated. They consider questions that can be answered by doing practical work, and plan how to answer the question.

Activities

- Introduce an island, real or fictitious, and explain that students are going to consider the energy needs of the islanders. Ask the students to come up with three questions that they could ask about the food and fuel that the islanders use or need. Hint that the islanders need to choose which foods to grow, and that there are certain fuels that might be there, and others that they could grow. Bring all the questions together and ask the students to divide the questions into those that can be investigated practically by doing an experiment and those that cannot.
- Students choose one of the questions to investigate, and plan and perform an experiment to answer it. (**Safety: ensure students do a risk assessment to work safely**.)
- Students could all do the same experiment or each group could answer a different question.
- Students could present the findings of their experiments to the rest of the class.

Homework

Workbook page 61 and the questions from the spread.

Key words

question, explanation, practical investigation, prediction

8.2 Student Book answers

1. No, because you cannot collect data/it is a matter of opinion/it depends what you mean by 'best'.
2. **a.** Natural gas takes the least time to heat the water so must store the most energy.
   b. No, the evidence does not support Laiba's hypothesis. She thought that solid fuels store the most energy, but it seems that gas stores more energy.
3. To check results/to get reliable data/to check for outliers.

8.3 Energy stores and transfers

Student Book pages 136–137

Prior learning

- Understand the notion of energy in movement

8.3 Student Book answers

1. Appropriate answers could include: Sun, candle, light bulb.
2. gravitational potential store
3. elastic potential store
4. gravitational potential, kinetic, thermal stores
5. This is not correct. There is no oxygen in space for anything to burn. The energy comes from a process called nuclear fusion. (The Sun is a nuclear store of energy.)

Extension

Students find out about nuclear fusion, nuclear fission, and burning. They make a poster that explains the difference between them.

Homework

Workbook page 62 and questions from the spread.

Key words

energy store, chemical store, gravity store, elastic store, kinetic store, thermal store, electric current, light, heating, radiation, nuclear fusion, nuclear store

Objective

- Describe different ways in which energy can be stored.

Overview

Students will have heard about energy in an everyday context, and may bring ideas about heat and light to this lesson.

At IGCSE they will be learning to think about energy in terms of 'stores' and 'transfers'. This way of thinking about energy does not separate energy into 'types'. The principal ideas are:

- Energy is just a number (a calculable quantity, but they won't do those calculations until IGCSE).
- The numbers always add up (energy is conserved).
- Energy tells you *what is possible* and not *why things happen*.

This means that:

- We introduce particular energy stores (e.g. kinetic store) because we can calculate something about them.
- What we used to call energy types (e.g. light, sound, electrical), are actually ways to *transfer* energy.

This lesson introduces the idea of stores and transfers, and gives students some practice in identifying them.

Although the descriptions are lengthy, 'energy stored thermally' is more accurate than 'thermal energy'. As students move through this chapter, they will use 'kinetic energy' as a shorthand for 'energy stored kinetically', but should be regularly reminded that there are no types of energy.

Activities

- Ask students to list the situations where they have heard the word energy. Explain that they will be learning a way of thinking about energy that they will use again later in their school science courses.
- Introduce the idea of 'stores' of energy and 'ways of transferring energy from one store (situation) to another'. Explain that energy is a number that can be calculated for a particular situation, like a stretched spring or bowl of hot water, and they will meet those calculations later. Students should be encouraged to see light, sound, and electrical energy as ways energy is transferred from one place to the next. Explain that 'heat' as a noun is 'energy stored thermally' or 'energy in a thermal store'. Add that they may meet the words 'thermal energy', and should understand that this is not a substance (as many people thought for many years). We heat things up, and this increases the energy in the thermal store; heat is a verb not a noun.
- Students design a card game based on energy stores. They make cards that illustrate places where you would see objects with the energy in different types of store for, example, a battery = energy in a chemical store.
- Students play their game then swap with another group and play that game.
- Students draw a table for all of the energy stores and write down as many examples for each one as they can think of on the basis of the games that they have played.

8.4

Energy transfer diagrams and dissipation

Student Book pages 138–139

Objective

- Demonstrate an energy transfer such as a bouncing ball by energy transfer diagram, e.g., gravitational potential energy → kinetic → elastic potential energy + thermal + sound → kinetic → gravitational potential energy, etc.

Overview

Students build on what they have learned about energy stores by considering energy transfers in more detail. They draw energy transfer diagrams for a wide range of energy transfers. They consider where the energy is actually going, in preparation for the next lesson on the conservation of energy. They consolidate their knowledge by completing a card sort to identify various energy transfers.

Activities

- Recap all the different energy stores by asking students to write down as many different energy stores as they can remember in 30 seconds. Follow up by asking them to choose one store and describe a process that would increase the energy in that store, and one that would decrease the energy in the store.
- Introduce the idea of an 'energy analysis', considering which stores lose energy and which stores gain energy in a process. Contrast the analysis with the physical situation. For example, if you throw a ball upwards, there is less energy in the chemical store in your muscles and more in the gravitational store of the ball. There are fewer useful chemicals in your muscles and the ball is higher up. This example also shows that picking different start and end points for your analysis will produce a different energy transfer diagram.
- Show a torch (or similar) and ask what energy transfers are taking place. Students may want to start with 'electricity'. Elicit that the torch would not work without the battery, where energy is stored chemically. Draw the energy transfer diagram showing stores as boxes and transfers as circles, as in the Student Book. Students should be reminded that we are not talking about 'light energy', but that light transfers energy.
- Students complete a circus of activities where they identify the energy stores and transfers and draw energy transfer diagrams.
- Discuss the processes and devices in the circus. Students will have a strong sense of what is 'useful' and what is not. Elicit that energy is transferred in a device (like a solar cell) or a process (like a trolley rolling down a ramp). Explain that energy that is not transferred usefully is dissipated, usually transferred to the thermal store of the surroundings. The air heats up when an object moves through it. Discuss which objects/stores have lost energy and which have gained in each process. Elicit that it is not always clear what the energy transfers are.
- Students complete a card sort of various processes in pairs. One student uses the cards to make a diagram and the other student guesses the device or process.

Homework

Workbook page 63 and the questions in the spread.

Key words

energy transfer, energy transfer diagram, dissipation

8.4 Student Book answers

1. Diagram showing:
   a. chemical – kinetic – thermal store
   b. chemical – gravitational potential – kinetic store – thermal store
2. Energy is wasted/transferred to the thermal store of the surroundings.
3. a. The air around the kettle heats up.
   b. The car makes sounds and heats up because of friction; it warms up the road and the air around it through friction.
4. The energy transfer that we want is to heat the surroundings, and energy dissipation heats the surroundings.

8.5 Gravitational potential energy and kinetic energy

Student Book pages 140–141

Objectives

- Relate potential energy and kinetic energy.
- Describe situations that involve energy changes between kinetic energy and gravitational potential energy and energy dissipation.

Overview

At IGCSE students will learn to calculate kinetic energy (KE) and gravitational potential energy (GPE). Here we use the terms as a shorthand for 'energy stored gravitationally' and 'energy stored kinetically'.

It will be useful here and in later lessons to pause and discuss ways of talking about energy: by 'kinetic energy' we mean 'energy stored kinetically'. 'Stored' just tells us that we could calculate it.

Students build a model of a cliff railway and work out the masses that you need to move one of the trains and how that relates to friction.

Activities

Explain why we are using GPE and KE in this lesson.

- Ask students to sketch a rollercoaster or mountain road and label the points where a person would have the most energy in their gravity store. Repeat for the kinetic store. Elicit that the energy transfer is due to the force of gravity.
- Show photographs or a diagram of the funicular railway at Palani in Tamil Nadu, India. Students model a cliff railway, and learn that you need to use extra force due to friction. **(Safety: ensure spilled water is cleared up.)**
- Ask students to report back on their system and to explain all the ways that energy is dissipated.
- Ask each group to think of three other situations in which GPE and KE interchange. Bring the examples together and discuss similarities and differences.

Homework

Workbook page 64 and questions from the spread.

Key words

gravitational potential energy, kinetic energy

8.5 Student Book answers

1. Kinetic energy is the energy that something has because it is moving. GPE is the energy that something has because of its position.
2. **a.** The man, because he has greater mass, and KE depends on speed and mass.
   b. Yes, if the boy runs faster than the man they could have the same amount of kinetic energy, because KE depends on mass and speed.
   c. The man, because he has greater mass.
3. Thermal energy due to friction (e.g. between the wheels and the rails, in the axle bearings, between the carriages and the air), sound.
4. **a.** 20 J/2 = 10 J
   b. 10 J. Half of the original GPE has changed to KE.
   c. Assuming no energy has dissipated.

8.6

Planning: Pendulum motion

TWS

Student Book pages 142–143

Key words

period, reaction time, preliminary work

8.6 Student Book answers

1. In a table with the quantity and unit at the top of each column.
2. A fair test investigation.
3. The hypothesis is testable because you can use it to make a prediction and then collect data to find out whether the prediction is correct.
4. If the pendulum is longer it will take more time to swing.
5. She repeated the measurements of time and then found the average time.
6. Adeela has said that she will keep the mass the same and pull the bob back by the same amount each time/ she will time how long the pendulum takes to swing 10 times and divide the result by 10 so that any errors in her measurement are made smaller.

Objectives

- Identify whether a given hypothesis is testable.
- Decide how many measurements to take.
- Present results clearly.

Overview

This lesson helps students develop their skills in Thinking and Working Scientifically.

In this lesson students learn the importance of collecting evidence to test a hypothesis and of repeat readings in experiments that involve measuring time. They also learn that you need to do preliminary work to find out the appropriate range and number of readings to take. They start by evaluating the plans in the Student Book and by carrying out the investigations as suggested. Then they plan their own investigation into the period of a mass on a spring, including the preliminary work needed to identify how to test a hypothesis.

Activities

- Students revise what they know about scientific questions from the Student Book, and discuss what makes a hypothesis testable.
- Students revise how to plan investigations by drawing a flowchart of the stages or using the card sort.
- Discuss the results, and the importance of dependent and independent variables to a fair test. Elicit the idea of a testable hypothesis.
- Give out stop-clocks and get students to see how fast they can turn a stop-clock on and off. Discuss reaction time and why it is an issue in measuring time intervals. Elicit the idea that timing many oscillations and then dividing the time by the number of oscillations reduces the error.
- Students read the plans the Student Book. Discuss which might be the best method or whether they are the same.
- Students carry out the investigations **(Safety: take care that the clamp stand does not fall over.)**
- Discuss any differences found in the methods for measuring time.
- Students then plan and carry out an investigation into the time period of a mass on a spring. Set up a mass on a spring and show how the mass oscillates if it is pulled down. Ask the students to define the period. They plan and carry out the investigation.
- Ask students to summarise what they have found out about the importance of preliminary work. Groups look at the summaries. As a group/class decide how to do preliminary work well (trying a very wide range to find the best range, working out how many readings you need to plot a good graph).

Extension

Plot a graph of the square of the period, T^2, against pendulum length l to show that T^2 is proportional to l.

Homework

Workbook page 65 and questions in the spread.

8.7

Elastic potential energy

Student Book pages 144–145

Objective

- Demonstrate an energy transfer such as a bouncing ball by energy transfer diagram, e.g.,. gravitational potential energy → kinetic → elastic potential energy + thermal + sound → kinetic → gravitational potential energy, etc.

Overview

In this lesson students learn how energy is stored when a material is deformed, and that the energy can be recovered when it returns to its original shape. At IGCSE students will learn to calculate elastic potential energy (EPE). This term denotes the *equation* that is used to do the calculation. Here we use the term as a shorthand for 'energy stored elastically'.

Students make links between what they have learned so far by considering a ball bouncing.

Activities

- Start by demonstrating a variety of activities and ask students what they have in common. For example, putting a mass on a spring and taking the mass off, letting a wind-up toy run, blowing up a balloon and letting it go, or flicking an elastic band. Elicit the explanation that there is a spring inside the toy, and that stored energy is transferred to a kinetic store. The springs or rubber change shape or extend and the more that they are deformed the more energy is stored. Introduce the idea of EPE as a way of saying energy stored elastically.
- Demonstrate bouncing a ball. Ask students to work out the energy transfer diagram.
- Students complete an investigation into bouncing balls and plot a graph of their results. They present the results to the class and describe the link that they have found using the language of 'the bigger the… the bigger the…'.
- Students consolidate what they have found out by designing and making a catapult to launch a marble to hit a target. Students learn how to calibrate their catapult so that they can hit a target on the floor. When they have finished tell them the distance that they have to put the target from the catapult. All groups have a single chance to hit the target. The winning group receives a prize. **(Safety: Take care when launching the marble. Only aim the catapult at a wall or into the corner of the room.)**

Extension

Students work out the percentage of energy dissipated, or 'wasted', for a sequence of bounces. They extend the investigation to look at the energy-absorbing properties of different surfaces.

Homework

Workbook page 66 and the questions in the spread.

Key words

elastic potential energy (EPE), deform, elastic

8.7 Student Book answers

1. a. Chemical energy to kinetic energy as she moves, to EPE in the stretched band, to kinetic energy and GPE as it flies away.

b. The band will store more EPE so will have more kinetic energy so will travel further.

2. a. GPE to kinetic energy to EPE to kinetic energy to GPE.

b. Thermal energy (heating up the surroundings).

3. Some energy is dissipated as thermal energy (and sound) when the ball deforms.

8.8 Conservation of energy

Student Book pages 146–147

Objectives

- Write down the law of conservation of energy.
- State the Law of Conservation of Energy and explain how the law applies to different situations.

Overview

Students are introduced to the idea of energy as an amount that we can keep track of, a bit like money. By considering the energy transfers that they have previously studied they differentiate between 'useful' and 'wasted' energy, and learn what is meant by efficiency. They learn the law of conservation of energy, and how that applies to the energy transfers that they have been investigating. They look at two different ways of modelling energy and use the models to describe some energy transfers. Finally, they discuss the fact that a lot of the 'wasted energy' is in the form of energy in a thermal store and how that can be incorporated into their models.

Students will have a good understanding of the transfer of energy, and may have worked with the idea that energy is conserved in other situations, e.g. the pendulum, in previous lessons.

Activities

- Review what students learned about energy so far. Students pick two of the devices/processes and identify the useful and the wasted energy. Compare groups' choices. Discuss the use of the word 'wasted', rather than energy that has 'gone' or been 'lost'. Emphasise that energy is something that we can keep track of and that this is a very important principle in physics, called the law of conservation of energy.
- Introduce the idea that sometimes the wasted energy and useful energy can be the same type, but in different places, for example a kettle heats water but also the air around it.
- Student use two models for energy: coloured liquid and 'money'. Demonstrate the first process (a torch) in the following way. Take a beaker and a yellow and blue label. Write 'battery' on the blue label and 'chemical energy' on the yellow label. Remind students that this means 'energy in a chemical store'. Fix both labels to the beaker with a rubber band. Label another beaker with 'surroundings'. Fill the chemical energy beaker with coloured liquid and then pour some into the 'surroundings' beaker while saying 'I'm transferring energy using light'.
- Pause then say 'I'm transferring energy using heating', and pour the remaining liquid into the 'surrounding' beaker. Discuss the way that this is a good representation because all the energy ends up in the beaker, but it is not a good representation because the transfer methods are actually happening at the same time, not consecutively.
- Discuss another example where the energy ends up in two different stores. When you cook food in an oven, some of the chemical energy (from fuel) ends up in the thermal store of the surroundings and some in the thermal store of the food. In this case there would be two beakers at the end, but the transfer method would be the same. Eventually energy ends up in the thermal store of the surroundings.

- Students continue with the modelling using liquid and also using counters or 'coins', **(Safety: Ensure students do not drink the liquid or flick elastic bands.)**
- Discuss how the students used the coins/counters to model the torch. Bring out similarities/differences between the models.
- Discuss what we mean by 'efficient'. Ask if is possible to say how efficient the devices were. Elicit the idea that to work out how efficient something is we need to know how much of the original energy is wasted. compare three types of light bulb, and think about how to incorporate wasted energy into each model.
- Students compare and contrast the models for a range of processes and produce a table of the pros and cons of using each model.

Homework

Workbook page 67 and the questions in the spread.

Key words

law of conservation of energy, useful energy, wasted energy, efficiency, dissipate

8.8 Student Book answers

1. a. Energy cannot be created or destroyed, but can be transferred.

b. Energy conservation states that there is always the same amount of energy after a process as there was before, whereas energy dissipation is the movement of thermal energy from a hot to a cold region (usually as 'wasted' energy).

2. useful, wasted, thermal

3. a. useful – thermal, kinetic;
wasted – thermal

b. useful – light, sound;
wasted – thermal

c. useful – thermal;
wasted – thermal, sound

4. It would not feel as warm.

5. You do not need as much electrical energy to get the useful energy that you want.

8.9

The world's energy needs

Student Book pages 148–149

Objective

- Compare the Renewable Energy Sources (wind, water, Sun and plants) and Non-Renewable Sources of energy (coal, natural gas, crude oil).

Overview

This lesson sets the scene for what students will learn in the next few lessons. It introduces the idea of renewable and non-renewable resources and explains that 'renewable' energy does not mean that you can use it again. Students learn that power-station generators convert primary sources into electricity, a secondary source, and that hydrogen gas is also a secondary source. In this lesson they learn how global energy demand has changed and how it varies from country to country. There are a lot of new words to learn in this lesson, but they will meet them again in the following lessons.

Activities

- Students read the Student Book and make a table of renewable and non-renewable resources. In pairs they make memory cards with the name of a resource on each card, and the same number of cards with renewable/non-renewable written on them. Then shuffle the cards and place them face down. Students take turns to pick two cards. If they match a resource with the correct renewable/non-renewable card they keep them. The winner is the student with the most pairs.
- Discuss the idea of primary and secondary sources and the converters shown in the table on page 166 of the Student Book. They will look at these sources and converters in more detail in the following lessons.
- Students look at the graph of global energy demand and individually write down three things that they notice from the graph. Then they share their ideas with their partner, and then with others in their group. Each group reports back on the three most striking things about the graph.
- Students analyse data about energy consumption and production, and the use of oil and renewables. Students look for other sources of data to check the data that they have been given. Emphasise that secondary data should always be checked.
- Students present their findings to the rest of the class. Each group thinks of a question that they would like to answer about energy resources and generating electricity for the future, and makes a display of questions that can be revisited later in the topic.

Homework

Workbook page 68 and the questions in the spread.

Key words

primary energy source, secondary energy source, coal, oil, gas, wind, water, biofuel, biomass, power station, refinery, renewable, non-renewable, primary data, secondary data

8.9 Student Book answers

1. **a.** A secondary energy source is produced from a primary energy source.
   b. Petrol is secondary. It is produced from oil in a refinery.
   c. Oil is primary. It comes from the ground.
2. A non-renewable source will run out. A renewable source will not run out.
3. **a.** coal
   b. oil
   c. ten times
4. China, and Indonesia

8.10

Non-renewable resources: Fossil fuels

Student Book pages 150–151

Objectives

- Describe how fossil fuels were formed.
- Explain how a fossil-fuel power station works.
- Describe uses of fossil fuels.

