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3 Cells

Teaching support for pages 100–101

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

SC4-15LW A student explains how new biological evidence changes people's understanding of the world

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

a identify that living things are made of cells

b identify structures within cells, including the nucleus, cytoplasm, cell membrane, cell wall and chloroplast, and describe their functions

c outline the role of respiration in providing energy for the activities of cells

d identify that new cells are produced by cell division

e distinguish between unicellular and multicellular organisms

f identify that different types of cells make up the tissues, organs and organ systems of multicellular organisms

Working scientifically

SC4-4WS – Questioning and predicting

SC4-5WS – Planning investigations

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

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SC4-9WS – Communicating

Learning across the curriculum

Crictical and creative thinking

Information and communication technology capability

Literacy

Numeracy

Personal and social capability

Work and enterprise

Ethical understanding

Teaching strategies

Introducing Chapter 3

This chapter introduces the cell as the basic unit of life, and builds on that concept to introduce the functions of multicellular organisms. Many students have not previously had the opportunity to use microscopes and observe cells before this point, and this chapter provides excellent opportunities for them to learn this vital scientific skill.

The chapter builds upon Stage 3, Outcome ST3-10LW: A student describes how structural features and other adaptations of living things help them to survive in their environment. It has very strong links with Chapter 2: Classification, and leads on to topics in Chapter 2: Functioning organisms, in the Year 8 student book.

Teaching tips

It is essential that when planning lessons, the focus goes beyond the dot points of the syllabus and addresses the umbrella statement and the outcome. In this case, the umbrella statement requires that the structures and functions of cells are made explicit.

There are many opportunities to add contextual information, such as the role of technology and the use of models in science, featured at the end of the chapter. There are also opportunities to determine students' skills in literacy and numeracy and build activities to progress their skills. This chapter requires that students have an understanding of metric measurements of length, particularly mm and µm, and the ability to interpret and draw scale diagrams.

The Powers of Ten webpage provides a useful presentation that gives students an understanding of scales, magnification, and the sizes of both small things and large things. See the Resources tab for the Powers of 10 weblink.

Common misconceptions

While the Syllabus dot points indicate that living things are made of cells, the converse – that all parts of all living things are cellular – is not true. Hair, finger nails and claws, and blood plasma are parts of organisms that are the products of cells but are not cellular themselves. The other point around which misconceptions arise is viruses, which are non-cellular; but in Chapter 2: Classification, in the section on living and non-living things, it can be seen that viruses are not truly living in that they require a living host to survive and reproduce.

Extra activities

Starter activity: Discussion, brainstorm and graphic organisers

Some students may not have a grasp of the relationship between structure and function, and this is an ideal time to use further analogies to explore and discuss this relationship. Students could discuss the relationship between the structures and functions of a house, a school, a book, a pencil case, a backpack, a bike, a knife or even an aquarium. This is an ideal opportunity to use a graphic organiser or concept map to explore student prior knowledge of the relationship between structure and function, and this could be modified at the end of the chapter to evaluate learning.

assess

Each chapter of the *Insight Science 7* student text includes related assessments and testbank questions that are graded for student ability and linked directly to the outcome statement codes in the Australian Curriculum for NSW syllabus.

Assessments

Assessments are auto-marking multiple choice quizzes. Questions are graduated in difficulty so teachers can assign as appropriate to students:

- Support (foundation)
- Consolidate (standard)
- Extend (advanced)

Students can review their quiz results to see which questions they answered correctly or incorrectly. Students can improve their results by attempting the quiz again with the challenge of randomised answer options.

Testbank

Testbank provides teacher-only access to ready-made chapter tests. They consist of a range of multiple choice, short answer and extended response questions with marking guidance for each short and extended response question. Multiple choice questions are auto-graded.

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The testbank can be used to generate tests for end of chapter, mid-year or end of year tests. Tests can be printed, downloaded, or assigned online.

Assigning tests

In order to assign work to students, your students must first:

(i) have the obook in their Oxford Digital library;

(ii) have linked to your Oxford Digital account; and

(iii) be added to a class you have created.

1 For a step-by-step guide on **getting started with your class set-up**, click here:
https://obook2.oxforddigital.com.au/teacher/classadmin.html

2 For a step-by-step guide on **assigning assessment for students**, click here:
https://obook2.oxforddigital.com.au/help/assess/Assigning_work_using_assess_teachers.html

Results

Student results can be monitored and graphed, or exported to Excel for incorporation into an LMS.

3 For a step-by-step guide on **using results in assess**, click here:
https://obook2.oxforddigital.com.au/help/assess/Using_results_in_assess_Teachers.html

Resources

Teacher obook

Chapter 3 Teaching program

A fully editable teaching program for this chapter, mapped to the NSW Syllabus

Weblink: Powers of ten

Powers of Ten website, where students can research scales and magnification in context

www.powersof10.com

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Discovering cells

Teaching support for page 102

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

SC4-15LW A student explains how new biological evidence changes people's understanding of the world

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

a identify that living things are made of cells

Working scientifically

Questions 3.1.1

SC4-7WS – Processing and analysing data and information

SC4-8WS – Communicating

Learning across the curriculum

Questions 3.1.1

Critical and creative thinking

Literacy

Teaching strategies

Introducing section 3.1

Technology is integral to the development of the cell theory. 'Looking at cells' is the logical introduction to the study of cells, as students become aware of the importance of the microscope and its development to the history of our understanding of cells.

Teaching tip

Concept maps can be constructed by students to determine their prior understanding. Brainstorm a list of words associated with cells and then link the words through a concept map. This can be added to and modified as a revision activity at the end of section 3.1.

Students could work in pairs in a 'think–pair–share' activity to read the sections on 'Discovering cells' and the cell theory, and then answer Questions 3.1.1. They could get their partner to read their answers and discuss them together.

Extra activities

Activity: Discovering cells

This description of the work of Hooke is an excellent example of how a scientific discovery can change our understanding (Outcome SC4-15LW). Brainstorming a list of things we would not have or know if we did not know about cells might help students to appreciate the significance of his discovery.

A good introduction to discussing the cell theory may be a discussion about 'What is a scientific theory?'. How much evidence would have needed to be collected between Hooke's initial observations and determining that all living things are made of cells?

Extension activity: Research

Students could work in groups to research the theory of spontaneous generation. What was the evidence for the theory and how was it eventually discounted?

Answers

Questions 3.1.1 answers

1 Cells are the basic structural and functional units that make up living organisms.

2 Most cells cannot be seen without a microscope. There are some exceptions, e.g. egg cells. The ostrich egg is reported to be the largest cell.

3 Robert Hooke invented the first microscope.

4 Cells have their name because when Hooke put thin slices of cork under the microscope, it looked like honeycomb. He thought these holes and their boundaries (cell walls) looked like the rooms in which monks stayed, which were called 'cells'.

5 Principles of the combined cell theory:

- Cells are the basic unit of life and structure.
- All organisms are composed of one or more cells.
- New cells are created from existing cells.

6 The microscope was essential for the development of the cell theory and its implications for understanding living things. Microscopes have also enabled us to understand unicellular organisms such as amoeba.