Overview

In the first half of this lesson students learn how fossil fuels were formed and why they are called fossil fuels. Students produce a piece of work based on the formation of fossil fuels. They learn how primary sources like fossil fuels are used to produce electricity, a secondary source, in a power station. They consider other uses of fossil fuels.

Finally, students look at where the fossil-fuel reserves are in their country and consider how much of the electricity that is needed should be generated with fossil fuels.

Activities

- If available, show students a lump of coal and a sealed container of crude oil (or 'fake' crude oil). Show them charcoal or charred wood and establish that the coal is effectively carbon, and that crude oil also contains carbon. Ask the reason for the name 'fossil' fuels. Elicit that they must be millions of years old, and that living trees and animals contain carbon.
- Students read about the formation of fossil fuels in the Student Book. They produce a cartoon, poster, or alternatively, divide the class into groups and get each group to produce a short section of a television programme on the formation of each of the fossil fuels.
- Students consolidate their knowledge.
- Show a suitable animation about how a power station works.
- Students research other uses of fossil fuels or use the Student Book to answer questions.
- Provide students with a map showing where fossil-fuel reserves are located in the local/national area. Consider how the reserves got there students debate how much electricity generation in their country should rely on fossil fuels.

Homework

Workbook page 69 and the questions in the spread.

Key words

coal-fired power station

8.10 Student Book answers

1. water, steam, turbine
2. Fossils are made from creatures that lived millions of years ago.
3. They need a supply of water to turn into steam.
4. Coal power stations produce electricity reliably.
5. Both coal and oil started as living things millions of years ago and were formed by thermal energy and pressure. Oil is made from animal remains and coal is made from plant remains.

8.11

Renewable resources: Solar and geothermal

Student Book pages 152–153

Objective

- Explain how energy from the Earth can be used to generate electricity.

Overview

This is the first of three lessons on renewable energy sources. In this lesson students learn how energy from the Sun can be harnessed to generate electricity or heat water. They learn that although some methods of generating electricity do not produce greenhouse gases while they are operating, greenhouse gases are generated when they are produced. They investigate the effect of light intensity on solar cells.

Activities

- Ask students to recall the difference between renewable and non-renewable energy sources. Then ask them to name as many renewable energy sources as they can.
- Show pictures of solar cells on roofs. Demonstrate connecting a solar cell to a voltmeter and hold it near a window or source of light. Students investigate solar cells by changing the distance from the lamp to the solar cell and the power of the lamp, **(Safety: Ensure students take care as the lamp will get hot.)**
- Discuss findings of the investigations, and how they got reliable results and made it a fair test.
- Ask students to think about other ways that people could use the energy from the Sun. Show pictures of solar water heating or demonstrate a solar oven if available. Students consider the practicality of using a solar roadway made of solar cells.
- Ask students to think of observations that you could make that could be explained by the fact that the Earth is very hot deep underground (volcanoes, geysers). Ask how this energy could be harnessed to heat homes or generate electricity using ideas from previous lessons.
- Students investigate the energy transfer from 'hot rocks' In discussions bring out that the rocks need to be at a much higher temperature to heat water to boiling point. **(Safety: Ensure students take care lifting the hot rock into the beaker.)**
- Display a map of suitable areas for geothermal power stations (such as https://www.thinkgeoenergy.com/global-map-to-identify-areas-suitable-for-geothermal-power-plants/). Emphasise that they do not need to be near plate boundaries to produce significant effects.

Extension

Students work out the relationship between the distance and the output of the solar cell, and the power of the lamp and the output of the solar cell.

Homework

Workbook page 70 and the questions from the spread.

Key words

solar energy, solar cell, geothermal energy, heat pump

8.11 Student Book answers

1. A solar cell generates electricity and a solar hot water panel heats water.
2. A single solar cell does not generate a big voltage.
3. Six times more efficient (30% compared with 5%).
4. Both power stations have a turbine and a generator/ heat water. In a coal-fired power station a fossil fuel is burned. Nothing is burned in a geothermal power station. The thermal energy comes from the hot centre of the Earth.
5. 4 solar power stations = 1 geothermal power station

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8.12

Renewable resources: Water and wind

Student Book pages 154–155

Objective

- Describe how wind, waves, tides and water behind dams can be used to generate electricity.

Overview

This is the second lesson on renewable energy sources. Students learn about the various methods that can be used to generate electricity using wind and water. They use a simple motor (as a generator) to make a model of a wind turbine. Groups then research each of the following methods of generating electricity: offshore wind farms, tidal energy, wave energy, and hydroelectric energy.

Activities

- Recap how a simple dynamo works. Demonstrate how a simple motor can be connected to a voltmeter to produce a voltage when you spin it. (Do not discuss the workings of a motor at this stage.)
- Students use the motor and voltmeter to model a simple wind turbine. They investigate how the number of blades or angle of the blades affects the voltage produced.
- Discuss the findings of the groups. Show pictures of wind turbines and ask whether the results that they obtained agree with the designs of real turbines. Ask them to suggest what the reasons might be for the differences.
- Discuss the ways that the same principle that they have used to generate electricity from the motion of the air might be used to generate electricity from the motion of water (tides, waves). Introduce the idea of hydroelectricity. Divide the class into groups and assign a different method to each group. Each group uses the Student Book, and relevant websites if available (you may wish to give students links to websites of local organisations that run power generators) to research the way that electricity is generated, and the advantages and disadvantages of the method. They produce a leaflet or prepare a short presentation.

Key words

reservoir, hydroelectricity, wind farm, wind turbine, wave power, tidal power

Homework

Workbook page 71 and the questions from the spread.

8.12 Student Book answers

1. Similarities: Water is used in both; there are turbines/generators in both.
   Differences: You can generate electricity whenever you want to in a hydroelectric power station; tidal power does not need a lake/drop in height.
2. No. You need to make and install the wind turbines and generators.

	Advantages	Disadvantages
a Wind	renewable – won't run out	turbines can kill wildlife, some people don't like the way they look
b Hydroelectric	renewable – won't run out electricity on demand	expensive to build/connect to homes and factories

3. Not when they are running, but greenhouse gases are produced when the dams, turbines and barrages are being constructed.

8.13

Renewable resources: Biofuels and bioplastics

Student Book pages 156–157

Objective

- Describe how we use plants to make fuels.

Overview

In this lesson students learn about the range of different biofuels. They come to appreciate the wide range of different crops that can be grown to produce biofuels. They should also realise that there are disadvantages, as biofuel crops can compete with food crops, and sowing and harvesting can generate carbon dioxide even though growing the plants means carbon dioxide is removed from the atmosphere.

They have an opportunity to summarise the pros and cons of all the different energy resources.

Finally, they consider the role of bioplastics, how these are produced, and the pros and cons of using them.

Activities

- Groups of students each take responsibility for a different section of a wall display that shows the range of different biofuels and how they are produced. Divide the class into groups. Each group prepares their section of the display. Students can be encouraged to use simple materials to make the display three-dimensional.
- When the display is complete, students consult it to fill out a table summarising the information,
- Alternatively, students could give presentations about 'their' biofuel to the rest of the class, during which the class complete the table. When this has been done they complete the display.
- Students use the material from last two lessons to complete the table about renewable resources.
- Show students a range of packaging. Show that packaging made from starch dissolves in water, but packaging made from plastic that comes from oil does not.
- Students make their own plastic**. (Safety: Students should be supervised when making the plastic. Make sure they do not take it out of the bag until it is cool enough to handle.)** Alternatively, students can compare different types of packaging or, if samples are not available, they can research the differences.

Homework

Workbook page 72 and the questions from the spread.

Key words

biomass, biofuel, biodiesel, bioethanol, biogas, bioplastic, biodegradable

8.13 Student Book answers

1. Biofuel: A fuel produced from renewable resources. Bioplastic: Plastics made from starch.
2. Renewable means that you can get more of it/it won't run out. Biodiesel is made from soybeans, and you can always grow more.
3. Biofuels and fossil fuels are both burned for energy/to produce electricity/run cars. They both produce CO_2 when they burn.

   Fossil fuels are non-renewable and biofuels are renewable. Fossil fuels produce pollution when burned, but biofuels do not.
4. Bioplastic is more expensive and difficult to produce.

8.14

STEAM: Harnessing solar power

Student Book pages 158–159

Prior learning

- The usability of solar panels in real life.
- How to construct series and parallel circuits.

Objectives

- Assemble and demonstrate a solar panel to operate a small fan. (STEAM)
- Design and make a solar water heater. (STEAM)

Overview

The best way to approach this lesson is through a blended approach of verbal recall, group work and hands-on approach.

This is an excellent opportunity to bring in student's own ideas and experiences. They may be unlikely to remember much of prior knowledge, so it is useful to reference that and get an idea of what they recall.

Activities

- Students can work on the project in different groups or phases.
- Introduce the idea of 'stores' of energy and 'ways of transferring energy from one store (situation) to another'. Students should be encouraged to see light, sound, and electrical energy as ways energy is transferred from one place to the next.
- Show a torch (or similar) and ask what energy transfers are taking place. Students may want to start with 'electricity'. Elicit that the torch would not work without the battery, where energy is stored chemically. Draw the energy transfer diagram showing stores as boxes and transfers as circles. Students should be reminded that we are not talking about 'light energy', but that light transfers energy.
- Remind students about what they know about charge. Explain to them that they will be building and testing electrical circuits. Remind them of **SAFETY: Whenever building and using circuits, the following precautions are a must:**
    - check wires are insulated.
    - connect the battery last/disconnect it when building and when finished.
    - do not connect circuits near water.
    - you or another teacher/technician should check circuits involving power supplies before use.
    - avoid connecting wires directly across the terminals of a battery; wires will get hot.
- Students to follow the steps in the students' books to make up circuits and test which ones are best for the task. Ask them to explain how to make the circuit work if it does not work. **(Safety: Take precautions when using circuits.)**
- Students to revise what they know about scientific questions from the Student Book and discuss what makes a hypothesis testable.
- Students revise how to plan investigations by drawing a flowchart of the stages.
- Discuss the results, and the importance of dependent and independent variables to a fair test. Elicit the idea of a testable hypothesis.

Key words

energy, potential energy, mechanical energy, renewable, non-renewable, conservation, solar, geothermal, stores of energy, energy supplies, fossil fuel.

8.14 Student Book answers

1. Kinetic store.
2. The speed of the fan slows down if a cloud passes over the sun.
3. Solar water heaters are useful even in countries with colder climates because the solar energy provides enough energy to heat up water without having to use any other form of energy.

8.15 Review answers

Student Book pages 160–161

Student Book answers

1	**a**	You need different amounts of energy for different activities.	**[1]**
	b	sitting, walking slowly, cycling	**[1]**
		In order of smallest amount of energy needed per minute to the largest amount of energy needed per minute	**[1]**
2		20 J, 0.2 kJ, 2000 J, 20 kJ, 2000 kJ	**[1]**
3		**1 – C, 2 – A, 3 – D, 4 – B**	**[4]**
4		**a, b, c.**	**[3]**
5	**a**	thermal, sound	**[1]**
	b	chemical in, kinetic out, thermal and/or sound downward	**[1]**
6	**a**	mass, speed	**[1]**
	b	any situation in which speed or mass is increasing	**[1]**
	c	no If, for example, you walk and then run on a flat road your kinetic energy has increased but your gravitational potential energy does not change.	**[1]**
7	**a**	**B**	**[1]**
	b	**A**, **D**	**[1]**
	c	**C**	**[1]**
8	**a**	a reason/(scientific) hypothesis	**[1]**
	b	No; the line is nearly horizontal so the time has stayed almost constant.	**[1]**
	c	e.g. Put different volumes of fuel in a burner, time how long it takes the same volume of water to boil.	**[1]**

9 — **[1] each correct column**

Primary energy sources	**Primary energy converters**	**Secondary sources/ carriers**
coal oil wood water	power station solar cell refineries	electricity petrol

10	**a**	The conversion of water and CO_2 into starch by plants using energy from the Sun.	**[1]**
	b	A fuel that has taken millions of years to form from dead animals or plants.	**[1]**
	c	Electricity generated by water falling through a dam from a high lake.	**[1]**
	d	A device that produces electricity from sunlight.	**[1]**

<table>
<tr><td>11</td><td>a</td><td>wood</td><td>[1]</td></tr>
<tr><td></td><td>b</td><td>700–900 EJ</td><td>[1]</td></tr>
<tr><td></td><td>c</td><td>Two from: bioethanol, biodiesel, biogas</td><td>[2]</td></tr>
<tr><td></td><td>d</td><td>e.g. cups, utensils, plates, bags, packaging</td><td>[1]</td></tr>
<tr><td></td><td>e</td><td>Bioplastics decompose faster than plastics made from oil.</td><td>[1]</td></tr>
<tr><td></td><td>f</td><td>Yes.
CO_2 is produced by machinery used to plant crops/harvest crops/make bioplastics.</td><td>[1]
[1]</td></tr>
<tr><td>12</td><td>a</td><td>How does the number of layers of film affect the voltage/output of the solar cell?</td><td>[1]</td></tr>
<tr><td></td><td>b</td><td><table><tr><th>Number of layers of plastic</th><th>Voltage output (V)</th></tr><tr><td></td><td></td></tr></table></td><td>[1] for each heading
[1] for volts</td></tr>
<tr><td></td><td>c</td><td>A bar chart
The number of sheets is discrete.</td><td>[1]
[1]</td></tr>
<tr><td>13</td><td>a</td><td>B, D, F, H, I, J, L</td><td>[1]</td></tr>
<tr><td></td><td>b</td><td>A, C, E, G</td><td>[1]</td></tr>
<tr><td></td><td>c</td><td>A, C, G, I</td><td>[1]</td></tr>
<tr><td></td><td>d</td><td>A, C, E, L</td><td>[1]</td></tr>
<tr><td></td><td>e</td><td>D, H, J</td><td>[1]</td></tr>
<tr><td></td><td>f</td><td>K
It is a secondary energy source. You use some of the other resources to produce it.</td><td>[1]
[1]</td></tr>
<tr><td>14</td><td>a</td><td>20 m^2</td><td>[1]</td></tr>
<tr><td></td><td>b</td><td>35 m^2</td><td>[1]</td></tr>
<tr><td></td><td>c</td><td>1250 kg</td><td>[1]</td></tr>
<tr><td></td><td>d</td><td>Maximum.
The company is selling the solar cells so wants you to see the most energy.</td><td>[1]
[1]</td></tr>
</table>

9.1

Charging up

Student Book pages 162–163

Objective

- Explain the phenomena of static electricity in everyday life.

Overview

In this lesson students are introduced to the idea of charging things and the idea of positive and negative charge.

Students investigate how charged objects attract or repel each other, and use the idea of charge to explain some everyday phenomena. They consider why electrostatic phenomena occur with insulators but not conductors. As some of the experiments are described in the Student Book, ensure that students do not look at the book until the end of the lesson.

Activities

- Students experiment with trying to stick a balloon to the wall by rubbing it on their clothes and putting it against the wall. If there are different types of surface in the room then they can see if it works for all surfaces or just some. They write down their explanation. They will review that explanation at the end of the lesson and see how their ideas have changed.
- Explain how atoms are made of tiny subatomic particles. Describe the structure and explain why atoms are neutral. If available, show an animation that shows the electrons, protons, and neutrons in different atoms. Students show what they know about the structure of the atom using diagrams or infographs in their notebooks..
- Rub a rod with a cloth. Talk through the movement of electrons to or from the rod producing an excess of charge. Demonstrate attraction/repulsion of charged rods as described on page 58 of the Student Book or let students experiment with it in the series of practicals.
- Students explore a range of electrostatic phenomena and record their results.
- Finally students return to their explanation of the balloon experiment at the start of the lesson and evaluate what they wrote. Then they write an explanation that uses ideas that they have learned in the lesson.

Extension

Students can investigate the history of electrostatics and find out the origin of the word ‘electric’.

Homework

Workbook page 73 and the questions from the spread.

Key words

electrostatic, charge, repulsion, attraction, positive (+) charge, negative (–) charge, nucleus, electron, proton, neutron, neutral, atom, conductor, insulator

9.1 Student Book answers

1. The atom has equal amounts of positive and negative charge/the same number of (positively charged) protons and (negatively charged) electrons.
2. **a.** cloth negative, rod positive
   b. Attract. The rods have opposite charge.
3. Because oppositely charged particles attract each other.

9.2

Dangers of electricity

Student Book pages 164–165

Objectives

- Describe how electricity can dangerous.
- Explain how the risk of damage or injury from electricity can be reduced.

Overview

In this lesson, students consolidate what they have learned about charge by considering the risks of the build-up of charge. They learn that charges moving through a material produce a current. This can cause a heating effect or produce the sparks that we see as lightning. Students learn about how lightning conductors work and produce a poster about safety in thunderstorms, as well as a leaflet about how the risk of shocks or injury in everyday situations can be reduced.

Activities

- Demonstrate the Van der Graaf generator or show a suitable video. Charge the dome and throw small pieces of paper at the dome or blow bubbles at it. Ask students to explain the observations using the idea of charge.
- Demonstrate how sparks are produced by bringing another earthed sphere close to the dome. **(Safety: Take precautions when using the Van der Graaf generator. Do not allow students to touch it without checking for heart conditions.)**
- Explain that the charge is moving through the air, that it is a current that is heating up the air, just like it heats up the filament of a lamp. Alternatively show a suitable video clip from the Internet.
- Ask students to choose where the safest place would be in a thunderstorm. Demonstrate with the Van der Graaf generator that points produce sparks more easily than blunt surfaces. Elicit that tall buildings and trees are more likely to be hit by lightning. Ask whether it is safer to lie flat or stand up in a storm. Discuss ways of reducing the risk of being hit by lightning.
- Explain how lightning conductors work and what is meant by earthing.
- Students read page 66 of the Student Book and produce a poster that explains what lightning is and what people should do to reduce the risk of being hit by lightning. They should include information about what happens if you are hit by lightning and why, and how lightning conductors provide a path for the charges to be earthed.
- There are lots of examples of places where charge can build up in everyday life. Students to plan a leaflet that explains how risks can be reduced.

Extension

Students find out about how lightning conductors were developed.

Homework

Workbook page 74 and the questions from the spread.

Key words

spark, current, lightning conductor, risk, Earth, earthing

9.2 Student Book answers

1. a. Earthing means connecting an object or a person to the Earth with a metal wire. Any charge that builds up flows down the wire to Earth.
   b. Lightning is a spark that forms when regions of charge build up in a cloud.
2. A current in the human body can burn you and damage or stop your heart.
3. The wristband is connected to the Earth with a metal wire, so any charge that builds up flows through the wire to Earth, rather than through the electrical components.
4. No; the charge would not flow through the plastic because it is an insulator.

9.3 Electric circuits

Student Book pages 166–167

Prior learning

- Recognise the components of simple circuits involving cells (batteries)
- Know how a switch can be used to break a circuit
- Construct complete circuits using switch, cell (battery), wire, and lamps
- Investigate how some metals are good conductors of electricity while most other materials are not
- Know why metals are used for cables and wires and why plastics are used to cover wires and as covers for plugs and switches

Objectives

- Describe a simple circuit as a path for flow of charges.
- Draw and interpret simple circuit diagrams (using symbols).
- Differentiate between open and close circut.