Resources

Student obook

Weblink: History of the microscope

This website includes all aspects of the history of the light microscope.

http://inventors.about.com/od/mstartinventions/a/microscope.htm

Worksheet 3.1: Cell analogy

A printable PDF of Workbook Activity 3.1

Teacher obook

Workbook answers

Answers to all activities in the *Insight Science 7* student workbook

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Microscopes and microscopy

Teaching support for pages 103–107

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

a identify that living things are made of cells

Working scientifically

Questions 3.1.1

SC4-7WS – Processing and analysing data and information

SC4-8WS – Communicating

Activity 3.1.1

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Communicating

Experiment 3.1.1

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Communicating

Activity 3.1.2

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Communicating

Learning across the curriculum

Questions 3.1.1

Critical and creative thinking

Literacy

Activity 3.1.1

Critical and creative thinking

Literacy

Experiment 3.1.1

Critical and creative thinking

Literacy

Personal and social capability

Work and enterprise

Activity 3.1.2

Critical and creative thinking

Literacy

Teaching strategies

Teaching tip

Students could collect together a portfolio of examples of their work throughout this chapter to be used for assessment. Get them to select their best answer to the revision questions to include in the portfolio.

Differentiation

Provide objects for students to examine using a stereo microscope. More skilled and capable students may explore other materials and may work to support less able partners to examine more objects.

Additional information: Development of microscopes

The first microscopes were probably inspired by refractive telescopes that were used in the early 17th century. They only had one lens, and improvements to the lens resulted in greater magnification and clearer images so that even bacteria were being observed by Leeuwenhoek by 1674. It was not until 1830

that Joseph Jackson developed a compound microscope, consisting of two lenses, that provided better images.

It is worth highlighting that the stereo microscope gives much smaller magnification than the compound light microscopes (most school stereo microscopes give a maximum 40x magnification and so are really glorified magnified glasses) and observe objects or substances that can be thick as they are lit from above. They are not generally used for observing cells, but are excellent for observing small invertebrates, leaf structures, aquatic small animals and plants, seeds, spores, pollen or flower structure.

Additional information: Preparing slides

This section allows students to make the connection between the organism and the cells as seen under the microscope, by involving them in slide preparation and viewing. Students may experience frustration and can easily become disengaged when they look through a microscope to see air bubbles, other artefacts or tissues that are too thick to be adequately observed. Use of some commercial cell cultures of pond life may aid in helping students to persevere and ensure some level of success.

Teaching tip

Instructions for setting up microscopes vary slightly depending on the microscope, so while the ten tips are important, you may need to add and sequence some instructions for ensuring the correct level of light is passing through the specimen on the compound light microscope.

Students could be taught how to use and focus stereo microscopes before the compound light microscope. Students need to learn to focus safely, early on in microscope work, as it is not really possible for the teacher or laboratory technician to set up the focus of a microscope to suit all students (students who wear glasses often need to remove them for microscope work and so will probably need to focus a microscope very differently from other students).

Differentiation

A dictadem (a modified version of a dictogloss) is a teaching strategy that can be used to demonstrate a technique or skill. The teacher conducts the demonstration in silence, then repeats it; the students, having watched carefully, are required to record a procedural text of the method. Students can then compare what they have written with each other. Just for fun, the teacher could then do a demonstration that includes some mistakes and the students have to observe and list the mistakes made. These types of activities help support literacy development and skills in correctly recording experimental procedure.

Extra activities

Activity: Microscope and microscopy

Set up stations around the laboratory with a variety of stimulus materials and activities in addition to about 5 different variations of microscopes/magnifying devices. Students rotate around the stations. The stimulus materials could also include electron micrographs of a range of living things or even STEM

images of metals used in nanotechnology. You could include a range of activities involving getting students to identify parts of the microscopes that are indicated, and numeracy activities based on calculation of scales and magnification (e.g. working out the greatest magnification that can be achieved by this microscope).

Extension activity: Microscope images

Students can collect images produced by the different types of microscopes – compound light, stereo, SEM and TEM – and write descriptions of how the images were produced. This summary can be displayed around the classroom.

Extension activity: Researching stains

Students can be extended to learn more about different stains, and how they can be used to stain different parts of cells because of their affinity for the different substances that make up cells and cell organelles.

Practical support

Numeracy builder answers

1 Objective lens of × 20. 5 × 20 = 100

2 Eyepiece of × 5 and objective lens of × 20 or eyepiece of × 10 and objective lens of × 10. 5 × 20 = 100, 10 × 10 = 100

3 Eyepiece of × 10 and objective lens of × 20. 10 × 20 = 200

Activity 3.1.1 support

Safety

- A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Practical hints

Hands-on activities are an excellent way to engage students. Younger students tend to take some time to develop the skills for working with microscopes and often have a brief look and then become distracted. You could start this activity with students developing skills through a transition of using a hand lens to the stereo microscope, even just looking at the tip of a pen. Students need to train their eye to focus at a distance similar to that of the object being observed. Frequently, they just see their own eyes, as they are focusing on the eyepiece lens.

Many stereo microscopes have two objective lenses, so this is a good time to talk about magnification and get students to see the difference when using the more powerful lens. It is also worth pointing out that the lower power of magnification is useful for scanning the field of view. Move the object of interest to the centre of the field before increasing magnification for a more detailed observation.

Answers

1 A hand lens, stereo microscope and light microscope all magnify objects and use lenses to bring about the magnification.

2 A hand-held magnifying glass has only one lens, whereas the other two have two lenses. The hand-held magnifying glass and stereo microscope can be used to magnify objects and small organisms, whereas the light microscope requires that light pass through the object being observed and so the object has to be prepared as a slide.

3 Answers will vary, depending on the object. For some students the hand-held magnifying glass will make some external features clearer and requires little skill to use. The other microscopes give greater magnification but depend on the skills of the user.

4 Answers will vary.

Experiment 3.1.1 support

Safety

- Glass slides and coverslips may break and cause cuts.
- A risk assessment should be completed before undertaking this Experiment. A suggested risk assessment template is provided in the teacher obook resources.

Discussion

1 The image of the newspaper will be inverted or reversed, meaning that anything viewed through a microscope will be the opposite to what is seen without the microscope.

2 Student responses will vary; however, students should be able to see the detail such as fibres and glue.

3 Student responses will vary; however, students should communicate that anything that is done actually occurs in the opposite way. For example, a specimen appearing under the microscope to move to the right is actually moving to the left of the slide.

4 Student response will vary, but generally should identify that more detail can be seen through the microscope than with the naked eye.

Conclusion

Student responses will vary; however, students should note that objects viewed under a microscope are reversed.

Activity 3.1.2 support

Safety

- Glass slides and coverslips may break and cause cuts.

- A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Class clean-up

- Prepared slides should be removed from the microscope and placed back in slide boxes after use.
- Broken slides or coverslips should be swept up using a dustpan and broom and disposed of in an appropriate sharps/broken glass receptacle.

Answers

Student responses will vary. If viewing commercially prepared slides, here are some possible answers:

- Human blood shows numerous cells that are concave or hollowed out and some larger irregular shaped cells.
- Plant root tip: The cells are rectangular and have cell walls. They seem to have small, bubble-like things inside them.
- Cross-section of a stem: Rings of block-like cells with bundles of larger cells in a ring.

Students often have difficulty constructing diagrams of cells they observe because they are overwhelmed by the numbers of cells and think they need to try to draw them all, and they do not make careful observations. Remind them to only draw 2 or 3 cells clearly and in detail.

Answers

Questions 3.1.2 answers

1 Students will probably have used a compound light microscope and stereo microscope in class.

2 Compound light microscope: consists of a heavy base, with a circular mirror that can be moved to direct light through a hole in the stage upon which a prepared slide is placed. Light passes through the specimen, so it must be very thin. Above the stage is a rotating set of small tubes that each contains objective lenses. Above the small tube is a longer tube that has an ocular or eyepiece lens at the top and is where you look at the specimen, so it is monocular. (Some light microscopes, especially those for senior students, are binocular.) At the side is a knob that is turned to focus the image. It is used to observe thin slices of specimens and can magnify up to 1500 times. The view is two-dimensional.

Stereo microscope: consists of a heavy base upon which the specimen is placed. The specimen is illuminated from above and the light is reflected up through a lens in a tube. The specimen may be relatively large. This relatively wide tube contains the objective lens and a set of tubes leading from this that contain eyepiece lenses, so that you look at the objects with both eyes. It is used for viewing larger objects and can magnify up to 200 times, but most school ones only magnify 40 times. The view is three-dimensional. There are two eyepiece lenses (one in each eyepiece as it is

binocular) and often two objective lenses that usually slide backwards or forwards to change magnification.

3 Very thin samples must be used under a compound microscope because the light must be able to pass through the specimen from the mirror up to the eye.

4 A wet mount is where the specimen is placed in a drop of water, or other liquid, and held between the slide and the coverslip by surface tension. The water or liquid stain fills the space between the coverslip and the slide so the surface is more even and the sample is supported. If prepared properly, wet mounts should not have air bubbles.

5 The reason you always look to the side of the microscope when adjusting the coarse focus knob is to ensure the objective lens is not touching the slide. It is easy to break the slide if you use the coarse focus while looking through the eyepiece.

6 It is important to label and date specimen drawings because these are like a summary of what was seen and when. They also help people understand the drawing. Labelled diagrams are important means of communication as they demonstrate the interpretation of the findings that may not be revealed in the image alone.

7 Magnification table

Eyepiece	Objective lens magnification	Total magnification
×5	×100	×500
×15	×20	×300
×10	×50	×500
×30	×450	×13500
×5	×100	×500

8 Student responses will vary. Generally it would be better to use a compound light microscope to view cells as they are too small to be observed under a stereo microscope. A stereo microscope could be used to observe how muscle tissues are jointed to tendons.

9 Student responses will vary, but should include references to the ‘Science skills: Ten tips for working with microscopes’ on page 105.

10 Student responses will vary, but may include choices like ‘light passes through the microscope/electrons are fired out of the microscope’, ‘used to view 3D objects/used to view thin slices of a specimen’, ‘monocular/binocular’, ‘electrons pass through the specimen/electrons bounce off the surface of the specimen’, etc.

Resources

Student obook

Video: Microscope skills

A video that reviews the parts of a microscope, how to use it and how to prepare a slide for viewing

Weblink: Slideshow of microscopic organisms that live on the body

This website covers all the flora and fauna that live on human bodies.

http://www.pbs.org/wgbh/nova/nature/bugs-that-live-on-you.html

Weblink: How to use a microscope

This website explains the role of each of the microscope parts and how to focus on a specimen.

http://www.wisc-online.com/Objects/ViewObject.aspx?ID=BIO905

Worksheet 3.2: Microscopes

A printable PDF of Workbook Activity 3.2

Teacher obook

A3.1.1 Under the microscope RA

A risk assessment template for students and teachers for Activity 3.1.1

A3.1.2 Looking at different cells RA

A risk assessment template for students and teachers for Activity 3.1.2

E3.1.1 Getting to know your microscope RA

A risk assessment template for students and teachers for Experiment 3.1.1

Workbook answers

Answers to all activities in the *Insight Science 7* student workbook

Weblink: Dictogloss

British Council website, where teachers can learn how to apply a dictogloss as a teaching strategy for language development for ESL or low-language students

http://www.teachingenglish.org.uk/knowledge-database/dictogloss

3.1 Checkpoint

Teaching support for page 108

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

SC4-15LW A student explains how new biological evidence changes people's understanding of the world

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

a identify that living things are made of cells

Working scientifically

SC4-4WS – Questioning and predicting

SC4-5WS – Planning investigations

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Learning across the curriculum

Critical and creative thinking

Literacy

Answers

Checkpoint 3.1 answers

1 Robert Hooke was the first person to describe cells.

2 Plant cells (cork) were the first cells to be drawn.

3 A stereo microscope would be used instead of a compound light microscope to view large objects. It is useful for observing details of external structures of plants and animals, and can even be used to observe some living specimens. Stereo microscopes can assist dissections.

4 From top right: eyepiece (ocular) lens, objective lenses, mirror. From top left: coarse focus knob, fine focus knob, stage, base.

5 Very thin samples must be used under a light microscope because the light emitted must be able to pass through the specimen.

6 The different lenses on a compound light microscope are the eyepiece (ocular) and objective lens. There are two lenses to give greater magnification and a clearer image. There are often a number of objective lenses. The lower magnification lens allows a broader field of view to be scanned and the area for closer examination can be selected. The objective lenses are then rotated to increase magnification and decrease the field of view so that more details, such as cell organelles, can be observed.

7 Similarities:

- Stereo and compound light microscopes both use light that, after leaving the specimen, has been refracted through lenses into the eye of the observer.
- Stereo microscopes and TEM are both used to observe the external features of the surface of a specimen, i.e. they produce a three-dimensional image.
- TEM and SEM use bombarding electrons to produce an image that then is converted into a picture that can be viewed.
- TEM and compound light microscopes are used to observe thin specimens that have been especially prepared, either in a slide or embedded. The both produce two-dimensional images.
- Compound light microscopes and stereo microscopes produce relatively small magnification (stereo even smaller than compound light, which can be up to 1500 times.)
- TEM and SEM produce extremely large magnification of images.

Differences:

- TEM and SEM use electrons, and images must be computer processed to be observed; compound and stereo microscopes use light, and images can be observed directly by the user.
- SEM and stereo microscopes produce 3D images; TEM and compound light produce 2D images.

- TEM and SEM provide large magnification; stereo and compound produce relatively small magnification
- Compound and stereo microscopes are relatively small, portable and inexpensive; SEM and TEM are large, require special housing, and are expensive.

8 The image seen through a compound light microscope is reversed or inverted because both the eyepiece and the objective lens are convex lenses, which means that the light rays entering will converge to a single point (focal point). The level of magnification and the orientation of the image will depend on the distance of the observer and relative position from the focal point. The eyepiece lens acts only as a simple magnifier, and enlarges the object/image. The objective lens has a very short focal length, resulting in the inversion of the image. A stereo microscope contains lenses with a much longer focal length that, while they still bend the light, result in the image being upright and laterally correct. Stereo microscopes are often used for dissections, so it is important that the image in not inverted.

9 It is an advantage to be able to view living cells or small organisms when wanting to investigate a wide range of biological activity, such as the uptake of food, cell division and movement. Being able to view a cell or small organism as it is functioning helps us to understand the role of various structures.

10 a: Scanning electron microscope – note the visible surface structures in 3D and the large magnification.

b: Transmission electron microscope – note the 2D image of large magnification.

c: Light microscope – note the 2D image and magnification that shows arrangement of cells.

d: Stereo microscope – note the 3D image of a crab with only relatively small magnification.

11 Student responses will vary, but should include mention of the fact that while the lenses of reading glasses and microscopes magnify, the shape of the lenses in microscopes is more curved and causes much greater magnification. Many lenses from reading glasses are only convex on one edge, whereas optical lenses are biconvex. Hooke's microscope was a tube with one eyepiece and one objective lens at either end, similar to our model. Modern compound microscopes have a set of rotating objective lenses that allow the user to increase magnification to see greater detail of the selected field of view. Hooke's microscope and modern versions enclose their lenses in tubes so no external light enters the field. This was quite difficult to do in our model, as putting lenses into a cardboard tube makes it more difficult to move them to produce a focused image. Some additional research may be required.