Overview

In this lesson students revise what they have learned earlier. They revise what they know about how to represent circuits using circuit symbols and circuit diagrams. They work out the circuit diagrams for a variety of different circuits. They use a simple circuit to work out which materials are conductors and which are insulators. Finally, they consider the safety aspects of working with components in electric circuits and make a safety leaflet or poster. Students should not look at the Student Book before this lesson.

Activities

- Explain to students that they will be building and testing a variety of electrical circuits.
- **Safety: Whenever building and using circuits, take the following precautions:**
  - check wires are insulated
  - connect the battery last/disconnect it when building and when finished
  - do not connect circuits near water
  - you or another teacher/technician should check circuits involving power supplies before use
  - avoid connecting wires directly across the terminals of a battery; wires will get hot.
- Students to draw electrical circuits and to fill in the names of circuit symbols next to their pictures.
- Make up five different circuits. Put them around the room, clearly labelled 1–5. Students go to each of the circuits and draw a diagram of the circuit using circuit symbols. They swap their diagrams with other groups. Each group marks the diagrams and comments on the quality of the diagram (drawn with a pencil and ruler, no gaps). They explain how to make the circuit work if it does not work**. (Safety: Take precautions when using circuits.)**
- Remind students about what they learned in Lesson 4.1 about charge. Students design a circuit to test whether something conducts electricity. They use their circuit to investigate a range of different objects, including graphite (use a pencil sharpened at both ends, but check beforehand that the graphite is not broken), or use carbon rods.
- Discuss the findings of the experiment and the fact that graphite (carbon) is a non-metal that conducts electricity. Elicit that there is a range of conductivity – even air conducts if enough charge is built up.
- Ask students what they think they will have to do in order to stay safe during these experiments. Students make a safety poster with illustrations.

Key words

electric circuit, component, circuit symbol, battery, terminal, cell

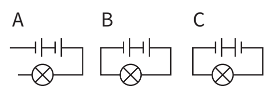
Extension

Students use the Internet to find out why some materials do not conduct electricity very well.

Homework

Workbook page 75 and the questions from the spread.

9.3 Student Book answers

1. a. 

b. B: there is a complete circuit and the cells are connected correctly.

c. In A, connect a wire from the lamp to the negative terminal of the battery to complete the circuit. In C, turn one of the cells around so that they are connected positive to negative.

2. The covering insulates the wire so that the current does not flow through you when you touch it and give you an electric shock.

9.4 Electric current

Student Book pages 168–169

Objectives

- Recognize electric current as a flow of charges.
- Describe the characteristics of series circuits.
- Draw and construct a series circuits.

Overview

Students learn that electrons moving through a wire constitute an electric current. They learn how to measure the current flowing in a circuit using an ammeter. They learn that a circuit with only one loop is called a series circuit, how to construct series circuits, and the disadvantages of series circuits.

Activities

- Remind students of what they learned about conductors and insulators. Explain that metals are good conductors because they contain lots of loosely bound electrons that can move through the wire. Show a suitable animation. Several are available online, including (at the time of publication – check before class) https://www.schoolphysics.co.uk/animations/ (electricity – magnetism, electric current), and http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc (show electron flow). The latter can be used in subsequent lessons to consolidate what students have learned. Emphasise that the charges are already in the wires and do not come out of the battery.
- Demonstrate how to construct a simple series circuit containing a bulb, lamp, wires, single cell, and a switch. Explain that this type of circuit is called a 'series' circuit. This is a circuit with components one after another in a loop. Highlight that all components are connected in a single loop, in a series.
- Construct a circuit with a single cell and a single bulb. Ask students to describe the brightness of the bulb. Explain that this is the 'normal' brightness and that

Prior learning

- Know that electrical current flows and that models can describe this flow, e.g. particles travelling around a circuit
- Predict and test the effects of making changes to circuits, including length or thickness of wire and the number and type of components
- Represent series circuits with drawings and conventional symbols

they can use this as a standard for comparisons using the terminology of more, or less, than 'normal' brightness.

- Explain that we measure the flow of electrons per second, or the current, using an ammeter. Demonstrate how to connect up an ammeter in a circuit. Students measure the current at different places in a series circuit. Elicit in discussion that the current is the same everywhere. Students may think that the current is used up, or comes out of the battery. Discuss what happens when you unscrew a bulb (or a bulb breaks) or when you short-circuit a bulb. **(Safety: Take precautions when using circuits)**
- Stimulate discussion on limitations of series circuits. Students need the key ideas of reduced power to components and vulnerability to component failure. They write down the problems in each situation on the sheet.

Extension

- Students find out who discovered the electron and how they did it. They make a poster explaining what they have found out.
- Students try to explain why the brightness of the bulbs diminishes.

Homework

Workbook page 76 and questions in the spread.

Key words

charge, electron, atom, ampere, amp, milliamp, ammeter, series

9.4 Student Book answers

1. Current is the amount of charge flowing past a point per second, and charge is a property of a particle or material.
2. **a.** Current is greater in circuit X, because current is the charge flowing per second.
   b. Circuit X has more cells: if there are the same number of lamps then a greater current means more cells.
   c. One cell: it has half the current of circuit X.

9.5 Current in series and parallel circuits

Student Book pages 170–171

Objectives

- Describe the difference between a series and a parallel circuit.
- Describe what happens to current in a parallel circuit.
- Describe how to measure current in series and parallel circuits.
- Describe the effect on the current of adding cells and lamps in series and parallel circuits.
- Identify the everyday uses of series and parallel circuits.

Overview

This lesson builds on what students learned about series circuits reviously. They learn that circuits with more than one loop are parallel circuits and they learn how to build parallel circuits. They measure the current in different branches of a parallel circuit and consider why parallel circuits are useful. They will explore how the current in a circuit changes with the types and arrangements of components in a circuit. They use the models that they learned about previously to explain the measurements of current in the circuit. Students keep the voltage the same in all of their circuits. They will learn about voltage in series and parallel circuits in the next lesson.

Activities

- Ask students to recall what they learned about series circuits in Stage 7: that adding more bulbs makes them dimmer, all the bulbs go out if one breaks, and the current is the same everywhere. Students could review this by doing an experiment. Explain that there is an alternative type of circuit called a parallel circuit. **(Safety: Ensure students take care when working with electricity)**.
- What does parallel mean? Show examples of parallel lines, e.g. gymnastic bars, and parallelograms. Explain that a parallel circuit contains more than one loop, and that each loop is independent of the other.
- Demonstrate how to make the parallel circuit with two bulbs and two switches. Arrange the wires to highlight the parallel portions of the loops and ensure that the switches are within the parallel loops of the circuit to allow independent control of bulbs.
- Ask students draw the parallel circuit they have seen and use two different colours to identify the two parallel regions of the circuit. To help with this, students can look at the two similar diagrams on page 220 of the Student Book. The first diagram is how parallel circuits are usually connected, but in practice it is identical to the second, which is easier for students to understand.
- Students then construct the parallel circuit. Ask them to compare the brightness of bulbs in each branch (identical), the current, and what happens when a single switch is turned off (individual control). Students expand their circuit by adding a switch in the circuit before the parallel branch split and record the effect (controls both branches).
- Students expand their circuit by increasing the number of parallel chains and record the effect of this on bulb brightness.
- Discuss the benefits of parallel circuits: full power supplied to each branch of the circuit; individual controls can be used; breaks in one branch do not affect the other branches.
- Students draw circuits for dealing with particular situations. Ask students to feed back solutions to their problems. Use these answers to highlight the greater versatility of parallel circuits.

Homework:

Workbook page 77 and questions in the spread.

9.6

Modelling electric circuits

TWS

Student Book pages 172–173

Objectives

- Describe a model of an electric circuit.
- Describe strengths and limitations of the model.

Overview

This lesson helps develop the skill of Thinking and Working Scientifically.

In this lesson students learn about models for how electric circuits work. They start by thinking about models in other topics that they have used so far and why we use them. Then they are introduced to two different models:

- the rope model
- the sweet model (equivalent to the truck model in the Student Book).

9.6 Student Book answers

1. **a.** Either turn the pump up so it pumps faster or make the pipes wider.
   b. Faster flow represents a greater current/more charge per second.
2. Someone counts the number of people passing per second.
3. Rope: person not pulling the rope; truck: factory has no bread; water: pump not working.
4. In the rope model you could have someone gripping the rope so hard that it does not move.
   In the truck model you could have a gate across the road.

They use the models to explain what is happening in a circuit. They work out the pros and cons of using each model. They will use these models in subsequent lessons to explain the behaviour of components in a circuit.

Activities

- Ask students to think of two models that they have used in science (model of the Solar System, or the Milky Way, or the atom). Ask them to explain *why* we use those models (to show things that are too big or too small to see to scale). Explain that scientists use other kinds of models to predict or explain, for example, computer models, mathematical models.
- Discuss with students why it can be difficult to work out what is happening in circuits (cannot see the charges flowing). Explain that they are going to learn about models to predict or explain what happens in an electric circuit.
- Students use the rope loops in pairs to model an electric circuit and work out how to model cells, current, components, and ammeters. To speed up the activity you could make the loops in advance.
- In discussion afterwards ask groups of four to report back and give one good point and one bad point about the model.
- Use the class to demonstrate the 'sweet' or 'people' model. This is an example of a 'donation' model. One student acts as a bulb and another as a battery. Give the person who is the battery a bowl of sweets. The rest of the students in the group all stand in a circle so that they are very close to each other. The person who is the battery should stand just outside the circle of students, and the person who is the bulb should stand opposite the battery. When you say 'Go' the students start to walk in a circle. The 'battery' gives each student a sweet as they walk past. When a student gets to the 'bulb' they give their sweet to the bulb, who puts it on a table. Ask students how you could extend the model to add another bulb or an ammeter.
- Discuss the pros and cons, particularly the delay before the 'energy' gets to the 'lamp', and need to know how many lamps are in the circuit.
- Students evaluate each model for its pros and cons using what they have learned, and check their findings with the Student Book.
- You could also introduce the idea of the water circuit, with a pump as a battery, the water as the current, and the diameter of the tube as the resistance. Students note one pro and one con of the model, and could vote on the model they think is best. Alternatively students could add another column to their table as an extension activity.

Homework

Workbook page 78 and questions in the spread.

Key words

model

9.7

STEAM: Planning investigations - Investigating the factors that affect the speed of a motor

Student Book pages 174–175

Prior learning
- Draw and interpret a circuit diagram and its symbols.
- How to construct series and parallel circuits.

Objectives

- investigate factors that affect brightness of bulbs or speed of motor:
  - number of batteries,
  - number of bulbs,
  - type of wire,
  - length of wire,
  - thickness of wire.
- Build a simple trip wire alarm.
- Suggest improvements to the designs.

Overview

This STEAM activity-based lesson is a good opportunity for students to put into practice the theoretical knowledge learned earlier.

It is recommended to run through the good experiment once and then present the opportunity for practical work to the students. The Student Book provides the step by step basic outline of the process of the practical and poses further questions for the students to investigate.

Activities

- Students can work on the project in different groups or phases.
- Ask students to list the situations where they have heard the idea of 'stores' of energy and 'ways of transferring energy from one store (situation) to another'.
- Remind students about what they know about charge. Explain to them that they will be building and testing electrical circuits. Remind them of **SAFETY: Whenever building and using circuits, the following precautions are a must:**
  - check wires are insulated.
  - connect the battery last/disconnect it when building and when finished.
  - do not connect circuits near water.
  - you or another teacher/technician should check circuits involving power supplies before use.
  - avoid connecting wires directly across the terminals of a battery; wires will get hot.
- Students to follow the steps in the students' books to make up circuits and test which ones are best for the task. Ask them to explain how to make the circuit work if it does not work. **(Safety: Take precautions when using circuits.)**
- Students to revise what they know about observations from the Student Book and discuss how to best record observations for analysis (Q4, part b).
- Students revise how to plan investigations by drawing a flowchart of the stages (Q4, part c).
- Discuss the results, and the importance of dependent and independent variables to a fair test. Elicit the idea of a testable hypothesis.

Homework

Q4, part a from the student book spread Also Workbook page 79.

Key words

earth wire, fuse, circuit breaker, switch, wire, ampere, electric power, battery, electric charge, neutral, friction, conductors, insulators, circuit, circuit symbols, circuit diagrams, closed and open circuit, electric current, ammeter, ampere voltage, resistance, volts, voltmeter, positive, negative terminals.

9.7 Student Book answers

1. a. Independent variable: diameter of wire

b. Dependent variables: current and the speed of the motor

c. Control variables: the type of wire, the length of wire, the number of cells.

2. If experiment is repeated, it is easy to spot any results that do not fit the pattern (anomalies).

3. For copper the current is bigger (3 x) and the motor spins much faster. Copper must have a lower resistance than nichrome.

4. a. Independent variable: length of wire Dependent variable: current and speed of the motor Control variables: diameter of wire, type of wire, number of cells

b. Table:

Length of wire /cm	Current /a			Observations
	1	2	Repeat	

c. If possible, students should carry out the investigation. They will discover as the length increases the current decreases and the motor turns slower. This is because the resistance of the wire increases as the length increases.

9.8 Review answers

Student Book pages 176–177

Student Book answers

1	**a**	not charged	**[1]**
	b	has a net charge because electrons have moved to it or from it	**[1]**
	c	property of a particle or object that can be positive or negative	**[1]**
	d	something that charge can travel through easily	**[1]**
	e	something that charge cannot travel through easily	**[1]**
	f	electrically connected to the ground so that charge can flow away	**[1]**
2	**a**	positive, negative	**[1] each**
	b	electrons	**[1]**
	c	repel	**[1]**
	d	attract	**[1]**
	e	force	**[1]**
3		Electrons are transferred from the jumper to the balloon/the balloon becomes negatively charged by friction. As the balloon is brought next to the wall the electrons in the wall are repelled. The negatively charged balloon is attracted to the positive charge left behind.	**[1]** **[1]** **[1]**
4	**a**	cell or battery	**[1]**
	b	series	**[1]**
	c	switch	**[1]**
	d	ammeter	**[1]**
5		charge, second, electrons, ammeter, amps, A	**[1] each**
6	**a**	Series circuit with battery or cell, motor, and switch. Students should annotate the switch to explain that the motor runs when the switch is closed, and turns off when the switch is open.	**[1]** **[1]**
	b	Charge flows/electrons flow/there is a current round the circuit (driven by the battery).	**[1]**

<table>
<tr><td>7</td><td></td><td>
<table>
<tr><th>Component/feature</th><th>Rope model</th><th>Supermarket model</th></tr>
<tr><td>battery</td><td>person pulling</td><td>factory making food</td></tr>
<tr><td>lamp</td><td>person gripping</td><td>supermarket</td></tr>
<tr><td>switch</td><td>person holding rope still</td><td>gate across road</td></tr>
<tr><td>current</td><td>rope moving per second</td><td>number of trucks per second</td></tr>
<tr><td>ammeter</td><td>person counting how much rope passes per second</td><td>person counting number of trucks per second</td></tr>
<tr><td>charge</td><td>piece of rope</td><td>truck</td></tr>
</table>
</td><td>[1] each</td></tr>
<tr><td>8</td><td>a i</td><td>The lamp in circuit B is brighter.</td><td>[1]</td></tr>
<tr><td></td><td>a ii</td><td>The ammeter reading in circuit B is greater.</td><td>[1]</td></tr>
<tr><td></td><td>b</td><td>The lamp would be as bright as the one in circuit A.
The ammeter would read the same as the one in circuit A.</td><td>[1]
[1]</td></tr>
<tr><td>9</td><td>a</td><td>
<table>
<tr><th>Position of switch on left</th><th>Position of switch on right</th><th>Bulbs on or off?</th></tr>
<tr><td>1</td><td>2</td><td>on</td></tr>
<tr><td>1</td><td>4</td><td>off</td></tr>
<tr><td>3</td><td>2</td><td>off</td></tr>
<tr><td>3</td><td>4</td><td>on</td></tr>
</table>
</td><td>[1] each</td></tr>
<tr><td></td><td>b</td><td>Switch 1/3 is at the top of the stairs and switch 2/4 is at the bottom. Regardless of the position of the switch at the bottom of the stairs, you can turn the lamps on by moving the switch at the top, and vice versa.</td><td>[1]</td></tr>
<tr><td>10</td><td>a</td><td>charged</td><td>[1]</td></tr>
<tr><td></td><td>b</td><td>insulator, charge, conductor</td><td>[1] each</td></tr>
<tr><td></td><td>c</td><td>charge</td><td>[1]</td></tr>
<tr><td></td><td>d</td><td>conductor, charge, earthed</td><td>[1] each</td></tr>
<tr><td>11</td><td>a</td><td>C</td><td>[1]</td></tr>
<tr><td></td><td>b</td><td>B</td><td>[1]</td></tr>
<tr><td>12</td><td>a</td><td>iv</td><td>[1]</td></tr>
<tr><td></td><td>b</td><td>i</td><td>[1]</td></tr>
<tr><td></td><td>c</td><td>iii</td><td>[1]</td></tr>
</table>

10.1

The properties of magnets

Student Book pages 178–179

Prior learning

- Explore the forces between magnets and know that magnets can attract or repel each other
- Know that magnets attract some metals but not others

Objectives

- Describe the properties of magnets.
- Know which materials are magnetic.
- Describe how to magnetise and demagnetise a magnetic material.
- Use a model to explain the behaviour of magnetic materials.

Overview

Students will be familiar with magnets evious grades. This lesson recaps what they know about repulsion and attraction, and magnetic materials. Students investigate magnetic materials and which materials can shield a paperclip from a magnet.

As an extension students are introduced to domain theory as a model to help explain how and why magnetic materials can be magnetised.

Activities

- Revise what was learned at Stage 6 with a quiz. Students each write three questions with answers from what they remember about magnets. Use their questions to make a quiz for the whole class. Show the students lodestone, if available, and talk about the origins of the discovery of magnetism.
- Students explore magnets and magnetic materials. **(Safety: Ensure students do not to get skin or fingers trapped between magnets.)** Discuss what they found out. Elicit that magnetism is a non-contact force, that magnets repel and attract, and that you can only tell if something is a magnet if it repels another magnet. Add cobalt and nickel to their list of magnetic materials if these were not available. Introduce the idea of soft and hard magnetic materials, which will be needed for Lesson 8.3 on electromagnets.
- Discuss the number of everyday objects that contain magnets. Students may have played with magnets or seen magnets on refrigerators.
- Students consolidate what they have learned in the lesson by writing a 'Did you know?' factsheet about magnets and magnetic materials,

Extension

Ask why some materials are magnetic but others are not. Introduce the idea of domains using diagrams and ask students to explain what they think will happen if you stroke a piece of (not magnetised) magnetic material with a magnet.

Students investigate domain theory and use it to explain what would happen if you broke a magnet in two.

Homework

Workbook page 80 and questions in the spread.