12 Our understanding of living things was improved with the development of the microscope. Recorded history demonstrates that there has been knowledge of prominent organs such as the heart for well over 3000 years (see page 125, 'Early anatomy'). The recognition of the structure of these organs, including the tissues and cells that comprise them, has only been able to occur in the last 350 years,

since the development and refinement of the microscope. For many organs, e.g. the kidneys, understanding the structure and arrangement of the cells has allowed us to develop an understanding of how they function. Scientists were also able to work out a reliable way of determining a living thing from a non-living one. The microscope showed that each and every living thing is made up of cells or their products, and what cells are made of.

13 Living matter is made up of cells, whereas non-living matter is not. Non-living matter can be classified as solid, liquid or gas, whereas living material is really a mixture of solids, liquids and gases. A critical feature of cells and living things is their ability to reproduce. This essentially means that living things are able to accomplish things that non-living things cannot. Dead matter is not the same as non-living. Dead implies it was once living and therefore would contain (dead) cells.

assess

3.1 Looking at cells assessments

Support

Consolidate

Extend

Resources

Teacher obook

Checkpoint 3.1 Worksheet A

Students who score less than 10 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet A, which is designed for extra support.

Checkpoint 3.1 Worksheet A answers

Answers for Checkpoint Worksheet A

Checkpoint 3.1 Worksheet B

Students who score between 10 and 25 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet B, which is designed for consolidation.

Checkpoint 3.1 Worksheet B answers

Answers for Checkpoint Worksheet B

Checkpoint 3.1 Worksheet C

Students who score more than 25 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet C, which is designed for extension.

Checkpoint 3.1 Worksheet C answers

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Answers for Checkpoint Worksheet C

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Cell components

Teaching support for pages 109–110

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

b identify structures within cells, including the nucleus, cytoplasm, cell membrane, cell wall and chloroplast, and describe their functions

Working scientifically

Activity 3.2.1

SC4-4WS – Questioning and predicting

SC4-8WS – Communicating

Questions 3.2.1

SC4-7WS – Processing and analysing data and information

SC4-8WS – Communicating

Learning across the curriculum

Activity 3.2.1

Critical and creative thinking

Personal and social capability

Literacy

Questions 3.2.1

Critical and creative thinking

Literacy

Teaching strategies

Introducing section 3.2: Cell structure and function

The key concept that runs through the biology topics in Stage 4 of the NSW Syllabus is the relationship between structure and function. This concept is developed in Chapter 2: Classification, and is integral to this section on cells. The link could be made with section 3.1 by discussing the relationship between the structure and function of the microscope. What would happen if a light microscope had no light source? What would happen if there was no eyepiece lens? The working of the whole depends on the integral parts, and the functioning of a part often depends on its structure. Once students have an understanding of the structural, functional unit of life, they can go on in section 3.3 to learn about variations in structure that relate to variations in function, and how cells are organised into a functioning multicellular organism.

Teaching tip

Many students find learning the cell components a bit overwhelming. It is important to regularly revisit the names of common structures and their functions. Playing a ‘celebrity heads’ game using the names of cell components can be a fun way for students to learn the names and functions of the common cell components.

Extra activities

Starter activity: Brainstorming cell components

Students could work in small groups with each group being given a card with a description of a cell and its role within an organism, e.g. ‘A cell that is part of the blood and carries the oxygen around to all parts of the body’, ‘a cell that secretes saliva so that food is moistened and easier to swallow’, ‘a cell that absorbs water from the soil so it can enter a plant’, ‘a cell that detects foreign substances in an organism’, ‘a cell that is an invasive pathogen’. Students discuss the function of their cell and invent some structures or features that they think the cell might have to help it carry out its function. Student groups draw a model of their cell and present it to the class. A discussion of similarities and differences could follow.

While this is a ‘creative thinking’ activity, it is useful in allowing students to demonstrate their prior understandings about cell structures and their functions.

Activity: Cell components

Students work in pairs, using the Internet to research the 8 parts of a cell identified in the student book. They create their own summary. Student pairs are then secretly given the name of a cell part and have to construct a list of clues that will ultimately help the other students to guess which cell part the pair has been allocated. The first clue must start with a simile such as: ‘I am like the electronic doors to a shopping centre’ (for the cell membrane). Students then have to alternate between a clue that states an aspect of the part’s structure and a clue that states an aspect of its function.

This can be linked into the ‘Literacy builder’ on page 119.

Answers

Questions 3.2.1 answers

1 The function of the cell membrane is to control the composition of the cell contents or cytoplasm. It does this by controlling the substances that enter across the membrane and the substances that leave.

2 Cellular respiration occurs in the mitochondrion.

3 The muscle cells would have more mitochondria because respiration would need to occur more in muscle cells, which need to contract and therefore need a lot of energy – more than bone or hair follicle cells.

4 Chloroplasts are not found in every plant cell. The cells that form the root system generally grow below the soil, are not exposed to sunlight and therefore would not carry out photosynthesis; thus these cells do not need chloroplasts. Other plant cells that may not have chloroplasts are the internal cells involved in transport or the cells in plant parts that are involved in the storage of food.

Resources

Student obook

Interactive activity: Parts of a cell

This interactive quiz is a drag-and-drop activity on the parts of a cell.

Weblink: Cells interactive website

This website contains interactive diagrams of plant, animal and bacterium cells.

http://www.cellsalive.com/cells/3dcell.htm

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Different cells

Teaching support for pages 111–115

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

b identify structures within cells, including the nucleus, cytoplasm, cell membrane, cell wall and chloroplast, and describe their functions

Working scientifically

Experiment 3.2.1

SC4-4WS – Questioning and predicting

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Activity 3.2.2

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Experiment 3.2.2

SC4-4WS – Questioning and predicting

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Questions 3.2.2

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Experiment 3.2.1

Critical and creative thinking

Literacy

Work and enterprise

Personal and social capability

Activity 3.2.2

Critical and creative thinking

Numeracy

Experiment 3.2.2

Critical and creative thinking

Numeracy

Literacy

Work and enterprise

Personal and social capability

Questions 3.2.2

Critical and creative thinking

Literacy

Teaching strategies

Teaching tip: Different cells

This part of the topic provides scope for deepening student understanding about how structure is related to function, and many opportunities to develop complete explanation texts. The idea of spontaneous generation of life, and the experiments of Pasteur and Koch to link infectious diseases to microorganisms, could be discussed.

You could revisit the cell theory and discuss how it developed over time as more and more observations were made. Despite the variety of types of cells, it became apparent that they had certain things in common, and were the structures that made up all living things.

Differentiation

For those with higher abilities:

- Students might like to learn about stem cells. They could be set a research task to define stem cells, distinguish between adult and embryonic stem cells and write a paragraph to explain their potential uses.

Differentiation

For those with higher abilities:

- Students examine a much wider range of cells (taking into account that human cheek and blood cells should not be used unless in a commercially prepared slide).
- Conduct a POE (predict, observe, explain). Students could make a prediction using their knowledge of organelles and, through observation, check their prediction. For example, they might predict that animals have more mitochondria than plants and they could then observe cells to verify and explain their findings. They may predict that muscle cells have more mitochondria than skin cells. Inquiries that allow students to choose their own question for investigation maximise student engagement.
- Use fresh stalks of celery that have been placed in water with food colour or eosin dye to see the xylem tissue stained. Students find it very difficult to slice material for slides sufficiently thinly to be able to see under a microscope, so either prepare slides for viewing under the compound light microscope or slice thin sections and view them under a stereo microscope. Students could research another chemicals/dyes that can be used to trace the movement of substances around either plants or humans.