Key words

lodestone, non-contact force, north pole, south pole, iron, nickel, cobalt, oxides, magnetise, demagnetise, domain

10.1 Student Book answers

1. Steel, iron, and nickel are magnetic; the others are not.
2. Steel. Steel stays magnetised when the magnet is removed.
3. a. B – north, C – south, D – north
   b. The magnets will repel in both experiments.
4. a. The domains behave like tiny magnets, so however small the piece there will be a north and a south pole.
   b. If you heat a magnet (or hit it with a hammer) the domains can move and will no longer be lined up.

10.2

Magnetic fields

Student Book pages 180–181

Objectives

- Recognize that a freelymoving magnet comes to rest pointing in a North-South direction.
- Draw magnetic field of a bar magnet using iron filings.
- Recognise that there is a space around the magnet where effect of magnetic force can be observed.

Overview

In this lesson students learn about the magnetic field around a bar magnet and the concept of a field as a region in space where something experiences a force. They find out about the shape of the field using iron filings and plotting compasses, and learn about the neutral point. They learn that we use magnetic field lines to represent magnetic fields, and what they represent.

Students learn about the wide range of objects that contain magnets.

Activities

- Students recap what they learned last lesson about the attraction and repulsion of magnetic materials. Introduce the idea of a magnetic field and link the idea of fields to gravity.
- Students investigate the field around a bar magnet, two magnets that are attracting, and two magnets that are repelling. They should be able to indicate the neutral point. Discuss their drawings and how we represent a field. Introduce magnetic field lines as a model for representing magnetic fields. Discuss the conventions (arrows, the direction, the density indicating strength). Students draw the magnetic fields from their experiment using magnetic field lines. **(Safety: Ensure students do not get skin or fingers trapped between magnets.)**
- Students investigate which materials block the magnetic field of a magnet. They learn that magnetic materials block the magnetic field of a magnet and that this is another method of working out which materials are magnetic.
- Demonstrate that fridge magnets stick to magnetic materials, like steel refrigerators, but do not stick to each other. Ask students to suggest why, and then to investigate the magnets to see if their theory was correct.

Extension

Students can find out how very strong magnets are made.

Homework

Workbook page 81 and questions in the spread.

Key words

magnetic field, neutral point, magnetic field line

10.2 Student Book answers

1. A magnetic field is a region where a magnetic material or a magnet experiences a force.
2. The field is strongest near the poles. The field lines are closer together at the poles.
3. It would not move. The magnetic fields cancel out so there will be no force acting on the ball.
4. You do not make a magnetic field with iron filings, but you can show its shape with iron filings.

10.3

Magnetic Earth

Student Book pages 182–183

Objective

- Recognize Earth's magnetic field which attracts freelypivoted magnet to line up.

Overview

Students revise what they have already learned about magnets and magnetic fields. They magnetise a needle, and make a compass.

They learn about the shape of the Earth's magnetic field and link it to how compasses work. They learn the difference between the Earth's magnetic north pole and the geographic North Pole, and that the magnetic north pole moves.

They link what they have learned previously about electromagnets to one possible theory about the origin of the Earth's magnetic field.

Finally they learn about the importance of the Earth's magnetic field in protecting the Earth from the solar wind.

Activities

- Revise ideas about magnets and magnetic fields by asking students to draw the field around a bar magnet, labelling north and south, and drawing arrows on the magnetic field lines.
- Students make a compass by stroking a steel needle or pin with a magnet. Students will need to know which direction is north. **(Safety: Needles and pins are very sharp.)**
- Elicit the idea that the compass needle must be made of a magnet or magnetic material. Students make a model of the Earth's magnetic field using. Discuss the way that they made it, particularly that the magnetic south pole has to be at the Earth's north. Discuss the difference between magnetic north and geographic north.
- Discuss the prevalent theory for the reason that the Earth has a magnetic field and link it to the experiments in Lesson 8.3 about electromagnets.
- Divide the class into groups to find out:
  - what would happen if the Earth's magnetic field disappeared
  - when the Earth's magnetic field is due to flip, and when it has done so in the past
  - about the magnetic field of other celestial objects.

  Groups present their findings to the rest of the class.

Homework

Workbook page 82 and questions in the spread.

Extension

Students research alternative theories for the origin of the Earth's magnetic field.

Key words

magnetic field, compass, solar wind, aurora

10.3 Student Book answers

1. The needle is a magnet; the Earth's magnetic field exerts a force on it.
2. It is like the field of a bar magnet with the south pole near the Earth's geographic North Pole.
3. a. The field at that location is diagonally downwards/ there is a dip in the field.

   b. The magnetic north pole (near the geographic North Pole), where the magnetic field direction is vertically downwards.

10.4

Electromagnets

Student Book pages 184–185

Objectives

- Construct an electromagnet and identify its application in everyday life.
- Compare different types of magnets (permanent, temporary, and electromagnets).

Overview

In this lesson students learn how to make an electromagnet. They start by investigating the magnetic field around a single wire, and then build an electromagnet. This lesson links to the previous lesson as students use what they learned about magnetic fields to investigate the magnetic field around an electromagnet. In the next lesson students will investigate the factors affecting the strength of an electromagnet in more detail.

Activities

- Students discuss the places where it might be helpful if you could turn a magnet on and off.
- Students investigate the magnetic field around a single wire using a plotting compass and iron filings. They find out what happens when the direction of the current is reversed and what happens when you use several loops of wire. Discuss how you can make an electromagnet that would act like a bar magnet. **(Safety: Ensure students take care when using electricity, and only connect the battery for short periods of time as the wire will get hot.)**
- Students make a simple electromagnet by wrapping a piece of insulated wire around a nail. They investigate the magnetic field around the electromagnet using a plotting compass and iron filings, and compare the strength of the electromagnet with the strength of the bar magnet.

Extension

Students investigate how commercial electromagnets are constructed.

Homework

Workbook page 83 and questions in the spread.

Key words

electromagnet, core

10.4 Student Book answers

1. The magnetic field would be reversed.
2. **a.** Iron is easily magnetised but loses its magnetism when the current is turned off.
   b. A steel core would stay magnetised so you would not be able to turn the electromagnet off.
3. Bring an electromagnet near the pile of pieces. Turn it on. The electromagnet will pick up the pieces of iron, so move them away and turn the electromagnet off.
4. No. The current only flows through the wire, not through the core. The important thing about the core is that it is a magnetic material, so that it makes the electromagnet stronger because it becomes magnetised.

10.5 Using electromagnets (SiC)

Student Book pages 186–187

Objectives

- Describe some uses of electromagnets.
- Explain why electromagnets are used instead of permanent magnets.

Overview

This lesson introduces students to some of the wide range of uses of electromagnets. They design and make a very simple device: a relay. This is an opportunity to consolidate their knowledge about electromagnets and magnetic materials by asking them to explain how it works. They use what they know about electromagnets to explain how an electric bell works. They summarise what they have learned by making a table of all the different uses of electromagnets.

Activities

- Students make a simple relay using a coil of wire. Challenge students to turn on one circuit using a magnet, then to use an electromagnet to make a switch close. Discuss the possible uses of this kind of circuit and how it is more useful to use an electromagnet to switch on circuits remotely than to use a permanent magnet. **(Safety: Ensure students Take care when using electricity, and only connect the battery for short periods of time as the wire will get hot.)**
- Students use what they know about electromagnetism to design a mechanism that keeps fire doors open.
- Give students a picture of an electric bell. Students use the diagram and what they know about electromagnets to explain how the bell works.
- Show pictures of MRI scans and briefly discuss how they are made. Discuss the pros and cons of MRI scans and X-rays. Students may not know that X-rays are dangerous.
- Students make a table of the uses of electromagnets that they have seen in the lesson. In each case they explain why electromagnets are used rather than permanent magnets.

Homework

Workbook page 84 and questions in the spread.

Key words

relay, reed switch, armature, magnetic resonance imaging (MRI) scanner

10.5 Student Book answers

1. In any situation where there is a risk of injury when you turn something on, e.g. high voltage, risk of burning.

2. a. When you press the button you 'make' the circuit work, which magnetises the iron and pulls the armature. This 'breaks' the circuit so the armature springs back.

b. The relay will not turn off until you release the switch/the doorbell circuit continues to be turned on and off for as long as the switch is pressed.

c. Both contain an electromagnet.

3. Permanent magnets are not strong enough, and cannot be turned on and off.

4. Because they have a constant magnetic field.

10.6 Review answers

Student Book pages 188–189

Student Book answers

1	**a**	false	**[1]**
	b	true	**[1]**
	c	false	**[1]**
	d	false	**[1]**
2		**A**, **B**, **C**, **F**	**[1]**
3	**a**	**A** – right, **B** – down, **C** – down, **D** – left	**[1] each**
	b	Any two magnets correctly placed to make the blue magnet move up, e.g. diagram **B** but with S at the top of the green magnet, or diagram **C** but with N at the bottom of the green magnet.	**[1]**
4	**a**	magnetic field, magnetic field	**[1] each**
	b	magnetic field, strong, poles	**[1] each**
	c	pole	**[1]**
5	**a**	using iron filings using (plotting) compasses	**[1]** **[1]**
	b	A point where the magnetic fields cancel out.	**[1]**
	c	magnet 1 The neutral point, where the field from magnet 1 is cancelled by the field from magnet 2/ where the fields are the same strength, is further away from magnet 1 than magnet 2.	**[1]** **[1]**
	d	Put a steel ball at different positions. When it is at the neutral point it will not move.	**[1]**
6		In the first picture the compass needle is lining up with the magnetic field of the Earth. (The magnetic North pole of the Earth is the pole to which north poles of magnets are attracted.) In the second picture the compass needle is lined up with the magnetic field of the magnet.	**[1]** **[1]**
7	**a**	A magnet that you cannot turn off.	**[1]**
	b	A material that is attracted to a magnet/that can be magnetised.	**[1]**
	c	A region where a magnet/magnetic material experiences a force.	**[1]**
	d	Lines that show the direction and strength of a magnetic field.	**[1]**
	e	A coil of wire carrying a current and wrapped around a core.	**[1]**
8	**a**	The coil becomes an electromagnet.	**[1]**
	b	The coil is no longer an electromagnet.	**[1]** **[1]**
	c	The hammer would be brought into contact with the bell and would not move away, because the steel would become magnetised and stay magnetised.	**[1]**

9	**a**	Wind the wire around the nail. Connect the wire to the battery and switch, and then turn it on.	**[1]** **[1]**
	b	Wind more turns of wire on the nail. Use a bigger battery (higher voltage).	**[1]** **[1]**
	c	**A**, **C**, **D**, **B**	**[1]**
10		**a, d**	**[1]**
11	**a**	iron	**[1]**
	b	Steel would stay magnetised. Copper is not a magnetic material, so would not make the electromagnet stronger.	**[1]** **[1]**
12	**a**	non-contact	**[1]**
	b	iron	**[1]**
	c	magnetic field	**[1]**
	d	electromagnet	**[1]**
	e	solenoid	**[1]**

11.1 Technology in Everyday life

Student Book pages 190–191

Prior learning
- Types of energy and energy conversions.
- Reproduction and growth in plants.
- Balanced diet and major digestive disorders.

Objectives
- Design a solar oven to convert solar energy into heat energy.
- Assemble a circuit to demonstrate the working of an electric bell. Suggest improvements to the design.
- Grow seasonal plants and vegetables in earthen pots and demonstrate the use of fertilisers on the growth of plants.
- Prepare yoghurt and cheese from milk to demonstrate the beneficial microorganisms.

Overview
The Technology in Everyday Life chapters are designed to enhance the research and technology application skills of the students.

The aim is to have the students recognise importance of science and technology to solve everyday problems and integrate scientific concepts/ STEAM in daily life to improve the quality of their own life and lives of others. And finally, to understand how scientific concepts/ STEAM affect their life and society.

Activities:
The activities added are as per the National Curriculum of Pakistan and detailed in the student book. The hands-on activities must ensure that the following scientific skills are practiced and encouraged during the class:
- identify whether a given hypothesis is testable
- make predictions of likely outcomes
- decide what equipment is required to carry out an investigation
- record observations and measurements
- practice using the available scientific instruments/ apparatus and follow safety measures
- describe strengths and limitations of their models

Key words:
beneficial microorganisms, fermentation, engineering design process, fertilisers, pesticides, solar energy, electric circuit

Homework:
Workbook page 85.

Student Book answers

Spread	Question	Answer
11.1	1	Energy resource that can be replaced/will not run out.
	2	It is hard to get fuel such as gas/electricity/wood in some remote parts of the world.
	3	The position of the sun in the sky changed/ has to move to make sure maximum radiation.

11.2	**1**	When the circuit is switched on the electromagnet is switched on. The steel strip is attracted and touches the nail head. This breaks the circuit and the electromagnet is switched off. The steel strip is released and moves back up completing the circuit. The process repeats until the cell is disconnected.
	2	A steel nail would have stayed magnetic when the circuit was switched off so the steel strip would have stayed attracted to it.
	3	Any suitable suggestions to increase the force with which the steel strip strikes the nail/bell: • increase the current • increase the number of coils on the electromagnet
11.3	**1**	Fertilisers.
	2	To provide the minerals they need to grow well.
	3	By including risk assessment, increasing the comparison sample of fertilisers and plant types across seasons, and ensuring meticulous data collection.
11.4	**1**	Microorganisms which cause us no harm and may provide benefit of some kind.
	2	[Heat milk (up to 83°C) and the cool (to 45°C)] --> [Stir in yogurt starter with milk (ratio of 0.5 cup starter to 1 cup milk)] --> [Mix the starter + milk to the rest of the milk] --> [Fill sterilized, dry, clean jars with milk and cover] --> [Keep jars warm until mixture thickens (up to 12 hours)] --> [Chill the resulting yogurt in fridge] -->[Yoghurt is ready!]
	3	Students can form research pairs to find out information, place it in tabular format and share during class discussions.

12.1

Solar System

Student Book pages 198–199

Objectives

- Describe the characteristics of different planets.
- Differentiate between planets and dwarf planet.

Overview

In this lesson students learn about the size and scale of the Solar System. They learn how the Solar System formed. They build a model to learn about the relative distances from the Sun to each of the planets, and why the planets orbit the Sun.

Activities

- Students work in pairs using a set of the Solar System cards fthey should be guided to create themselves.

  Students can:

  a Use the information to organise cards in order of distance from the Sun and work out the meaning of inner and outer planets.

  b Play Top Trumps. The aim of the game is to collect all the cards in the pack. Shuffle the cards and deal them all out. Player 1 looks at their top card, picks a category and reads it out to player 2 (e.g. distance from Sun). The player with the highest number in that category wins the card and puts it, with their own, to the back of their hand. The winner then reads a category from the next card. The game continues until one player holds all the cards.
- Discuss the distances to different planets. Explain that it is difficult to draw the Solar System to scale because of the great distances involved. Give a sense of the distances – from your town to the next town/city is *x* km, from the capital of your country to the next is *y* km, from Earth to the Moon is about 384 400 km, from Earth to the Sun is about 150 000 000 km.
- Students then build a scale model of the Solar System with modelling clay or pictures for the Sun and planets. Each model will need about 5 metres of floor or wall space, so arrange groups and space accordingly.
- Students make a stop-motion animation to show the formation of the Solar system.
- Set them the task of describing the Solar System in 50 words or fewer. They read each other's work and assess it.

Extension

- Students plot a graph of the distances to the planets.
- Students find out how scientists find out the data on the cards.

Homework

Workbook page 86 and questions in the spread.

Key words

Solar System, inner planets, outer planets, asteroid belt, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, dwarf planet, Pluto

12.1 Student Book answers

1. **a.** A collection of planets orbiting a star.
   b. Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
   c. i. The outer planets have many more moons than the inner planets. The outer planets have rings and the inner planets do not.
   ii. Inner planets are rocky, outer planets are mainly gas and ice.
2. Students to plot graphs using the skills they have learned so far.
3. The outer planets have much greater diameters. It does not matter that they are mostly gas there is a lot of material which has a very large mass.

12.2

Asteroids, meteorites, and comets

Student Book pages 200–201

Prior learning

- Planetary systems can contain stars, planets, asteroids and comets.

Objectives

- Describe the characteristics of asteroids, meteorites and comets.
- Inquire into the sighting of Halley's comet. Describe what they would feel if they saw it.

Overview

In this lesson students learn about asteroids, meteorites and comets. They learn the distinctions between these and other objects in the Solar System, such as planets and moons. They learn how they form and how we have come to know what they are and where they are in our Solar System. Students consider whether there could be asteroids, meteorites and comets, in other solar systems beyond ours.

Activities

- Show a series of images of astronomical objects and ask what they are. Students make a list of them. Discuss the definitions and why some objects are difficult to categorise in terms of size. Elicit the difference between asteroids, meteors, comets, meteoroids, and meteorites. Explain how they are different.
- Students to take their list and try to classify the objects on it using the Venn diagrams.
- Discuss the origin of the name asteroid' and how it is linked to 'star'. Ask students to recall the story of Galileo, and how the technology of the telescope helped to decide the correct model of the Solar System. Explain that asteroids were only visible with a telescope.
- Ask students to recall how the Solar System formed. Explain that asteroids are objects left over from the formation of the Solar System, so are made of the same material as most of the other objects.
- Students use sand and rocks to make presentation that shows the formation of asteroids, comets, and meteors. Pictures should be labelled, which could be done using hand-written cards on the sand and rocks.

Encourage students to role play as someone who has never heard of a comet, versus a person who has. Their reactions and feedback should be recorded individually or as group work.

Homework

Workbook page 77, questions from the spread.

Extension

Q1and 4 from the student book spread.

Key words

geostationary, asteroid, meteor, comet, orbit, solar system.

12.2 Student Book answers

1. rock, Sun, irregular, Mars, Jupiter
2. Similarity: both orbit the sun Difference: asteroids made of rock and comets made of ice.
3. Visible to the naked eye and has an orbit that brings in close to earth in a short period of time. Allowed astronomers to determine the length of time for the orbit and predict its next appearance to prove it was the same comet.
4. Encourage students to reply in their own words.

12.3

Satellites

Student Book pages 202–203

Prior learning

- The Solar has the sun at its center and the planets revolve around the sun.
- Be able to define the term 'space'.

12.3 Student Book answers

1. Any 4 from: monitoring weather, communications, monitoring the earth, GPS, exploring space,
2. Orbit is above the equator and takes one day/24 hours. The satellite remains above the same spot on the earth.
3. The radiation does not have to pass through the atmosphere so can detect stars further away
4. Planets: mercury, Mars, Venus, Jupiter and Saturn. Possible research: Cassini (Saturn) 2004-2017 – looked at the moons of Saturn and discovered new ones and water jets on Enceladus Galileo (Jupiter) 1989 -2003 – water under icy surface of Europa, first moon detected around an asteroid, volcanic activity on Io, what the rings of Jupiter are made from Magellan (Venus) 1990-94 mapped the surface of the planet (mostly lava flows from volcanic activity) Mars missions – many of these Mars global surveyor, mars rover missions, Mars Viking – students could focus on anyone.

Objective

- Describe the uses of various satellites in space i.e., geostationary, weather, communication and Global Positioning System (GPS).

Overview

In this lesson students learn about our place in the Universe. They develop an understanding of the concept of space as vacuum, yet populated by galaxies and stars and other heavenly bodies, regaining an appreciation of the Solar System as part of a galaxy, the Milky Way, that is one of millions of galaxies in the Universe.