Differentiation

For those with lower abilities:

- You can start by comparing sizes of larger parts of living things such as leaves. Students trace the leaves onto grid paper and count the number of units for length and width, and possibly also count the total number to assess the leaf area. To highlight the fact that cells are three-dimensional and that in a microscope view it is the cross section of a cell that is being observed, students could then look at a variety of fruit structures and their cross sections. A banana is useful, as the cross section lengthwise is so different from that across the banana. Point out that in a cross section of living tissue, the cells being observed are cross sections and could have been taken across a variety of planes.

- One of the main points of the activity to compare cell size is for students to understand how small cells are, and that the size of the cell is a key part of its functioning – small size results in a relatively large surface area to volume ratio. This concept is difficult for students with lower abilities, but you can start by discussing the areas of the leaves measured, and adaptations for absorbing light or losing water, and maybe by doing a simple activity such as comparing the time taken for caster sugar to dissolve compared with ordinary sugar crystals.

For those with higher abilities:

- The reason why cells are small could be explored further with a range of investigations into the impact of the ratio of surface area to volume.
- Students could do detailed research into the red blood cell and why its size and shape (and lack of a nucleus) helps to support it function of carrying oxygen around in the blood. Some students may then make comparisons between white and red blood cells, their size, shapes and roles.
- Students could research nanotechnology and many of the units used to describe really small things.

Extra activities

Starter activity: Cause and effect

The introduction to types of cells is an ideal opportunity to build on the skills of students to use the cause and effect graphic organiser. Students work in groups and each group is given photographs or diagrams of particular types of plant and animal cells and a statement about the function of the cell. For example, a picture of a neurone with a statement about it conducting nerve messages, a picture of a muscle cell with a statement about it contracting, a photograph of a xylem cell with a statement about it conducting water, a photograph of a guard cell with a statement about it controlling the opening of pores in leaves. If no photographs are available, the diagrams in Figure 3.18 could be used.

Students make observations about the cells and infer or predict a causal relationship between an observed feature and the stated function. It does not matter if the inference is correct, so long as it is logical. Once the cause-and-effect graphic organisers have been constructed, the statements can be changed into correctly written explanatory sentences. Students who need literacy support may need to be provided with a range of connective phrases such as ‘in order to’, ‘as a result of’, etc.

Activity: Specimen diagrams

Many students find it difficult to draw appropriate specimen diagrams. Peer assessments could be used here to help all students improve their drawing abilities and their ability to provide constructive criticism. Encourage students to focus on providing 2 positive points and two areas that could be improved upon.

Activity: Comparing plant and animal cells

Learning about the organelles helps to deepen student understanding of the difference between plants and animals. Students could work in pairs: one member does a SWOT (strengths, weaknesses, opportunities, threats) analysis of being a plant cell and the other does one of an animal cell. After each pair has discussed their analyses, there could be a class discussion.

This is an ideal opportunity to draw out the relationship between structure and function of animals and plants. Plants do not need to move, because they have chloroplasts and can make their own food. Their cells, being surrounded by a rigid cell wall, could not easily change shape to allow movement anyway. Animal cells lack the cell wall and so can change shape, but also lack the supporting structures and so large terrestrial multicellular animals often depend on cells that secrete a form of skeleton.

Develop critical and creative thinking by getting each pair to design a cell with a limit of five organelles in addition to the cytoplasm and cell membrane. They have to explain how their cell functions.

Extension activity: Research

Students work in groups that are each given a different virus to research, including determining the size and structure of the virus. Hold a class discussion including the question of why viruses are not cells, nor truly living organisms.

Practical support

Experiment 3.2.1 support

Practical hints

- Students are likely to need assistance with ensuring their onion skin is thin enough, and with staining their onion cells. The most common errors are having too thick a piece of onion skin or applying too much stain, resulting in saturation of the cells. If saturation occurs, students will need to start again.
- Save the students' prepared slides from this experiment for Experiment 3.2.2 on measuring cells.
- Iodine and methylene blue will stain clothing, so ensure lab coats or aprons are worn. This iodine solution is a weak solution of iodine; however, it is classified as corrosive in its solid state and skin contact should be avoided. Wash skin immediately with water if contact is made.

Safety

Chemical safety in schools is an invaluable resource (mandatory for DEC schools) that discusses the hazards, risks and rules when handling chemicals and biological specimens.

Volume 2, 3.2.6 Safe use of biological material/organism/tissue, subsection 3.2.6.2 Microbiology indicates that the use of human blood, other than commercially prepared slides, and human cheek cell smears should not be conducted. Similarly, wild cultures of microorganisms should not be subcultured.

This resource lists strains of safe bacteria that can be obtained and subcultured. In particular, *Lactobacillus acidophilus* (from yoghurt) and *Lactobacillus casei* (from Yakult) are safe.

- Slides and coverslips are made of glass so can be broken. Coverslips, in particular, are very thin and can break, creating a cutting hazard.
- Iodine stain will stain clothing, so ensure lab coats or aprons are worn. This is a weak solution of iodine; however, it is classified as corrosive in its solid state and skin contact should be avoided.
- A risk assessment template should be completed before undertaking this Experiment and by the lab technician before preparing the chemicals for it. Suggested templates are provided in the teacher obook resources.

Class clean-up

Remove coverslips from slides and place in a separate container to the microscope slides.

Lab tech notes

Place coverslips in the glass bin or sharps container. Soak microscope slides in a strong detergent overnight, then rinse with water or wash in a dishwasher in an appropriate slide washer, allow to dry, and reuse.

To prepare iodine stain:

Make up at least 24 hours before it is required for use. For making up 300 mL of iodine stain, you will require the following:

- 1 g iodine (wear gloves)
- 5 g potassium iodide
- 300 mL distilled water

1 Dissolve 5 g of potassium iodide in 300 mL of distilled water.

2 Add 1 g of iodine. Mix on a magnetic stirrer.

3 Iodine solution will deteriorate in the presence of light and with time, so store in a dark bottle.

To prepare methylene blue stain:

1 Make up a stock solution of methylene blue stain:

- 1.5 g methylene blue
- 100 mL 95% ethyl alcohol (ethanol)

2 Dissolve the methylene blue stain in the 100 mL of ethyl alcohol (ethanol).

To prepare the working solution:

Mix 10 mL of stock solution with 90 mL of distilled water.

Discussion

1 This type of preparation is called a wet mount.

2 The onion skin cells that were stained contained components that were more clearly visible than the cells that were not stained.

3 The onion cells came from the bulb of the plant, which is underground. This part of the plant is not exposed to sunlight and so cannot photosynthesis. As a result, the onion cells do not contain chloroplasts, which are required for photosynthesis. The *Spirogyra* cells are leaf cells, which do photosynthesise and so contain many chloroplasts.

4 The nucleus is difficult to see amongst the numerous green chloroplasts and is also unstained.

5 The green chloroplasts are very prominent in the *Spirogyra* cells. Chloroplasts are needed for photosynthesis.

6 The bulb of the onion is underground and cannot photosynthesise without sunlight, therefore no chloroplasts are present.

7 The key features of the cell (the cell wall and chloroplasts) are already prominent.

8 Student responses will vary depending on the slides they viewed, but more prepared slides will be stained. Some answers may include that the colours were unnatural, or that all features of the cell were easily visible.

9 Animals cells do not have a cell wall or chloroplasts, whereas plant cells usually have both. Animal cells have a greater variety of shapes and sizes than plant cells.

10 Differences between plant and animal cells include cell wall/shape and colour. Similarities include the presence of a nucleus and a boundary structure (cell/membrane). Most of the organelles present in Figure 3.13 are not visible under a light microscope.

11 Students need to represent their data in the Venn diagram. The central section should state: nucleus, cell membrane, cytoplasm, mitochondria and ribosomes (possibly vacuoles, though these do vary); the section on the right should state: cell wall, chloroplasts; and the section on the left should probably be empty.