Emphasize that the models and images are constructed and that living humans will not be able to look back and take a photograph of the Solar System from beyond it, yet they have designed satellites which us fulfil this ambition.

Activities

- Begin with a dramatic example of circular motion and swing a bucket half full of water on a rope in a vertical circle without spilling a drop. It is much safer to do this outside. Take care to use several plies of a strong string so that the string will not break. Alternatively, show a video of this demonstration. Discuss that fact that the bucket goes around in a circle because of the tension in the string.
- Discuss what the students observed in this activity. Elicit the idea that the force depends on the speed and the mass, and that satellites move around the Earth using same principle.
- Students discuss in pairs to work out which physical force is acting to keep the satellites in orbit. Satellites are kept in orbit by the force of gravity. Students investigate different types of satellites and their uses, and link it to what they have learned in the experiments.
- Students could research a particular satellite and present their findings.

Homework

Workbook page 88 and questions from the spread.

Extension

Q4 from the student book spread.

Key words

orbit, dwarf planet, weather, solar system, artificial satellites, core, light year, milky way.

12.4

Review answers

Student Book pages 204–205

Student Book answers

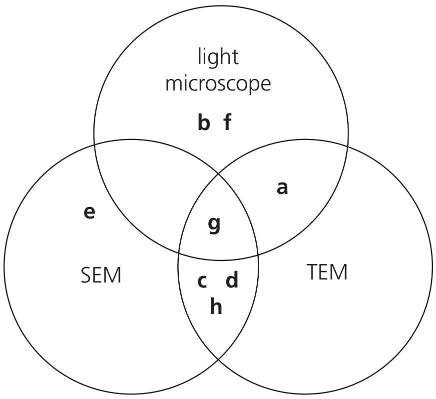
1	**a**	four, rock, small, rings.	[4]
	b	four, gas, large, rings.	[4]
	c	dwarf, orbit.	[2]
2		**A** **D**	[1]
3	**a**	2	[1]
	b	They are both made from stellar dust and gas/they both orbit the Sun.	[1]
	c	Planets are usually spherical; asteroids are not a uniform shape/planets are much larger than asteroids, which are rarely over 500 km in diameter.	[1]
4		**A** – 2 **B** – 4 **C** – 1 **D** – 3	[1] each
5	**a**	An orbit above the earth's equator which takes 24 hours/day.	[2]
	b	the satellite is above the same point on the earth so antennae can point at the same point in the sky all the time to communicate with the satellite.	[2]
	c	Any two uses of following: Monitoring weather data from satellites is loaded into a computer model and used to predict weather. Navigation/GPS 4 satellites are used to locate your position accurately. Monitoring the earth images can be used to monitor the planet eg tracking animals, deforestation desertification etc. Space exploration without the interference of the earth's atmosphere can collect data from distant stars and from planets.	[4]
6	**a**	B	[1]
	b	Because B like most asteroids is an irregularly shaped piece of rock.	[1]
	c	Mars and Jupiter	[2]
7	**a**	D as it has an orbital period of 1 day.	[2]
	b	A as it is closest to the Earth so would be able to take the clearest pictures.	[2]
	c	A line/scatter graph as the data is continuous.	[2]
	d	As the height increases the time for one orbit increases.	[1]
	e	Answer between 10 000 km and 36000 km (height is 20 000 km).	[1]

8	**a**	**i**	[1]
	b	**i**	[1]
	c	**i**	[1]
	d	**i**	[1]
	e	**iii**	[1]
	f	**i**	[1]
	g	**i**	[1]

1.1 The building blocks of life

1. The missing words are: cells; bacteria; billions; seven; respiration/excretion/growth (order of these three doesn't matter); 20–30; microscope.

2.



Extension

a. e.g. magnify up to 1 million times; enable us to see a lot of detail inside cells.
b. e.g. very large, very expensive, can't be used in schools or in the field.

1.2 The cell story

1. The first microscopes were made in the 17th century CE.
2. The first material seen under a microscope by Robert Hooke was a thin slice of cork.
3. Anton van Leeuwenhoek was excited when he looked down his microscope at a drop of pond water because he saw living microscopic animals moving around. He was the first person to see living cells.
4. There were two main reasons: for many years microscopes were not very good so very few people actually saw any cells; and for many years communication between countries was not very good so scientists in one place did not know what was happening elsewhere.
5. The cell is the basic unit of life/basic unit of structure of all organisms. All organisms consist of one or more cells.

Extension

You should write fluently. Show you understand that Leeuwenhoek made lenses to see his cloth clearly. Note his pleasure/pride in using the lenses to make a microscope. You should imagine and describe his excitement at seeing tiny living organisms swimming about.

1.3 Animal and plant cells

1. A nucleus, B cell membrane, C cytoplasm, D mitochondria.
2. A cell wall, B cell membrane, C vacuole, D nucleus, E cytoplasm, F mitochondria, G chloroplasts
3. A3; B5; C7; D1; E4; F2; G6

Extension

Muscle cells – they do a lot of work moving the body around so they need a lot of energy and need a lot of mitochondria. Fat cells need less energy so have fewer mitochondria.

1.4 Using a microscope

1. Eyepiece A, objective lens B; stage C, slide D, coarse focus E, fine focus F, light source G.
2. The correct order is:
   - Move the stage of the microscope to its lowest position.
   - Choose the objective lens with the lowest magnification and move it into position.
   - Put the object you want to look at on the stage. Keep it in place using the clips.
   - Look through the eyepiece lens and turn the coarse focus knob slowly until the object comes into focus.
   - Once the object is in focus , turn the fine focus knob slightly to see if it makes the image even sharper.
   - To see your specimen in more detail, repeat these steps using an objective lens with a higher magnification.

- Draw your observations using a pencil. Record the magnification you are using.

3. total magnification = 5 × 4 = ×20

Extension

total magnification = eyepiece lens magnification × objective lens magnification. ×100 = ×4 objective lens magnification. Rearrange to calculate objective lens magnification = 100/4 = ×25.

1.5 Seeing, drawing and comparing cells

1. i. Carefully create a specimen slide with no air bubbles and observe under the microscope.
   ii. draw only what you see and only draw one or two cells, without shading.
   iii. always use a pencil and draw as clearly as possible.
   iv. label the sketch carefully and only label what you observe.

2. Encourage the students to draw and label the magnified cheek and onion cells as observed under the microscope.

Extension

Organelle	Animal cell	Plant cell
Nucleus	Present	Present
Cytoplasm	Present	Present
Cell membrane	Present	Present
Mitochondria	Present	Present
Cell wall	Absent	Present
Sap vacuole	Absent	Present
Chloroplasts	Absent	Present, if present

1.6 Specialised animal cells

1. The missing words are: cells; respiration; multicellular; specialised; structure; function.

2. A3; B1; C2; D5; E4

3. Filled with haemoglobin: red substance/molecule that carries oxygen.

   Small and flexible: can pass through tiny blood vessels to carry oxygen to the cells.

   No nucleus: makes more space for haemoglobin to carry oxygen.

   Biconcave: gives a large surface area to pick up oxygen.

Extension

Main adaptations of ciliated cells: cilia – tiny hair like structures on the edge of the cell – and many mitochondria. Cilia beat to move things about in the body. This movement needs energy, so ciliated cells have lots of mitochondria to provide the energy from respiration needed for the cilia to beat.

1.7 Specialised plant cells

1. **a.** Photosynthesis.
   b. (Adaptations can be given in any order) Adaptation/explanation 1: Cells are located near top of the leaf/so they get as much sunlight as possible. Adaptation/explanation 2: cells are brick-shaped/so they can be packed together as tightly as possible. Adaptation/explanation 3: they contain large numbers of chloroplasts/to capture light for photosynthesis and make food.

2. **a.** Root hair cell.
   b. Take in water and mineral salts from the soil.
   c. Your labels should be the same as in your Student Book. Your notes on the diagram should include: long microscopic hair to give a big surface area to take in water and mineral salts; found on outside of the root – to grow into the soil and reach the soil water; large sap-filled vacuole which helps move water from the soil into the root.

Extension

a. Chloroplasts in palisade cells.

b. Palisade cells found in top layers of leaf where they get a lot of sun. Chloroplasts capture light to use in photosynthesis and make food for the plant. Root hair cells grow under the ground where there is no light – they don't need chloroplasts as there is no light to capture and so they cannot photosynthesise.

1.8 Modelling cells

1.

Feature	Animal cells	Plant cells
cell membrane	✓	✓
cell wall	✗	✓
nucleus	✓	✓
large sap vacuole	✗	✓
chloroplasts	✗	✓
cytoplasm	✓	✓
mitochondria	✓	✓
carries out respiration	✓	✓
carries out photosynthesis	✗	✓

2. The missing words are: physical; explain; big/small; small/big; misconceptions; remember.

3. The same: any sensible points, e.g. have a nucleus, have cytoplasm, have cell membrane, have mitochondria.

   Different: Must include – plant cells are bigger than animal cells; any other sensible points, e.g. plant cells are more regular in shape than animal cells; plant cells have a cell wall/chloroplasts/large vacuole and animal cells do not.

1.9 Tissues and organs in animals

1. A2; B4; C1; D5; E3

2. Brain: controls the body; lungs: take in oxygen and remove carbon dioxide; heart: pumps blood around the body; stomach: digests food; liver: removes toxins (poisons) from the body; intestine: absorbs nutrients from food; kidney: filters the blood and produces urine; bladder: stores urine.

Extension

Depends on which organ system you chose. Your answer should show awareness of the organs making up the organ system and some of the key tissues, e.g. muscle tissue to move food through the digestive system.

1.10 Tissues and organs in plants

1. The missing words are: multicellular; organisation; cells; tissues; organs; whole organism; two; shoot; photosynthetic; root.

2. **a.** A leaf; B stem; C roots

   b. Stem holds the plant upright; root anchors the plant in the ground and takes up water and mineral salts from the soil; leaf absorbs sunlight for making food by photosynthesis.

3. **a.** flower. **b.** reproduction.

   c. Because it is not always present/plants only flower at certain times of the year.

4. **a.** xylem. **b.** phloem. **c.** palisade tissue.

2.1 Reproduction: a characteristic of life

1. The missing words are: reproduction, reproduction, genetic material, DNA, molecule, information, sexual reproduction, asexual reproduction.

2. **a.** In absence of reproduction there would be no more living things left on the Earth.

b. Reproduction is essential for survival of a wide variety of living things.

Asexual reproduction	Sexual reproduction
	two special reproductive cells called gametes join to form a new individual.
	produces new organisms
only one parent organism needed.	
offspring are identical.	introduces variation into the offspring.

Extension

a. The offspring produced by asexual reproduction are identical to their parents, so the useful characteristics in the parent are always present in the offspring. This is an advantage as long as the external conditions do not change.

b. The offspring produced by sexual reproduction show variation from their parents, which is an advantage in a changing world. The variation guarantees that there are always offspring able to cope with a new disease, or particularly difficult growing conditions and so the plant adapts to changes and the species does not die out.

2.2 Natural asexual reproduction in plants

1. The bulb results in the formation of new identical plants by natural asexual reproduction.

a protective outer layer, b- leaves full of stored food, c- bud, d- short stem, e- roots.

2. Encourage students to draw either a strawberry runner plant or a mint plant. They should be able to identify that this is a form of asexual reproduction, where new baby plants form, at the end of the runner stems.

3. a. Encourage students to sketch a tuber based on the image in the book.

b. Plant tubers help plants survive poor conditions. When conditions are good for growing, buds on the tubers sprout to form new identical, independent plants, in a form of asexual reproduction.

c. People enjoy eating tubers due to their high starch content, which provide dense nutritional value to humans.

2.3 Sexual reproduction in plants

1. Sexual reproduction.

B. A. the seed is being planted for later germination.

B. under favourable conditions, the seed germinates, i.e. a tiny root and shoot burst from the seed and baby plant begins to grow.

C. the first leaves of the baby plant (a sprout!) open.

D. a properly formed baby plant (a seedling) begins to photosynthesise.

E. plant grows and develops till it matures into a full tree.

F. flowers develop signalling reproductive maturity of the plant. The processes of pollination and fertilisation occur.

G. fruit forms signalling successful fertilisation and resultant seed formation.

H. the female parts of the flower mature to form fruits around the seeds.

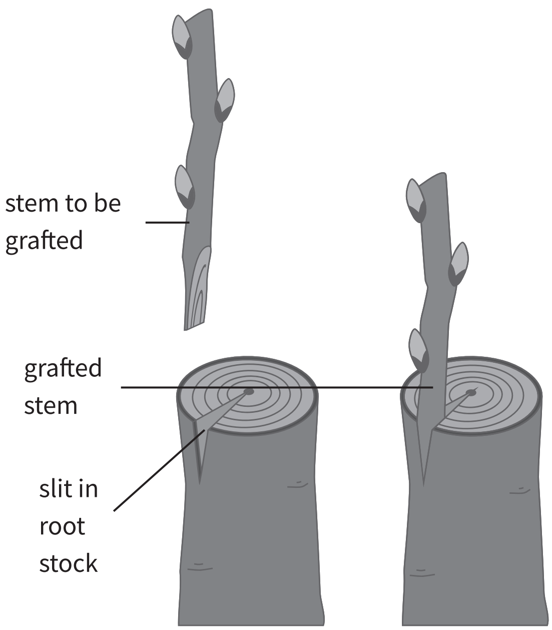
Extension

Sexual reproduction, discussed in this chapter is very important to plants and animals, as it introduces variation. Variation results in new genetic variety which is similar to the parental stock. This helps in species to adapt and survive harsh or unfavourable conditions.

2.4 Artificial asexual reproduction in plants

- The missing words are: natural, runners, bulbs, artificial, artificial propagation,, cuttings, grafting.
- **a.** Grafting

  b.

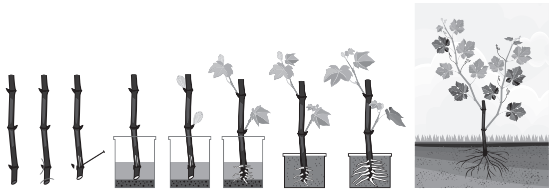


c. This type of artificial propagation may be carried out between plants of the same or related species, e.g. orange and lemon plants. When grafting is successful the two plants unite and the grafted piece sprouts. For grafting to work the transport vessels of both plants must be in direct contact so food and water moves easily between the two plants.

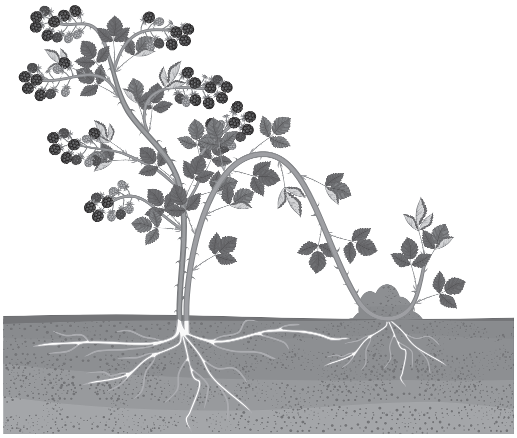
Many fruit trees including apples, oranges and lemons are reproduced in this way to give many identical fruit trees.

Extension

i. Taking cuttings: If you cut off a small section of a stem or root and put in a moist soil, it may produce roots and sprouts. In this way a new independent plant is produced. Plants such as sugar cane and cassava can be propagated by stem cuttings.



ii. Layering: In layering new roots grow from an area of a healthy stem. In ground layering a branch of a plant is bent down until it touches the ground, pegged in place and covered with soil. After some time, the portion of the branch under the soil grows roots. If this branch is cut off from the main plant, it develops into an independent plant. Blackberries and raspberries are examples of plants that are propagated by ground layering. Air layering, when roots grow from a cut stem in the air, is used to propagate plants such as mangos and bamboo.



2.5 Why is artificial propagation important?

1.

Natural asexual reproduction	Artificial asexual reproduction
bulbs	grafting
runners	budding
tubers	cuttings
	layering

2. **a.** An overall increase in yield.
   b. high yielding, high quality/high nutritional value, disease resistant.
   c. In general, as scientists people began to learn to propagate plants asexually artificially, they have used the information gained from sugarcane development, to grow more food and improve society. In Pakistan, new sugar cane plants are produced from sections of the best cane, improving the yield of sugar cane per hectare of land. They have also improved the way the land is fertilised and crops are watered foroptimum yield.

Extension

Encourage students to write the answer in their own words. They can also use the internet to search for more specific examples and applications and the institutions and scientists at the forefront of research.

3.1 The importance of digestion

1. **a.** Food is the fuel our body needs to carry out the reactions of life.
   b. Food gives us the building blocks we need to grow new tissues.
   c. Food gives us the building blocks to repair damaged tissues.
2. The missing words are: broken down/digested, carbohydrates, proteins, insoluble, cannot, cells, alimentary canal, broken down, soluble, blood.
3. Physical digestion is the process of breaking down food physically into smaller pieces by the teeth. This makes it easier to swallow and increases the surface area of the food ready for chemical digestion.
4. In chemical digestion the large insoluble food molecules are broken down into smaller, soluble molecules that can be carried around the body in the blood and used by the cells.

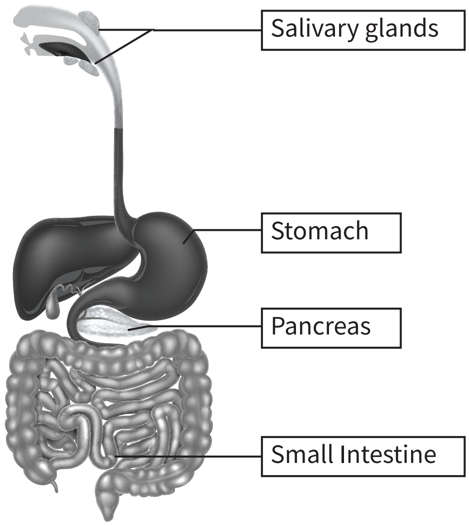
Extension

a. The surface area of a square is calculated by multiplying the length of the sides. The area of the square = length of side x length of side A square which has sides 10mm will have the area = 10 x 10 = 100 mm^2 or 100 square millimetres.

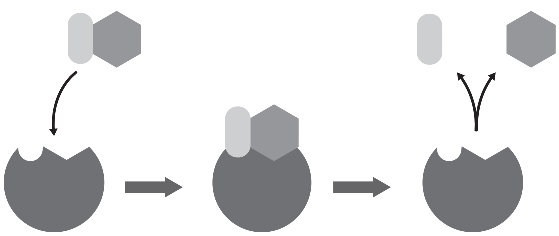
The surface area of a cube is calculated by working out the area of one side (a square) and multiplying by 6, because there are six sides! If sides of this cube are 10mm long, and the surface area of a cube has six identical sides so the surface area of the cube = 6 X 100 = 600mm^2
.

b. A large surface area makes it easier for the chemical digestion of the food as it moves through the alimentary canal. The physical digestion of our food results in it being chopped into small pieces by our teeth, drastically increasing its surface area. This helps in chemical digestion where the large, insoluble molecules of the main food types are chemically broken down into much smaller, simpler, soluble molecules for our bodies to use for energy, for growth and for repair.

3.2 The human digestive system



- **a.** An enzyme is a special protein produced by some parts of the alimentary canal. It is a biological catalyst that brings about the speedy chemical digestion of our food.
- **b.** Enzymes are biological catalyst that brings about the speedy chemical digestion of food in the alimentary canal.
- **c.**



Large food molecules bind to enzymes in the alimentary canal. The enzyme speeds up the breakdown of the large food molecule into smaller molecules which are used our bodies.

3.3 More about the digestive system

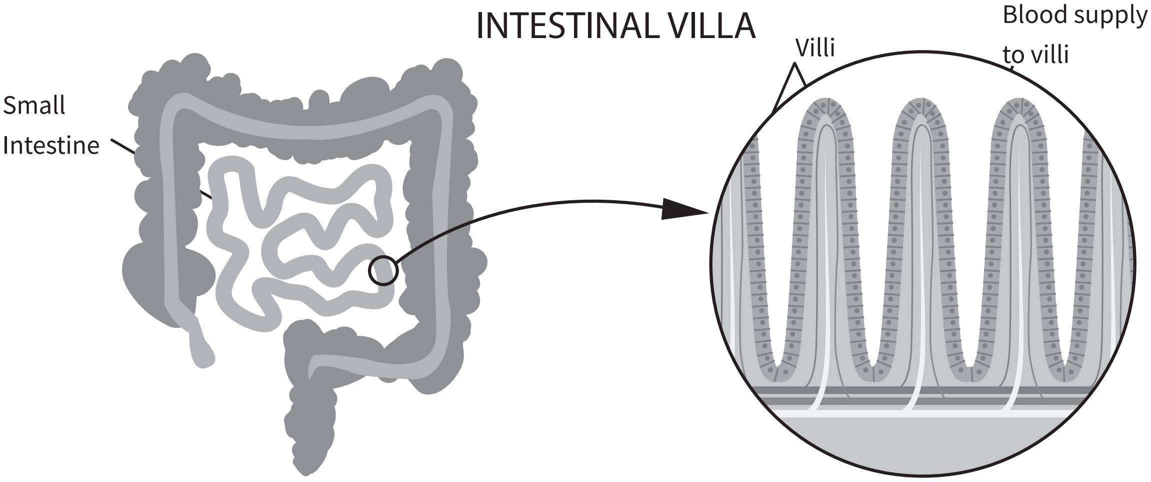
1.

Label	Name	Function
A	Liver	Large, purplish red organ which makes a yellowish-green liquid called Bile, which helps us digest fats and oils easily.
B	Gallbladder	Small bag located under the liver, which stores bile.
C	Bile duct	A small tube connected to the gallbladder and the small intestine. It carries bile from the gallbladder to the small intestine.
D	Small intestine	Long tubular part of the digestive canal, which makes enzymes to speed up food digestion, resulting in final breakdown of food. It also here that digested food is absorbed into the blood.
E	Oesophagus	The beginning of the alimentary canal, the Oesophagus carries the chewed mix of food and saliva down to the stomach.
F	Stomach	A bag of muscle which contains acid and an enzyme which starts to break down the protein in the food.
G	Pancreas	Leaf like organ which makes

2. a. Digestion is the process by which the food we eat is broken down into small, soluble, useful molecules that travel around our bodies in our blood to the cells that need them.

b. Egestion is also known as defecation, a process in which the undigested food is removed from the body. This waste is stored in the rectum, until it is passed out of the body through the anus, in the form of faeces.

Extension



3.4 Modelling the alimentary canal

- Sometimes it is not possible to do a practical investigation to understand a biological concept – more so as a biological system is alive and cannot always be experimented upon. In such cases models can help to test a hypothesis, answer questions, predict or to explain a phenomenon. Scientists can either make a physical model, or a computer model.

  However, there are limitations to how much can be explained by or understood from a model. This is because biological systems are complicated and there exists a lot of variation. So simple model may miss some important details. Additionally, since models make guesses about how things work, some of these guesses may not be correct.

- Encourage the students to attempt this questions based off of their own understanding of the topic.

4.1 The food we eat

1. A3; B4; C5; D2; E1

1. **a.** Carbohydrates. **b.** Fats. **c.** Carbohydrates and fats. **d.** Proteins and fats.

2. Fats are needed: for insulation, for making cell membranes, and as a source of energy.

3. digestive system; large, insoluble; small, soluble; diffusion; cells.

Extension

Their diet lacks protein so their growth may be slowed (stunted)/ if they get any injuries they will not heal easily.

4.2 Carbohydrates, fats, oils and energy

1.

Nutrient	Small molecules joined to make them
starches	sugars
proteins	amino acids
fats	fatty acids and glycerol

2. **a.** F; **b.** T; **c.** F; **d.** F; **e.** T
   - **b.** Glucose is an example of a **sugar/carbohydrate**.
   - **c.** Fats and oils contain **more** energy per gram than carbohydrates.
   - **d.** Each fat or oil has a different set of **fatty acids** attached to a glycerol molecule.

3.

Glycogen	Fat
a short-term carbohydrate energy store stored in our muscles and liver used for quick, instant energy	a long-term energy store stored in special cells under the skin and around the body organs broken down for energy over time if not enough food is eaten

Extension

All of these foods are high in fats and many are high in sugars. This combination often tastes very good, so we want to eat a lot of it BUT fats and sugars are very high in energy. It is easy to eat more of these foods than we need and our bodies store the extra energy as fat in our fat cells.

4.3 Measuring the energy in food - managing variables

1. **a.** Changed. **b.** Controlled. **c.** Controlled. **d.** Controlled. **e.** Measured. **f.** Measured. **g.** Calculated.

2.

Measuring instrument	Variable measured	Units used
thermometer	temperature	°C
measuring cylinder	volume	cm^3
electronic balance	mass	g

3. Any two from: a large amount of food would make the water boil (so she could not calculate an accurate temperature rise); some of the heat would escape around the sides of the test tube; pieces of burning food could fall off and be a hazard.

Extension

a. Bread produces a lower temperature rise per gram because it contains less fat than chicken or cheese.

Temperature rise (°C)	Temperature rise per gram (°C per gram)
30	20
46	46
66	33

b. Any two from: use the same mass of each type of food; make sure the initial water temperature is the same for each food type; repeat each experiment several times to find the mean temperature rise per gram; any other sensible suggestion.

4.4 A balanced diet

1. The missing words are: nutrient, proportions, proteins/lipids, lipids/proteins, minerals, rice, energy, fibre/water, water/fibre.

1. Chocolate is high in sugar which releases energy quickly but it also contains a lot of fats so it is very high in energy – eating a lot of chocolate to supply the carbohydrates you need would lead to weight gain because of all the energy in the fat. It does not contain many other important nutrients, e.g. protein. Any other sensible point.,

2. a. A model which shows the proportions of the different types of food that should be eaten in a balanced diet.

   b. **Bottom layer**: carbohydrates, e.g. bread, rice, pasta, etc. **second layer**: fruit and vegetables, e.g. banana, lemons, mangos, yams, etc. **third layer**: protein, e.g. meat (or specific meats), eggs, cheese, etc. **top layer**: fats and oils, e.g. butter, cream, different oils, etc.

Extension

Any three factors from: age, level of activity, climate where you are living, if you are pregnant, if you are ill, any other sensible suggestion.

For example, age: children need plenty of energy and a lot of protein, calcium, and vitamin D as they are growing new bone and muscle. Older people need less energy from food as they are less active but need plenty of minerals, vitamins,

and protein to keep repairing their body; young active people need plenty of carbohydrates to supply their energy needs. People in cold countries need more energy than those in hot countries to stay warm. Any other sensible points.

4.5 Diet, growth, and development

1. The missing words are: ill, explain, scurvy, deficiency, lack, vitamins, nutrients.

2. Anaemia – iron; night blindness – vitamin A; scurvy – vitamin C; rickets – vitamin D AND calcium.

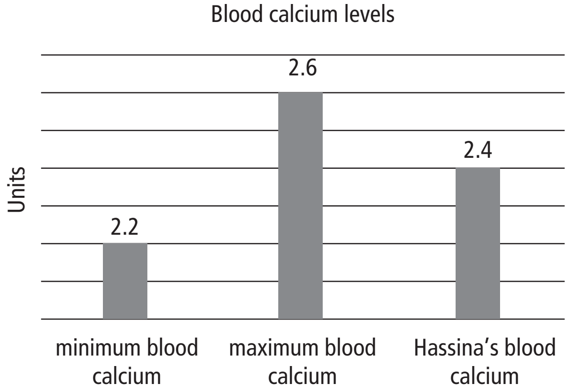
3. a. Hassina may have scurvy and anaemia.

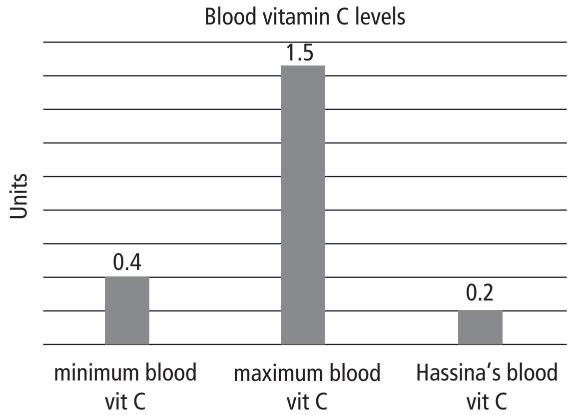
   b. Scurvy would cause bleeding gums, swollen legs, and a lack of energy. Anaemia would cause tiredness, weakness, and a lack of energy.

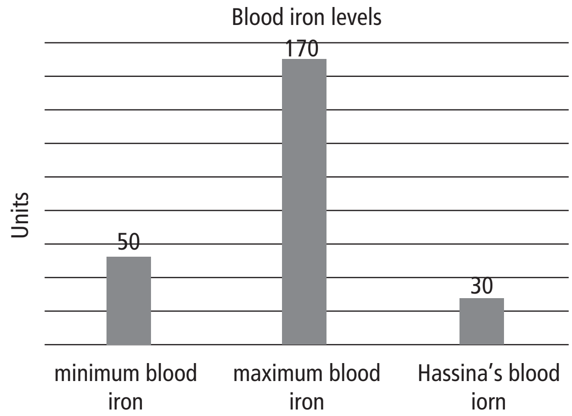
   c. Scurvy: eats lots of citrus fruits and tomatoes which are rich in vitamin C.
   Anaemia: eat food rich in iron, e.g. red meat, egg yolks, apricots.

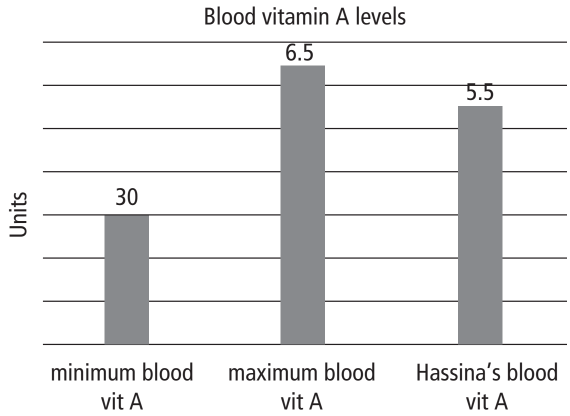
Extension

a.









b. The scales/amounts of the different substances are very different. If they were all on the same graph, you wouldn't be able to see the differences clearly.

c. Displaying the data on these bar charts makes it very easy to see whether Hassina's blood levels of the different minerals and vitamins come within the normal range.

4.6 Starvation, stunting, obesity, and health

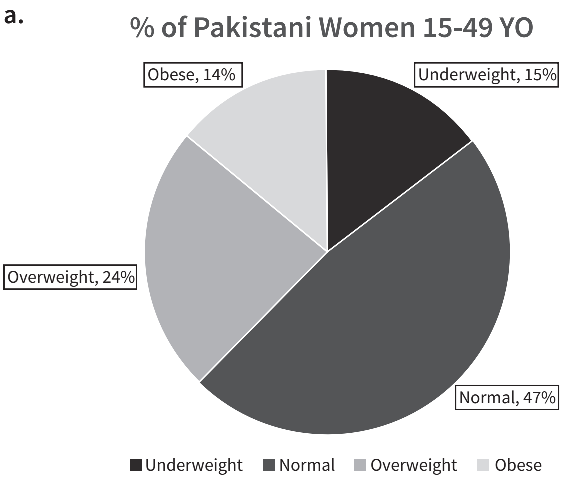
1. Underline: too thin; waste away; little; deficiency; fail to grow; do not; Starving; ill; is not; million.
2. The missing words are: body, obese, energy, fat, diabetes, blood, heart.
3. A3; B1/4; C2; D4/1
4. Diabetes: problems controlling the blood sugar levels which cause tiredness, circulation problems, blindness, and eventually death.

   Heart disease: fatty material builds up in the blood vessels which may cause a heart attack.

   Arthritis: weight causes strain on the skeleton leading to wear and pain in the joints.

4.7 The problems of wasting and obesity in Pakistan

1. a.



   b. Being underweight or overweight affects overall health, fitness and well-being. Lack of food, wasting and stunting is most common in very young children. In adult women being overweight is more of a problem than being underweight.

   Being underweight means a person does not have enough food to eat, is very thin and at risk of deficiency and other diseases because the body does not have the raw materials it needs.

   Being overweight or obese indicates a person is eating more food than the body needs, which gets stored as fat. Obesity increases the risk of many diseases including diabetes, heart disease and some cancers.

2. healthy (the right weight and height for their age), underweight (do not weigh as much as they should for their age), stunted (are not as tall as they should be for their age), wasted (do not weigh enough compared to their height, and are very thin with little muscle), overweight (weigh too much for their height).

Extension

When adults and children suffer from malnutrition, the effects differ in both due to growth stages, ability to absorb and use the food, and individual circumstances. In children, during childhood, the body is rapidly growing and developing and requires proper nutrition to build bones, muscles, and organs. Lack of essential nutrients results in stunted growth, delayed or disturbed brain development, immune system function, and overall health. Some children may suffer from improper nutrition but end up overweight due to improper food provided by their adult caretakers.

In adults, growth has largely completed, and body requires nutrition for repair and maintenance. This means that malnutrition in adults affects existing tissues (muscles, fat, etc.) resulting in them becoming thin or overweight.

4.8 Some major digestive disorders

1. The missing words are: alimentary canal, health, Pakistan, millions, adults, diarrhoeal diseases, infections, ulcers, cancers.
2. a. Diarrhoeal diseases are caused by faecal bacteria. The reason handwashing is essential to prevent the spread of diarrhoeal diseases is because washing hands with soap and water several times a day – especially after going to the latrine, and before preparing or eating food, helps to remove

these bacteria from our hands. This prevents the bacteria from spreading from one person to another and from infecting the alimentary canal.

b.

Extension

The 3 lifestyle factors which can increase the risk of alimentary cancer in humans, include, the use of Tobacco, lack of fiber in the diet, and obesity. In order to reduce the risk of alimentary cancer(s), we must:

- Quit smoking and avoid second hand smoke.
- Increase the amount of dietary fiber intake.
- Avoid obesity through exercise and change sin diets, such as reduce red and processed meats, increase healthy fats, reduce or avoid, sugar, sugary drinks and alcohol.

4.9 Health and inequality

You need to provide a piece of clear writing, including reference to scientific understanding in populations helping to solve issues linked to diet, the difference between deficiency diseases and starvation which are not usually a choice, and diseases linked to obesity which often do link to lifestyle choices, etc.

5.1 The particle model

1. Materials, particles, mixtures, substances, sugar/silver, sugar/silver.
2. Particle separation – why 1 g of ice takes up less space than 1 g of steam; particle mass – why a gold coin is heavier than a silver coin of the same mass; if and how the particles move – why liquid water flows but solid rock does not flow; how strongly the particles hold together – why gold is easier to scratch than diamond.

Extension

Substances only – **B**, **C**.
Materials and substances – **A**, **D**, **E**.

5.2 The states of matter

1. Three, gas, gas, liquid, gas.
2. **a.** Particles arranged in rows, touching their neighbours.
   b. Vibrate on the spot.
3. Particles should touch their neighbours and the bottom of the container.
4. All – **A**.
   Gases and liquids – **C**, **F**, **G**.
   Solids and liquids – **D**, **E.**
   Gases only – **B.**
   Solids only – **H**, **I.**

Extension

a. **R** – the particles move around, sliding over each other all the time, so you can pour a liquid.
b. **Q** – the particles are always touching each other, so a given mass of liquid cannot get bigger (assuming the temperature does not change).

5.3 Using the particle model

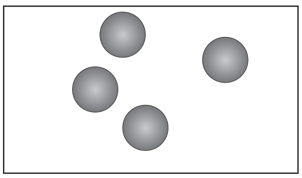
1. a. i. The size and shape of each frozen lump of carbon dioxide remains the same.

   ii. To remain in solid shape, carbon dioxide must be kept cold.

   b. i. In gas state, carbon dioxide molecules spread out into the container (or the air if it is not kept inside a container).

   ii. Carbon dioxide at room temperature is in gaseous state.

   c. It is used to keep vaccines cold.

2. 

3. In the solid state, a substance has a fixed shape. : The particles are in fixed positions.

   In the solid state, you can compress a substance only a tiny bit. ; In the liquid state, a substance takes the shape of the bottom of its container. : The particle touch each other.

   In the gas state, a substance flows.; In the liquid state, a substance flows. : The particles move around.

   In the gas state, you can compress a substance a lot.; In the gas state, a substance takes the shape of its whole container.: The particles spread out to fill all the available space.

Extension

a. For example, if a gas has a smell, you can smell it quickly across a room.

b. b. For example, if you put a powder on the surface of liquid water and observe through a microscope,the pieces of powder move around.

c. For example, the shape of a substance does not change in the solid state.

d. For example, if you melt a block of ice and then heat the liquid water until it has all evaporated, the steam takes up more space than the ice.

5.4 Diffusion

1. The correct words/phrases are: move randomly in all directions; change direction; spread out; many; few; diffusion; by itself.

2. **i.** B; **ii.** C; **iii.** A.

3. a. Diffusion happens more quickly at higher temperatures, because the increased temperature provides more energy to the particles which begin moving faster.

   b. This happens because the particles in gas move faster than particles in liquid state. Conversely, the particles in liquid form have less energy than particles in gas form and so they move slower.

   c. Because the particles in solid cannot move from place to place.

Extension

a. Students can refer to the TWS pages in the beginning of the book to research and provide answers. Amount of liquid, size of crystal, observation time for each test tube, are some of the possible correct answers.

b. C. Due to the higher temperature.

c. Using smaller sized crystals or increasing the water temperature.

5.5 Evidence for the particle model

1. The missing words are: bigger; air; all; smaller; greater; stops.

2. In the liquid state, particles move fast and randomly all the time. : If you dissolve salt in water and drink it, you can taste salt in every sip.

   In the gas state, particles spread out to fill the whole available space. : If you blow up a balloon, it gets bigger.

A substance in the solid state is made up of particles.
: If you look through a microscope at pollen in water, the pollen particles appear to jiggle around.