12 Individual student response

Conclusion

Student responses will vary; however, students should note that plant and animal cells have differences and similarities.

Activity 3.2.2 support

2 From smallest to largest: *Staphylococcus* bacterium, *Escherichia coli*, human red blood cell, human white blood cell, human cheek cell, epidermal plant cell

3 *Staphylococcus* bacterium, mitochondrion, *Escherichia coli*, chloroplast, human red blood cell, human white blood cell, human cheek cell, epidermal plant cell

4 Mitochondria are not visible using a light microscope.

5 Influenza would be the smallest – one tenth the size of *Staphylococcus* bacterium – so it would come first in the list.

6 Viruses would need to be observed using an electron microscope – they are far too small to see with a light microscope.

Experiment 3.2.2 support

Practical hints

This experiment requires the same slides used in Experiment 3.2.1 to look at cell size.

Safety

- Slides and coverslips are made of glass so can be broken. Coverslips, in particular, are very thin and can break, creating a cutting hazard.
- Coverslips should be placed in the glass bin or sharps container. Soak microscope slides in a strong detergent overnight, then rinse in water or wash in a dishwasher in an appropriate slide washer, allow to dry, and reuse.
- A risk assessment should be completed before undertaking this Experiment. A suggested risk assessment template is provided in the teacher obook resources.

Discussion

The students' ranking should be reasonably similar to that of Table 3.2 in Activity 3.2.2.

Conclusion

Student responses will vary; however, students should understand that the sizes of plant and animal cells differ depending on their function.

Answers

Questions 3.2.2 answers

1 The unit used to describe cell size is usually a micrometre, µm (a millionth of a metre or $\times 10^{-6}$).

2 Cells grow, respond, move, need nutrition and water, produce wastes and exchange gases. Many cells also reproduce. These are all features of living things.

3 Plants and fungi are relatively stationary as they obtain food either by photosynthesis or decomposition. The cell wall provides support but limits the movement or ability to change the shape of the cell. Animal cells lack the support of a cell wall, but are able to change shape. This supports the movement of animals in their efforts to obtain nutrition.

4 The other organelles and cytoplasm are also made of smaller parts. They are not shown probably because it would make the diagram too complex.

5 0.45 mm. ×400 magnification is 10 times bigger than ×40, so the field of view is 10 times smaller.

Resources

Student obook

Video link: Cell organelles

A video overview of the common characteristics of cells

http://science.howstuffworks.com/life/28732-assignment-discovery-elements-of-cells-video.htm

Video: Fieldwork introduction

A video explaining how to observe trees and bushes in their natural environment

Video link: Cells and their interaction

This video goes on a microscopic journey through a white blood cell

http://www.xvivo.net/the-inner-life-of-the-cell/

Weblink: Cell size and scale

This website allows students to zoom in on different sized objects from a coffee bean to a carbon atom, including many common cells in between.

http://learn.genetics.utah.edu/content/begin/cells/scale/

Weblink: Cell size interactive

This website allows students to zoom in on tiny objects placed on the head of a pin and compare their sizes.

http://www.cellsalive.com/howbig.htm

Weblink; Cell jigsaw activity

This website enables students to assemble various cells as jigsaw puzzle activities.

http://www.cellsalive.com/puzzles/index.htm

Worksheet 3.3: Plant and animal cells

A printable PDF of Workbook Activity 3.3

Teacher obook

E3.2.2 Comparing plant and animal cells RA LABTECH

A risk assessment template for the preparation of ingredients by the Lab Technician for Experiment 3.2.2

E3.2.2 Comparing plant and animal cells RA

A risk assessment template for students and teachers for Experiment 3.2.2

E3.2.3 Measuring cells RA

A risk assessment template for students and teachers for Experiment 3.2.3

Workbook answers

Answers to all activities in the *Insight Science 7* student workbook

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A closer look at respiration

Teaching support for pages 116–117

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

c outline the role of respiration in providing energy for the activities of cells

Working scientifically

Experiment 3.2.3

SC4-4WS – Questioning and predicting

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Questions 3.2.3

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Experiment 3.2.3

Critical and creative thinking

Literacy

Questions 3.2.3

Critical and creative thinking

Literacy

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Teaching strategies

Teaching tip

Respiration is a key concept in science, and this is one of the few opportunities (as well as in the context of the functioning of multicellular organisms) that you have to develop deep understanding. Great emphasis should be placed on the role of respiration in providing energy for organisms.

Additional information: Mitochondria and respiration

The label on Figure 3.19b indicates that mitochondria contain enzyme complexes. This term will be new to students and probably does not need to be remembered at this stage. A simple explanation, maybe with the example of a digestive enzyme, is sufficient.

It is also worth distinguishing aerobic from non-aerobic respiration and providing an example of anaerobic respiration.

Common misconceptions

Confusion between breathing and respiration is common, and is clarified clearly in the text of this chapter.

The text compares respiration to burning in order to point out similarities, but to avoid misconceptions it is important to point out the differences, particularly their rates and how they both are controlled.

Differentiation

For those with lower abilities:

- A simple activity of blowing out through a straw into limewater will help students remember the change that occurs in limewater when exposed to carbon dioxide.
- Students could use labels and ‘role play’ the processes that occur in Experiment 3.2.3.

For those with higher abilities:

- Students often forget the importance of water as a product of respiration, as they concentrate on the importance of carbon dioxide and energy. Students could research the use of the water from respiration by some animals such as camels, which have little water to drink and use fat reserves for survival.

Extra activities

Starter activity: Discussion

Before taking a closer look at respiration by reading page 116, take a big picture view of respiration. Students need to be reminded that respiration occurs in all living things all of the time because without it, they have no energy. The word equation for respiration should be presented and explained.

Figure 3.19 is useful, as the two images of a mitochondrion show the actual transmission electron microscope image and the three-dimensional labelled model giving an interpretation of the microscopic image. The main point of relating structure to function is the highly complex folding of membranes which could be compared with a production line in a factory, Respiration occurs in a series of small steps, not in one single reaction, and it is the control of the steps that allows living things to release energy in the amounts required.

Activity: Summarising respiration

Students construct a Venn diagram on burning and respiration to highlight the differences as well as the similarities.

Alternatively students construct a diagram to highlight the inputs and outputs of cellular aerobic respiration, placing a diagram of a mitochondrion below the arrow between inputs and outputs to emphasise that it occurs in the mitochondrion.

Extension activity: Evaluating experimental method

Experiment 3.2.3 could be used as a basis of evaluation of experimental method. Further evidence that the carbon dioxide was a result of respiration could be obtained if plants were placed in bottle C instead of snails. Students could be asked to make predictions. The plants could be placed in sunlight without the soda lime. The limewater could be replaced and the experiment repeated in dark conditions.

Practical support

Experiment 3.2.3: The products of respiration (demonstration)

Practical hints

The more small animals used in bottle C, the sooner results will be seen. Mealworms from any pet store are an ideal animal to use.

All stoppers and tubing needs to fit without any air leaks.

This experiment is interesting and works well. Concerns over water usage may, however, cause some reluctance to leave a tap running for this demonstration. A simpler alternative could be to set up a fermentation experiment using yeast. This will demonstrate the production of carbon dioxide as a result of anaerobic respiration.

Place a teaspoon of sugar and a teaspoon of baker's or brewer's yeast in a flask. Add about 100 mL warm water and swirl to dissolve the sugar. Insert a stopper with tubing in the flask and place the end of the

tubing in another flask containing limewater. Leave in a warm spot or incubate the flasks at 35°C. You should see the limewater turn milky within 30 minutes.