Extension

According to the particle model of matter, the liquid particles are in in constant motion, which indicates that they have energy. During evaporation, particles require energy to escape the surface and change state to gas. Therefore, since seawater is primarily composed of water with dissolved salts, and only salt is left behind, this proves that as stated in the particle theory, the seawater also consists of particles. It further illustrates that as water particles evaporate, the dissolved salt particles in the seawater are left behind. They in turn, come closer to each other and form crystal solids, which are observed.

5.6 Some changes of state

1. True– b, d; False– a, c.

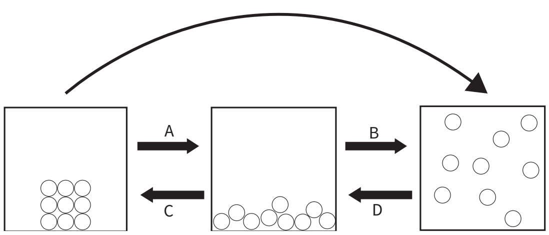
   Corrected false statements:

   a. Condensing is the change of state from gas to liquid.

   c. When a substance changes state from liquid to gas, its particles get further apart.

2. **a.** D; **b.** B;

   c.



3.

	True of evaporation only	True of boiling only	True of both evaporation and boiling
This involves a change of state from a substance in its liquid state.			✓
Particles leave the surface of the liquid only.	✓		
Bubbles of the substance in its gas state form throughout the liquid.		✓	
This can happen at any temperatue.	✓		
During this change of stae, the praticles get further apart.			✓

Extension

a. Methane.

b. Ethane, methane.

c. Hexadecane.

5.7 Investigating boiling temperatures

1. Hypothesis – a possible explanation that is based on evidence and that can be tested further; anomalous result – a piece of data that does not fit the pattern in a series of results;
   conclusion – a description of what an experiment shows, with an explanation.

2. **a.** • Pour a known volume of water into a beaker, place on a tripod and gauze, heat with a Bunsen burner, use the thermometer to measure the boiling temperature, record the temperature in a table.

- Get a fresh beaker of the same volume of water, add one spoonful of salt, stir until the water dissolves, repeat the step above
- Repeat the first two steps above with 3, 4, and 5 spoonfuls of salt.
- Plot a graph of the results.
- Look at the graph – if the boiling temperature increases as the amount of salt increases, her hypothesis is correct.

b. **i.** Data plotted correctly.

ii. Point at (3, 101).

iii. As amount of salt increases, boiling temperature increases.

iv. For example, use a balance to measure mass of salt.

5.8 More changes of state

1. Solid, liquid, move out of, move around, touch each other, strongly.

2. **a.** Sodium.

b. Sodium, lead, copper, manganese, iron, chromium.

c. Copper.

Extension

a. **i.** water; **ii.** mercury

b. Horizontal scale from approximately –120 °C to +360 °C, with divisions evenly spaced.

c. Melting points and boiling points correctly plotted on the scale, all labelled with name of substance and whether it is a melting point or boiling point.

d. **i.** gas

ii. liquid

iii. mercury

5.9 Models in science

1. **D**

2.

	This is a strength of the particle model	This is a limitation of the particle model	This can be a strength or a limitation
The particle model explains why some properties of a substance are different in the liquid and gas states.	✓		
In the particle model, each particle is a sphere.		✓	
The particle model cannot explain all properties.		✓	
The particle model explains why different substances have different melting points.	✓		
Some predictions made with the particle model are not correct.		✓	
The particle model is simpler than reality.			✓

3. For example:

   Better – tomato model 3D; can move tomatoes to represent changing movement and positions of particles in changes of state.

   Worse – difficult to arrange tomatoes in regular pattern to represent solid state; difficult to hold tomatoes in positions far apart to represent particles in gas state.

6.1 Elements and Compounds

1. True – a, d; False – b, c, e, g.

   Correct versions of false statements:

   b. An element cannot be split up to make other substances.

   c. There are about 100 elements.

   e. In the periodic table, metals are on the left of the stepped line.

   g. Most materials are made of different combination of substances.

2. Elements – gold, copper, vanadium, iodine, oxygen, chlorine.

3. **a.** Hydrogen, helium.

   b. Nitrogen.

   c. Carbon.

   d. Silver.

   e. Iron.

   f. Platinum.

   g. Carbon, Calcium, Chromium, Cobalt, Chlorine.

Extension

a. Encourage students to research using the internet and share their findings with the class

6.2 Metal and non-metal elements

1. Properties of solid metals: Good conductor of electricity; Malleable; Good conductor of thermal energy; Ductile; Shiny; Sonorous

   Properties of solid non-metals: Not shiny; Poor conductor of thermal energy; Brittle.

2. Calcium; Carbon; Chlorine; Sulfur.

3. **a.** B; **b.** B and D, as they are both good thermal conductors and shiny in solid state; **c.** A and C,

Extension

Encourage students to create logical sets of questions and answers and share them with the class.

6.3 Chemical symbols

1. **a.** Mg

   b. Be

   c. Fe

2.

Name of element	chemical symbol
hydrogen	H
helium	He
lithium	Li
beryllium	Be
boron	B
carbon	C
nitrogen	N
oxygen	O
fluorine	F
neon	Ne

3.

Chemical symbol	Name of element
Na	sodium
Mg	magnesium
Al	aluminium
Si	silicon
P	phosphorus
S	sulfur
Cl	chlorine
Ar	argon
K	potassium
Ca	calcium

4. Re V I Si O N I S Ne Ce S S Ar Y – revision is necessary.

Extension

a. P

b. Cl

c. Be

6.4 Atoms

1. True– **a**, **c**, **e**, **f**.
   False– **b**, **d**, **g**.
   Corrected versions of false statements:
   b. A model is an idea that explains observations and helps in making predictions.
   d. One copper atom on its own does not have the same properties as a block of copper.
   g. Platinum and silver atoms are different.
2. **a.** B, C, D, F
   b. A, E
   c. C, D
   d. B, F
   e. C, D

Extension

10 000 000 000 000

6.5 Molecules

1. True: b, d, e, g; False: a, c, f, h.

   Correct versions of false statements:
   - A molecule is any particle made up of two or more atoms, strongly joined together.
   - All metal elements do not exist as molecules; some exist in their elemental form as individual atoms, e.g. gold and silver. Most exist as crystals.

   f. A sulfur molecule is made up of 8 atoms.
   h. Elements that exist as giant molecules have high melting points.
2. Oxygen, Bromine, Hydrogen.

Element	Melting point (°C)
A	3550
B	−7
C	−220
D	−189

3. - C
   - B, C, D.
   - A.

Extension

Encourage students to create logical sets of questions and answers and share them with the class.

6.6 Discovering the elements

1. **a.** **i.** Three from – copper, silver, gold, iron, tin, lead, carbon, sulfur.
   ii. Because they exist naturally on their own.
   b. **i.** hydrogen, nitrogen, oxygen, chlorine.
   ii. They are reactive and form stable compounds, which couldn't be broken up until 1700s.

Extension

a. No other known element had the same properties.
b. Difficult to communicate over great distances in the early 1800s.
c. Different samples of cast iron had different properties.

6.7 Compounds

1. Two, strongly, different, two, strongly.
2. Hydrogen – gas, burns easily; oxygen – element; water – compound, liquid, puts out fires.
3. **a.** An idea that explains observations and helps in making predictions.
   b. Strengths – 3D, making it easier to picture molecules; shows arrangements of atoms in molecules; atoms of different elements easy to distinguish because they are different sizes and colours.

   Weaknesses – not easily transportable; expensive; waste of food.

Extension

a. A, C

b. A, D

c. C

d. D

6.8 Naming compounds

1. **a.** Magnesium oxide.
   b. Iron sulfide.
   c. Aluminium chloride.
   d. Iron bromide.
   e. Potassium iodide.
   f. Sodium nitride.
2. **a.** Calcium, carbon, oxygen.
   b. Iron, sulfur, oxygen.
   c. Sodium, nitrogen, oxygen.
   d. Potassium, phosphorus, oxygen.
3. **a.** Sodium carbonate.
   b. Magnesium nitrate.
   c. Copper sulfate.
4.

Molecule of compound made up of...	Name of compound
1 atom of carbon and 2 atoms of oxygen	carbon dioxide
1 atom of carbon and 1 atom of oxygen	carbon monoxide
1 atom of nitrogen and 2 atoms of oxygen	nitrogen dioxide
1 atom of sulfur and 3 atoms of oxygen	sulfur trioxide
1 atom of sulfur and 2 atoms of oxygen	sulfur dioxide

Extension

a. Carbon dioxide.

b. Carbon monoxide.

c. Sulfur trioxide.

6.9 Chemical formulae

1. **a.** 2, 1; **b.** 2; **c.** 2, 1
2. Iodine – I_2 ; dinitrogen tetroxide – N_2O_4; carbon monoxide – CO; carbon dioxide – CO_2; sulfurtrioxide – SO_3.
3. **a.** H_2O; **b.** CO_2; **c.** O_2
4. Potassium iodide – KI; lithium oxide – Li_2O; sodium nitrate – $NaNO_3$; calcium sulfate – $CaSO_4$; magnesium carbonate – $MgCO_3$.

Extension

a. 13 carbon atoms, 21 hydrogen atoms, 1 nitrogen atom, 3 oxygen atoms.

b. 13 × 5 = 65 carbon atoms; 21 × 5 = 105 hydrogen atoms; 1 × 5 = 5 nitrogen atom; 3 × 5 = 15 oxygen atoms.

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6.10 Elements and compounds in daily life

1. The two properties that make aluminium suitable for making cups are: Aluminium is shiny. And it can be made into different shapes.

2.

Substance	Is the substance an element or compound?	Use of the substance
Platinum	Element	as convert in cars
sodium chloride	Compound	as salt is food
nitrogen	Element	commen in atmosphere
sucrose	Compound	from of sugar
iron (in steel)	Compound	make tools and structures
graphite (a type of carbon)	Element	pencil leads

3. Encourage students to share logical answers based on scientific logic, for parts a and b.

Extension

Copper is used to make wires due to these three properties: good conductivity, malleability, and ductility.

6.11 Making compounds

1. The correct words/phrases are: chemical; rearranged; differently; stays the same; reactants; products.
2. a. The arrow means 'reacts to make', it indicates the direction of the reaction.
   b. iron; sulfur.
   c. iron sulfide.
3. a. Sodium; Chlorine.
   b. Sodium chloride
   c. sodium chloride
4. a. Calcium bromide
   b. Potassium
   c. Oxygen

Extension

a. Lithium + Chlorine → Lithium chloride

b. Magnesium + Sulfur → Magnesium sulfide

c. Nitrogen + Oxygen → Nitrogen dioxide

d. Aluminium + Iodine → Aluminium iodide

e. Zinc + Oxygen → Zinc oxide

f. Sodium + Water → Sodium hydroxide + Hydrogen

6.12 Investigating a chemical reaction

1. From top – hypothesis, prediction, conclusion.
2. a. 27 g – 25 g = 2 g
   b. Colour change from green solid to black solid.
   c. One of the products, carbon dioxide, leaves the test tube as a gas as it is made.
   d. 26 g – 25 g = 1 g
   e. 2 g – 1 g = 1 g
   f. The mass of solid product is less than the mass of solid reactant because one of the products (carbon dioxide) forms as a gas that leaves the test tube.

7.1 Mixtures

1. True – **c**, **e**.
   False – **a**, **b**, **d**.

   Corrected versions of false statements:

   a. The different substances in a mixture are not joined together.

   b. You can change the amounts of substances in a mixture.

   d. In a mixture, the substances keep their own properties.

2.

Mixture	Mixture of elements only	Mixture of compounds only	Mixture of element(s) and compound
nitrogen and oxygen	✓		
sodium chloride (salt) dissolved in water		✓	
chlorine dissolved in water			✓
nitrogen, oxygen, and carbon dioxide			✓

3. **a.** B
   b. C
   c. A
   d. D
   e. E

Extension

Mixture of elements and compounds.

7.2 Comparing elements, mixtures, and compounds

1. An element, cannot, element, compound, different.

2.

	Mixtures of elements	Compounds
Can it easily be separated into its elements?	yes	no
How do its properties compare to those of its elements?	similar	not similar
Are its elements joined together?	no	yes
Can you change the amounts of each element in 100 g of the mixture or compound?	yes	no

3. **a.** E
   b. B
   c. A
   d. C
   e. D

Extension

Paragraph covering the points in the table in question **2**.

7.3 Comparing pure substances and mixtures

1. One type, elements and compounds, nothing mixed with it, is.

2. **a.** Sample **A** is a pure substance because its temperature does not change while it freezes.
   b. 60 °C

Extension

a. Similarities – both may include an element or a compound.
b. Differences – a pure substance consists of one substance only, but an impure substance is a mixture of substances.

7.4 Inside mixtures: solutions

1. Solute – a substance that dissolves in a liquid to make a solution;
solvent – the liquid that a substance dissolves in;
solution – a mixture made when a substance dissolves in a liquid;
dissolving – the processes of adding a solid to a liquid so that you can no longer see separate pieces of solid;
soluble – able to dissolve;
insoluble – when a substance cannot mix with a liquid to make a solution.
2. A – sugar particles are randomly positioned and mixed with and surrounded by water particles.
3. 250 g + 10 g = 260 g

Extension

Name	Correct or incorrect?
Komal	correct
Rehan	incorrect – the solution is a mixture of two compounds
Mariam	correct
Kiran	incorrect – copper sulfate is soluble in water
Parveen	incorrect – copper sulfate is the solute and water is the solvent
Rida	correct

7.5 Inside mixtures: Alloys

1. True– **b**, **c**, **f**.

   False– **a**, **d**, **e**.

   Corrected versions of false statements:

   a. An alloy is a mixture of a metal with small amounts of other elements.

   d. Most alloys are stronger than the elements that are in them.

   e. Most alloys are harder than the elements that are in them.

2. **a.** In pure iron, the atoms are arranged in straight rows. In steel, the straight rows are disrupted by the presence of smaller, randomly placed carbon atoms.

   b. The iron atom layers cannot slide over each other easily in steel, but they can slide over each other easily in pure iron.

Extension

a. Differences – the alloy is almost five times harder than pure titanium, the alloy is about four times stronger than pure titanium; similarities – both are shiny and both are not damaged when exposed to air or water.

b. The alloy is stronger because the different-sized aluminium and vanadium atoms disrupt the layers of titanium atoms, meaning that the layers of atoms can no longer slide over each other easily.

7.6 Inside mixtures: The Air

1. True: a, b; False: c, d, e.

   Correct versions of false statements:

   c. Approximately 21% of the air is oxygen.

   d. Carbon dioxide makes up 0.04% of the air.

   e. Approximately 1% of the air is Argon.

2.

Substance	Is the substance an element or compound?	Use of the substance
nitrogen (gas state)	Element	To keep food fresh.
nitrogen (liquid state)	Element	To freeze things; medically to freeze and remove warts.
oxygen	Element	Required for respiration.
argon	Element	Required during welding processes to prevent metal from reacting with oxygen.
carbon dioxide	Compound	Required for photosynthesis.

Extension

a. Hydrogen.

b. 98%

c. The biggest difference between the atmospheres of Earth and Uranus lies in the majority gas present in each. In Uranus' atmosphere Hydrogen is present in the greatest percentage, whereas on Earth, Nitrogen is the gas present in the largest amount. In Earth's atmosphere, Oxygen is the second abundant gas at 21%, whereas in Uranus' Helium is the second abundant gas at 15%. These combinations of gases result in very different atmospheres: Uranus's atmosphere is more volatile than Earth's atmosphere.

7.7 Separating mixtures: Filtration and Evaporation

1. The correct words/phrases are: evaporation; salt; copper sulfate; solvent; solute.
2. F: a, c, d. Evaporation is required for b. And for d, straining may also be an option.
3. **a.** A solution of salt and water.

   b. Ground up rocks.

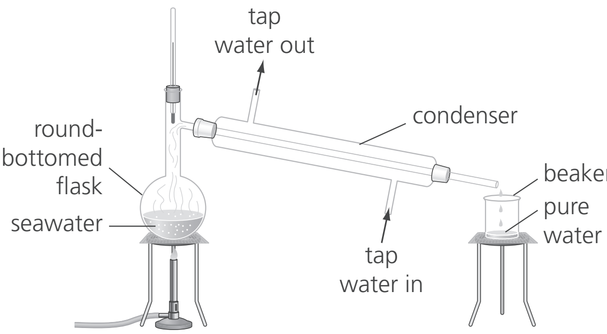
   c. **i.** C;

   ii. D;

   iii. Mass of original sample of rock salt = 100 g.
   Mass of waste (rock) filtrate = 20 g.

   100 – 20 = 80 grams mass of Salt.

7.8 Separating mixtures: Distillation

1. Salt – solute;
   seawater – solution;
   water – solvent.
2. Pure, seawater, seawater, evaporates, condenses.
3. 

Extension

For example, it is expensive to obtain tap water by distillation because the energy costs are high.

7.9 Separating mixtures: Chromatography

1. **B**, **D**, **F**, **A**, **C**, **E**
2. **a.** B.
   b. Because the ink spots are at the same heights as the sample from pen B.
3. **a.** For example – in the production of some COVID-19 vaccines; to test clothes and luggage for explosives; to identify food nutrients.

Extension

Chromatogram, three, blue, more, least.

8.1. What is energy?

1. Missing words in order: energy, food, energy, food/ fuel, fuel/food, joules, 1000, joules.
2. **a.** Oil.
   b. Wood.
   c. Energy = 20 kJ = 20 kJ × 1000 = 20 000 J
   d. Wood has ⅓ of the energy per g, so mass needed = 3 g
3. **a.** Your body needs energy to keep process like breathing or digestion going, even when you are not moving.
   b. 4 minutes
   c. Children need energy to grow as well as the energy the use for the activities they do each day.

Extension

a. Variables to control: mass of food, volume of water.

b. I predict that food with more energy will cause a greater increase in the temperature of the water.

c. Some of the energy is transferred to heat to the surroundings.

d. His value will be smaller than the actual value of the energy stored, because his experiment is not perfect and some energy will not be transferred to the water, but transferred to the surroundings.

8.2 Asking questions: Energy

1. **a.**

prediction	possible explanation for what will happen
hypothesis	what you think will happen
data	measurements or observations

   b. C, D, A, E, B
2. **a.** The volume of biofuel and water used in all the tests is the same.
   b. Methanol, ethanol, dry wood, green wood.
3. **a.** How does the material that a ball is made from affect the height it will bounce?
   b. Different materials deform by different amounts and will store different amounts of EPE.
   c. Any suitable answer, but must include: material of the ball, height of bounce.

Extension

a. Investigation A: How does the volume of liquid used affect the temperature change in water?

Investigation B: How does the type of surface a ball is dropped onto affect the height of the bounce?

b. Investigation A: type of liquid fuel, volume of water, time heated. Investigation B: the ball, height the ball is dropped from.

8.3 Energy stores and transfers

1. **a.** Correct words in order from top to bottom: lifted up, speed up/slow down, thermal, spring, chemical.
   b. Electric current, heating, forces, radiation.
2. **a.** Kinetic store/forces.
   b. Kinetic store/gravitational potential store/forces.
   c. Sound.
   d. Light.
   e. Kinetic store/gravitational potential store/forces.
   f. Chemical store.