Safety

Soda lime is a mixture of 75% calcium hydroxide, 3% sodium hydroxide and 1% potassium hydroxide. It is corrosive to skin and eyes, and is toxic if ingested. Care should be taken when handling this chemical, and eye and skin protection worn when splashes can occur. Students should be prevented from handling this chemical.

- A risk assessment template should be completed before undertaking this Experiment and by the lab technician before preparing the chemicals for it. Suggested templates are provided in the teacher obook resources.

Lab tech notes

Clear 5 mm vinyl tubing purchased from any hardware fits well into stopper holes and removes the need to bend glass tubing. U tubes can be fragile – take care when handling.

Results and discussion

Bubbles are seen in both bottles B and D as air is being sucked through the system.

The limewater in bottle B remains clear while that in bottles D becomes milky.

When carbon dioxide is bubbled through limewater (calcium hydroxide), insoluble calcium carbonate is formed which turns the limewater milky. This is a standard test for carbon dioxide.

The air bubbling through bottle B has passed through the soda lime ‘scrubber’, which removes any carbon dioxide from it. However, the air bubbling through bottle D contains the carbon dioxide produced in cellular respiration from the animals.

Any water vapour formed during respiration in the animals would be drawn out by the vacuum into the limewater in bottle D and therefore would not be detected.

1 Observations

Bottle B	**Bottle C**	**Bottle D**
The limewater stayed clear.	The bottle became foggy, with condensation on the inside.	The limewater turned milky.

2 The limewater in bottles B and D bubbled when the air started to flow. (If set up correctly)

3 The limewater in bottle B stayed the same, clear at the end of the investigation. The limewater in bottle D turned milky.

4 Limewater was used to detect carbon dioxide gas. Limewater turns milky in the presence of carbon dioxide.

5 The limewater in bottle B remained clear because the soda lime had absorbed the carbon dioxide from the incoming air.

6 The bottle C went foggy as evidence that water was being produced by the snails. To check this, the experiment should be repeated with bottle C empty.

7 Limewater in bottle D turned milky indicating that the snails had produced carbon dioxide.

8 Respiration was happening in the cells of the snails

Answers

Questions 3.2.3 answers

1 Cellular respiration occurs in the mitochondria in cells.

2 Cellular respiration occurs constantly because cells need energy all of the time.

3 The source of energy for cellular respiration is the chemical energy in glucose.

4 Respiration is a chemical reaction that occurs within mitochondria inside cells. Breathing is a physical process of drawing air into and out of the body.

5 Muscle cells, organ cells that produce chemicals, and nerve cells would have the most because they are constantly working and need lots of energy. Skin and bone cells do not require much energy and so would only have a few mitochondria.

6 oxygen + glucose → carbon dioxide + water

Resources

Student obook

Worksheet 3.4: Respiration and cells

A printable PDF of Workbook Activity 3.4

Teacher obook

E3.2.4 The products of respiration RA LABTECH

A risk assessment template for the preparation of ingredients by the Lab Technician for Experiment 3.2.4

E3.2.4 The products of respiration RA

A risk assessment template for students and teachers for Experiment 3.2.4

Workbook answers

Answers to all activities in the *Insight Science 7* student workbook

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Cell division

Teaching support for pages 118–119

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

d identify that new cells are produced by cell division

Working scientifically

Questions 3.2.4

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Questions 3.2.4

Critical and creative thinking

Literacy

Extra activities

Starter activity: Cell division numeracy

Engage students in a numeracy exercise. If a bacterium divides every 20 minutes, how many bacteria will be produced in six hours?

Activity: Cell division

Many animations and time lapse photography films of mitosis are available on the Internet. A quick search will provide lots of relevant material. Students could be asked to role play or model this form of cell division.

Activity: Summary

Students could be provided with sets of diagrams that summarise the main phases of mitosis. They have to try to put them in the correct sequence to demonstrate what has to occur in cell division to ensure that the daughter cells have the essential components of a cell and are genetically the same as the parent.

Teaching strategies

Additional information: Cancer cells

As the 'Deeper understanding' box explains, cancer is really the result of the failure of cell death as well as uncontrolled cell reproduction.

Common misconceptions

Some students believe that all cells can divide and produce more cells of the same kind. It is a good idea to introduce the concept of cell specialisation and differentiation and stem cells. Stem cell research and understanding has changed dramatically, and has implications for the development of treatments for many diseases.

Differentiation

For those with lower abilities:

- The use of similes, metaphors and analogies may be beneficial for students with lower abilities. One to possibly discuss is: Cell division is like a production line in a factory.

For those with higher abilities:

- Some more able students may enjoy seeing some microscope slides of dividing tissues such as root tips, or having the phases of cell division identified. For the highly interested and capable students the concept of a special type of cell division that results in the production of sex cells, meiosis, could be researched.
- Discuss this quote with students. 'Science is built up of facts like a house is built up of stones; but an accumulation of facts is no more a science than a heap of stones is a house' – Henri Poincare.

Answers

Literacy builder support

Other possible similes that could be analysed in class include:

• The mitochondria are like power stations.

• The chloroplasts are like photovoltaic cells.

• The nucleus is like Parliament.

• The vacuole is like a water tank (or septic tank).

• A red blood cell is like a car.

• If a cell is like a house, the cytoplasm is like the air in the rooms.

Literacy builder answers

1 It is likely that the similes will be different between groups.

2 Similes are useful because they help you to imagine how something works or its structure. They help your mind to move from the known to the unknown.

3 Similes are not scientifically accurate, and they are an informal way of communicating science ideas, so they should not be used in formal science communications.

4 Similes are used in English, but could also be used in history, geography and many other subjects.

5 Most students do not have trouble making comparisons. One strategy could be to list the features and characteristics of the thing you are describing and then make links to other things.

Questions 3.2.4 answers

1 Cells need to be made to replace old cells and damaged cells, and to provide new cells for growth and reproduction. Cell division also allows for the production of specialised cells to carry out specialised functions.

2 DNA is the substance that provides instructions for the cell. It is found in the nucleus of the cell.

3 DNA must be copied so that a full set of instructions is passed on to the new cell, otherwise the DNA would be halved each time the cell divided.

4 The process of making an identical copy of DNA is called replication.

5 Apoptosis is the programmed death of a cell. It occurs if DNA is damaged or the cell is old.

6 Malignant tumours are cancerous and continue to grow and spread. Benign tumours tend not to spread to other parts of the body and do not grow back if removed.

7 DNA is located in the nucleus. During the first stages of cell division, the nucleus breaks down to allow the DNA to replicate and separate into separate cells. After the DNA has separated, two new nuclei form around it, one in each cell.

8 Binary fission produces an exact copy of the whole organism in one go. This is possible for unicellular organisms because they only have one cell. Multicellular organisms cannot reproduce every cell at the same time because multicellular organisms are too complex.

9 Students will need to do some independent research. This flowchart could cover Interphase, Prophase, Metaphase, Anaphase and Telophase, even though these terms are not required to be covered in Stage 4 of the curriculum.

10 DNA is sometimes called the blueprint for the cell.

Resources

Student obook

Video: Cell reproduction

A short video explaining how cells reproduce

http://videos.howstuffworks.com/discovery/31977-assignment-discovery-cell-reproduction-video.htm

Weblink: Animal cell mitosis

This website contains a step-by-step animation of the process of cell mitosis showing the processes that occur at each stage.

http://www.cellsalive.com/mitosis.htm

Worksheet 3.5: Cell division

A printable PDF of Workbook Activity 3.5

Teacher obook

Workbook answers

Answers to all activities in the *Insight Science 7* student workbook

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3.2 Checkpoint

Teaching support for page 120

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

b identify structures within cells, including the nucleus, cytoplasm, cell membrane, cell wall and chloroplast, and describe their functions

c outline the role of respiration in providing energy for the activities of cells

d identify that new cells are produced by cell division

Working scientifically

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Critical and creative thinking

Literacy

Answers

Checkpoint 3.2 answers

1 The type of cell division that results in the creation of cells identical to the parent and assists growth and repair of tissues is called mitosis.