Extension

a. **1.** The reaction that produces energy in the Sun is a nuclear reaction.
2. Nuclear fusion happens when hydrogen atoms combine to form helium.
3. Nuclear fission happens when elements, like uranium, break down.
4. The fuel in a nuclear power station is usually uranium.

b. The Sun cannot be a huge ball of fire as fire needs oxygen to burn and there is no oxygen in space.

8.4 Energy transfer diagrams and dissipation

1. **a.** T **b.** F **c.** T **d.** F
2. Correct answers in order: First row: chemically, light, thermally. Second row: more, fewer. Third row: cooler, warmer.
3. **a.** Food or fuels
   b. Stretched or compressed spring, elastic band.
   c. Using your muscles, gravity.

Extension

a. **i.** Eating breakfast and walking to school: energy stored chemically (food) ⟶ energy stored kinetically, energy stored thermally, transferred by forces.
ii. A ball rolling up and down a hill: energy stored kinetically ⟶ energy stored gravitationally and energy stored thermally, transferred by forces
iii. A candle burning: energy stored chemically ⟶ energy stored thermally, transferred by light
iv. A loudspeaker in a television: energy stored chemically (fuel in power station) ⟶ energy stored thermally, transferred by an electric current and by sound.

b. e.g. Photosynthesis – when a plant transfers energy from a nuclear to chemical store.

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8.5 Gravitational potential energy and kinetic energy

1.

	GPE	Kinetic energy
Energy that something has because of its position.	✓	
Energy that something has because of its movement.		✓
This gets bigger if an object is higher off the ground.	✓	
Is measured in joules.	✓	✓
A fast-moving elephant has lots of this.		✓
A walking mouse has less of this than the elephant.	✓	✓

2. **a.** A **b.** F **c.** B
   d. No – the marble would need more energy to reach a higher point than it has at the start. Energy cannot be created, so it would not reach a higher point.
   e. Energy has been transferred by sound and is stored thermally.

3. **a.** Gravitational potential energy is transferred to kinetic energy as the ball falls and speeds up. When the ball lands the kinetic energy is transferred back to GPE and some is transferred by sound and stored thermally in the surroundings.
   b. **i.** A **ii.** C **iii.** A

8.6 Planning: Pendulum motion

1.

A longer pendulum has a longer period because it has further to travel.	✓
A longer pendulum is better than a shorter pendulum.	

2. **a.** He has not included units.
   b. Any suitable answer: e.g. repeating measurements, ensuring other variables are controlled.
   c. Any suitable answer. Students should clearly state the dependent and independent variables, controlled variables and what they are testing.

Extension

a. You can do preliminary work.

b. Any suitable answer: Preliminary work ensures you are testing the right range of variables and that your experiment will work.

8.7 Elastic potential energy

1. **a.** F **b.** T **c.** F **d.** F **e.** T **f.** T
   b. When materials deform **energy is stored elastically.**
   c. The springs in a mattress will store **more** potential energy if someone heavier sits on it.
   d. If something **does** return to its original shape when we remove the force, we say it is elastic.

2. **a.** As the student stretches the elastic band it gains elastic potential energy as it shape changes. When she lets the band go, the elastic potential energy is transferred to into kinetic energy.
   b. D, C, A, B
   c. If the band is pulled back further it will gain more elastic potential energy, so the band will move further when it is released as there is more elastic potential energy that can be transferred to kinetic energy.

Extension

a. A ball will never bounce higher than the height you drop it from as it cannot gain energy / energy is always lost to the surroundings as the ball falls/bounces..

b. The student expected the result as the height of the drop was being doubled, and so she expected the height of the bounce to also double. When you double the height of the drop, the height of the bounce is less than double.

8.8 Conservation of energy

1. Correct words in order: created or destroyed (either order), transferred or stored (either order), conservation, money, the same, types.
2. Correct answers in order: useful, wasted, wasted, useful.
3. **a.** Correct answers in order: 20%, 50%.
   b. The kettle wastes energy heating the air. The radio wastes energy by heating the air.
   c. Kettle, a higher percentage is transferred to useful energy.

Extension

a. Correct answers in order: 30, 500, 1000, 10
b. The law of conservation of energy states that energy can never be lost or gained, so the total energy is always equal to the useful energy and the wasted energy.
c. A – less energy is wasted.
d. C – more energy is wasted.

8.9 The world's energy needs

1. **a.** Hydroelectric.
   b. Coal, oil, gas, nuclear.
   c.

Fuel	Percentage use in 1971	Percentage use in 2015	Percentage change in use
coal	40	41.3	1.3
oil	20.9	21.9	1
gas	13.3	4.8	−8.5
nuclear	2.1	11.7	9.6
all renewables	23.7	20.3	−3.4

   d. In order: gas, hydroelectric, oil, coal, nuclear.
   e. He isn't correct, all renewables have decreased.
   f. Gas.
   g. One of the following: solar power, biomass, wind power, tidal power, wave power, geothermal power.

Extension

a. 44 years

b.

Percentage change per year
+0.030
+0.023
−0.19
+0.22
−0.077

8.10 Non-renewable resources: Fossil fuels

1. Missing words in order: trees, millions, mud, rock, compressed, millions, mud, trees.

2.

	True for coal	True for oil	True for both
Took a very long time to form.			✓
Made from trees.	✓		
Made from sea creatures.		✓	
Can be found underground.			✓
Formed as a result of heat and pressure			✓

3. a. C, B, D, A, E

   i Oil is used to make petrol, which is used in cars.

   ii Coal is burned in a fireplace to heat houses.

   iii Oil can be used in a central heating system, in a stove.

Extension

a. Students' own answers: e.g.

Advantages	Disadvantages
very reliable	produces carbon dioxide
fossil fuels readily available	contributes to climate change
electricity produced constantly	produces pollution

b. It is not possible to predict when fossil fuels will run out because our use of them is always changing and we do not know if we will find more deposits.

c. Fossil fuels take millions of years to form under high temperatures and pressures so it is not possible to make more of them.

8.11 Renewable resources: Solar energy and geothermal

1. a. Missing words in order: Sun, light, light, voltage, closer, brighter, renewable.

   b. Missing words in order: light, water

   c. Missing word: greenhouse.

   d. Missing word: dark.

2. a. Clockwise from the top: generator, hot water, cold water.

   b. Geothermal power stations do not produce carbon dioxide when they are running, but lots is produced while they are being built, so they do contribute to climate change.

   c. The best place to put a geothermal power station is where the Earth's crust is thinner, so the warm magma is closer to the surface.

3.

Advantage or disadvantage	Solar	Geothermal	Both
It is unreliable.	✓		
It doesn't produce much carbon dioxide when running.			✓
It is expensive to produce/build.			✓
It won't run out.			✓

8.12 Renewable resources: Water and wind

1.

Hydroelectricity …	… can destroy habitats when valleys are flooded.
When water falls through turbines in a dam …	… electricity (called hydroelectricity) is generated.
A tidal barrage contains turbines and generators …	… to generate electricity when the tide goes out.
Wind turbines produce carbon dioxide …	… when they are being manufactured.
When water moves into a chamber on a shoreline …	… electricity is generated by wave power.

2. **a.** Correct points plotted.
   b. Correct line of best fit.
   c. 5 km/h
   d. 1170 watts
   e. Approximately 400 watts.
   f. Wind power does not produce any greenhouse gases when it is operating.

Extension

a. Waves vary a lot.

b. Wind.

c. Any suitable answer: Wind power is unreliable, there can be days when there is no wind at all.

d. Any suitable answer: The power output of the largest power station is quite low, and there are few suitable places to build tidal power stations.

8.13 Renewable resources: Biofuels Energy and bioplastics

1. Words in this order: oil, long, plants, biofuels, renewable.

2. Biodiesel comes from plant oils.

   Bioethanol comes from sugar.

   Biogas comes from landfill sites.

3. **a.** **i.** A **ii.** D **iii.** A **iv.** A
   b. e.g. fossil fuel power stations can be adapted to use biofuels.
   c. e.g. most cars are not designed to run on biofuels/a lot of land is needed to grow biofuels.

Extension

a. They are all plants so use the same amount of energy from the Sun.

b. Palm oil, it has the biggest energy output.

c. Energy output of palm oil is 200 (gigajoules per hectare), and for soybeans is 50 (gigajoules per hectare).

You need $\frac{200}{50}$ = 4 times as much soybeans as palm oil, so 4 kg.

9.1 Charging up

1. Positive/negative, negative/positive, electrons, conductors, iron, insulators, plastic.

2. **a.** Positive.
   b. The diagram shows more positive symbols on the rod than negative charges.
   c. Minus at the top of the piece of paper.
   d. The paper will be attracted to the rod if it is negatively charged
   e. The paper has an opposing charge to the rod, so it will be attracted to the rod.

3. a. i. Positive.
   ii. The paint will be attracted to the car.
   iii. It is cleaner and more efficient as the paint is attracted to the car and will not go everywhere OR the paint droplets repel each other (since they are all positive) so you get a more even spread of paint.
   b. Positive.

9.2 Dangers of electricity

1.

Cell	Bulb brightness	Current
1	Dim	0.08 A
2	Brighter	0.16 A
3	Very bright	0.24 A

   a. As you increase the number of cells the bulbs become brighter and the current increases. When you double the number of cells you double the current.
   b. The current is bigger because the cell provides the push for the current. Increasing the push increase the current. There is more charge per second and there is more energy per charge so the bulb will be brighter.

2. Select 5 different type wires all of the same length and diameter. Connect the bulb in series with the test wire and a cell. (can include ammeter). Observe the brightness of the bulb. (record the reading on the ammeter) Repeat with the next test wire.

9.3 Electric circuits

1. a. The process of connecting objects to the ground.
   b. A flash of light you see when the air conducts electricity.
   c. The flow of electric charge.
   d. The probability of something happening and the consequences if it does.

2. a. As the petrol moves through the nozzle electrons are transferred/the petrol is charged by friction.
   b. A spark could ignite the petrol.
   c. The nozzle is earthed through the car.
   d. It will earth the nozzle allowing charge to flow away.
   e. Earthing the nozzle reduces the risk to drivers and cars of petrol igniting and exploding by conducting away the charge, so it reduces the probability of an accident.

3. a. A lightning conductor will carry any charge from lightning to the ground, avoiding damage to the building.
   b. If lightning strikes your car a current will be conducted to earth, but if you are outside and lightning strikes you a current will harm you severely.

Extension

a. Not normally, but if charge builds up in a cloud then air will conduct electricity.
b. A vacuum is an insulator as there are no particles that can be charged or carry charge.
c. It is very dangerous to be out in a thunderstorm because you could be struck by lightning, and the current would flow through you to earth.

9.4 Electric current

1. Images in the left column are, in order: cell, open switch, ammeter, lamp, battery, voltmeter, motor. Images in the right column are, in order: ammeter, lamp, cell, voltmeter, motor, open switch,battery.

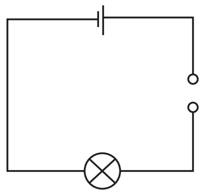
2.

Conductors	Insulators
metal spoon, piece of graphite, aluminium foil, iron nail	wooden spoon, plastic spoon, paper cup, plastic bag

3. a. Metal conducts electricity and wires need to be able to conduct electricity.
   b. Plastic is an insulator so it covers wires to protect you from the current.
   c. The pins need to conduct electricity and metal is a conductor.

d. The outside of a plug is made of plastic to protect you from the current.

Extension



a. There should be a gap to connect the material, and connect the cell to the lamp.

b. The air conducts electricity, such as lightning, at very high currents and voltages.

9.5 Current in series and parallel circuits

1.

Current is measured ...	... In series with a component
An ammeter is placed ...	... In amperes, or amps
In a series circuit the current	... Can be different in different places
In a parallel circuit the current	... Is the same everywhere

2. A1, C1, C2, C3, D2, and D3.

3. If one bulb is faulty the other bulbs will stay on. You can add more bulbs and they will all be the same brightness.

4. a. A and B both equally bright.

b. No bulbs are alight.

c. Only B is lit (and its brighter than in part a).

9.6 Modelling electric circuits

1.

The current in a wire is …	… in ampere, or amps.
Inside a metal wire …	… the charge flowing per second.
There are 1000 milliamps …	… provides the push to make electrons in a wire move.
You measure current …	… in one amp.
The battery …	… there are lots of electrons that move.

2. a. B and C

b. A – close the switch, D – reverse one of the cells, E – add a cell.

3. a. F **b.** F **c.** T **d.** F

4. a. 2 A

b. 2 A

c. The current flowing through the battery is 2 A.

Extension

a. 12 mA

b. 0.35 A

9.7 Planning investigations: factors that affect the speed of a motor

1. a. Correct answers in order: water, cyclist, chain, waterfall, rate of water flow.

b. Add a tap or valve.

c. No cyclist to turn the pedals.

2. Any suitable answer: e.g. circuit 1 needs two different components, circuit two has cells incorrectly connected.

Extension

a. The pipe would leak near a waterfall.

b. There have to be the same number of links in the chain either side.

10.1 The properties of magnets

1. Missing words in order: iron, attracted to, repelled by, Iron, attracted to south.
2. a. The fish cannot be made from wood if the game is based on magnetism as wood is not a magnetic material.
   b. The following two statements are correct: The ball at the end of the rod is a magnet and the fish are made of a magnetic material. The ball at the end of the rod is a magnet and the fish are magnets.
   c. The game would not work if both the rod and fish were made of magnetic materials, at least one must be a magnet.

Extension

a. Students should draw aligned domains pointing north to south in the magnet and unaligned in the rod.
b. A is the north pole.

10.2 Magnetic fields

1. Diagram 1: north on the left, south on the right. Diagram 2: draw field lines from north to south.
2. Diagram 1: two repelling north poles. Diagram 2: north on the left, south on the right. Diagram 3: two repelling south poles.
3. a. Use a plotting compass or cover the magnet with a sheet of plastic, sprinkle iron filings, and tap the sheet.
   b. i. Where the lines are close together.
      ii. Where the arrows are pointing away from.

Extension

a. Magnetic material.
b. Top.
c. The top is the region that contains the magnet, these fields are weak and need to be close to the surface to hold the magnet on.

10.3 Magnetic Earth

1. Words in this order: magnet, north, magnet, iron, wind.
2. a. Diagram as in Unit 10.3 of the Student book, with S labelled at the top of the rectangle, and N at the bottom.
   b. The solid line meets the circle at the geographical north pole and the dashed line meets the circle at the magnetic north pole. They are not in the same place.
3. a. In front of you.
   b. To your right.
   c. Behind you.

Extension

Sensible suggestion: e.g. The aurora happens where the charged particles from the solar wind enter the Earth's atmosphere. This is at the Poles where there is a force on them/they are drawn in towards the Earth.

10.4 Electromagnets

1. **a.** F **b.** F **c.** T **d.** T **e.** F **f.** F
2. a. Students should draw arrows pointing clockwise around the wire.
   b. They would face the opposite direction.
3. a. She should wrap the copper wire around an iron nail and connect it to a battery.
   b. Both types of nail can be magnetised in this way, but the steel nail will remain magnetised when the current is switched off. It is more useful to use iron, which will not remain magnetised.

Extension

a. A straight line should be drawn close to all of the points, through the origin.
b. The line of best fit should be steeper – double each point.
c. This will be above line A because the iron makes the electromagnet stronger.

10.5 Using electromagnets

1. When the window is closed the contacts in circuit 1 are touching and the circuit is complete. This means the electromagnet attracts and opens the switch for circuit 2 and the bell does not ring. If the window is opened, circuit 1 is broken and the electromagnet is switched off. This closes the switch in circuit 2 and the bell begins to ring.
2. **a.** When the current is too big the electromagnet increases in strength and attracts the soft iron armature. This then stops holding the contacts together and they are pulled apart by the spring breaking the circuit.
   b. The circuit is reset by pressing the button. The electromagnet is no longer attracting the iron arm, so the reset button pushes the contacts back together and the springs pulls the armature back into place to hold them together.

Extension

In X-ray machines electromagnets are used to switch the machine on and off remotely to stop the radiologist being exposed to a high dose of X-rays. Electromagnets do not produce the image. In an MRI machine, very strong magnets are used to produce the image, not to turn the machine on and off.

11.1 Technology in everyday life

1. Across: 1. Renewable; 3. Photosynthesis; 5. Electromagnet. Down: 2. Electromagnet; 4. Breaks.
2. Microorganisms: Tiny little organisms which can only be seen using a microscope.

   Fertilisers: The minerals used up by earlier crops are replaced by adding this to the soil.

   Lactic acid: Microorganism in yoghurt breaks down lactose in the milk into this.

12.1 The planets in our solar system

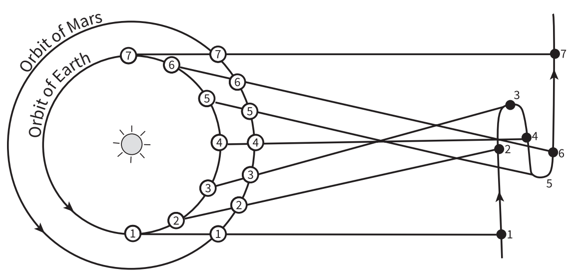
1.

	Correct
All plnets orbits the sun.	✓
Pluto is an exoplanet.	
Dwarf planets do not orbit the sun.	
Planets that are further from the sun are colder than planets that are closer.	✓
All the inner planets are rocky	✓
Asteriods orbits the sun between mars and jupiter.	✓

2. **a.** Diameter.
   b. Number of moons.
   c. Distance from the sun and time orbit the sun, because the further a planet is form the sun, the further it has to travel to orbit the sun once.

Extension

We see Mars because it reflects light from the Sun. Because the earth is moving faster the position of Mars appears to change in the night sky.



12.2 Asteroids, meteorites and comets

1. True: b; False: a, c.

   The corrected statements are:

   a. The tail of a comet appears when it gets close to the sun because the ice melts.

c. Asteroids and meteoroids are made of rock but comets are made from ice and dust.

2. Shading between the last two circles, or shading on the last circle.

3. a. These sentences underlined: An asteroid orbits the Sun. All the asteroids were made at the same time as the rest of the objects in the Solar System.

   b. These sentences corrected:

   We see it because it reflects light.
   A meteoroid is a tiny piece of a comet or asteroid.
   When a meteoroid comes through the atmosphere we call it a meteor.
   Comets are made of ice and dust.

Extension

Any two reasonable suggestions, such as: Different numbers/sizes of planets/at different distances/without an asteroid belt/with an asteroid belt in a different orbit.

12.3 Satellites

1. The correct words are: slower; equator; 24; communications.

2. Navigation satellites: are used to work out your position accurately.

   Communication satellites: are used for television or internet transmissions.

   Astronomical satellites: are used to monitor and take photos of space.

   - a. the advantage of using a weather satellite in geostationary orbit, is that it allows the monitoring of weather conditions and monitoring weather patterns at a particular spot.

     b. the advantage of using a weather satellite in a low orbit is that it will orbit the earth many times a day, as it is faster. This allows for weather information collection from all over the Earth, at multiple times during the day.

Notes