2 The cell membrane controls the flow of substances into and out of cells.

3 Plant cells have a cell wall and chloroplasts while animal cells do not. Plant cells have one large vacuole while animal cells tend to have lots of small ones.

4 Mitochondria carry out cellular or aerobic respiration.

5 Substances that need to enter cells include glucose, oxygen and water. Substances that need to leave cells include carbon dioxide. In the case of plant cells, the passage of carbon dioxide may need to be in and the oxygen out when photosynthesis is occurring. Cells may also, from time to time, need to exclude water, ammonia or urea.

6 Heart muscle cells – high; skin cells – medium; bone cells – low. The more energy a cell requires to move or to produce substances, the more mitochondria it will require. The heart is constantly beating so it requires a high number. Skin tissue cells grow hair, secrete oil, and have nerve endings that fire, so they have fewer than heart cells but still quite a few. There are several types of bone cells, but once the bone has been secreted, it will require little energy and will therefore need fewer mitochondria.

7 Mustard gas (poisonous gas from World War 1), nitrous acid (found in the atmosphere when nitric oxide, a by-product of combustion in cars, reacts with water) and acridine orange (laboratory dye) are mutagens. This means that these chemicals cause a change in the structure of the inherited material, DNA. Their impacts can be minimised by avoiding contact or inhalation of these substances. Ionising radiation as occurs in ultraviolet light and X-rays is also linked to cancer through the changes it promotes to the genetic material.

8 The green leafy part of the onion is responsible for photosynthesis, and so the cells would contain many chloroplasts to carry out the photosynthesis reactions. The presence of so many chloroplasts in the cells gives the leaves their green appearance. The white cells in the stem would not be exposed to light and would not contain the chloroplasts or have the green colour.

9 Student responses may vary, but could include: Pfeiffer J and Editors of LIFE (1965) The Cell Life Science Library, Time-Life International

Meiosis	**Mitosis**
Daughter cells have half the genetic material	Daughter cells have identical genetic material
Occurs in sex organs only	Occurs where growth and repair is happening in organisms

10 a – muscle cell: Muscle cells are long and thin which would help them contract to move parts of the body. b – white blood cells: The white blood cells are round, which helps their movement through blood vessels; they have a rough surface that may be associated with the ability of the cells to detect and respond to foreign cells. c – nerve cells (neurons): The nerve cells have long projections which mean that the nerve impulses can travel great distances before having to move to the next cell.

assess

3.2 Cell structure and function assessments

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Support

Consolidate

Extend

Resources

Teacher obook

Checkpoint 3.2 Worksheet A

Students who score less than 10 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet A, which is designed for extra support.

Checkpoint 3.2 Worksheet A answers

Answers for Checkpoint Worksheet A

Checkpoint 3.2 Worksheet B

Students who score between 10 and 20 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet B, which is designed for consolidation.

Checkpoint 3.2 Worksheet B answers

Answers for Checkpoint Worksheet B

Checkpoint 3.2 Worksheet C

Students who score more than 20 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet C, which is designed for extension.

Checkpoint 3.2 Worksheet C answers

Answers for Checkpoint Worksheet C

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How organisms function

Teaching support for pages 121–125

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

SC4-15LW A student explains how new biological evidence changes people's understanding of the world

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

e distinguish between unicellular and multicellular organisms

f identify that different types of cells make up the tissues, organs and organ systems of multicellular organisms

Working scientifically

Activity 3.3.1

SC4-4WS – Questioning and predicting

SC4-8WS – Communicating

Activity 3.3.2

SC4-4WS – Questioning and predicting

SC4-5WS – Planning investigations

SC4-6WS – Conducting investigations

SC4-8WS – Problem solving

SC4-9WS – Communicating

Questions 3.3.1

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Activity 3.3.1

Critical and creative thinking

Personal and social capability

Literacy

Activity 3.3.2

Critical and creative thinking

Personal and social capability

Literacy

Questions 3.3.1

Critical and creative thinking

Personal and social capability

Literacy

Teaching strategies

Introducing section 3.3

Students have just learnt about cells, their structure, function and variety. In multicellular organisms, as well as carrying out their functions, the individual cells need to receive their requirements and have their wastes removed. This is achieved because the cells of the same type are organised into tissues. A range of different tissues are organised within organs that carry out specific functions that relate to the composite tissues and the organ structure. The organs themselves are organised into organ systems that work to achieve a major bodily function. Examples include the root system that absorbs water and mineral nutrients from the soil. The analogy of cells being like building bricks is frequently made. If we take this analogy one step further, the walls in a building are the tissues, and the rooms are the organs that carry out functions, such as bedrooms, kitchens, bathrooms etc., so that the needs of the people living in the house are met.

This section of the chapter provides a transition to the work students will do in Year 8 when they learn about the body's organ systems in more detail.

Teaching strategy: Different types of cells

Brainstorm a list of suggestions to complete the statement: 'The human body is made up of: …'.

This list could then be combined by student groups into a concept map. This helps planning so that the focus can be on bridging the gap between student understandings and the goal to understand the relationship between cells, tissues, organs and organ systems.

Additional information

Consideration of inputs and outputs highlights the digestive, respiratory, excretory and circulatory systems. Organ systems also include the nervous, endocrine, lymphatic and musculoskeletal systems. Multicellular organisms, because of their size, need to be able to obtain more nutrients than unicellular organisms; so in the case of animals, systems to support effective food gathering/capturing, avoidance of predators, etc. are also required.

Common misconceptions

Not all body systems are involved with inputs and outputs. The size and complexity of multicellular organisms means control and coordination systems to enable organisms to respond and reproduce are also necessary, even if they do not become part of inputs and outputs.

Differentiation

For those with lower abilities:

- Invent an organism from outer space. Draw a diagram and label inputs and outputs, and suggest some processes that occur to convert inputs into outputs.

For those with higher abilities:

- Compare inputs and outputs of plants with those of animals, and the processes that occur internally that convert the inputs to outputs.

Teaching tip: Cells, tissues and organs

The relationship between tissues and organs is the only relationship that is not fully expanded upon in this section or later chapters. Suggestions for how to do this are contained in ‘Activity: Cells, tissues and organs’, below. This is another area where students could be encouraged to develop analogies or similes to explain the relationship between cells, tissues and organs.

Additional information

More examples of tissues that relate to function include:

- Ciliated epithelial cells line the nasal septum, trachea and bronchi. The beating of the cilia of these cells helps to remove dust and other particles from the respiratory system.
- Columnar epithelial cells line the digestive tract where they have a role in secretion, absorption or protection.
- Cuboidal epithelial cells line the kidney tubules, salivary and pancreatic ducts where they secrete, excrete or absorb.

- Stratified squamous epithelial cells, because of their many layers, serve to protect the vagina, anus, oesophagus and mouth.

Common misconceptions

The term tissue is commonly used in a variety of ways. Skin is often referred to as a tissue or an organ. A tissue is not just a small piece of an organ but a group of cells that perform a particular role. The fact that many body organs appear in such neat packages is a result of squamous epithelial tissues that usually encompass visceral organs, line the body cavities and are important parts of the alveoli and capillaries. Squamous cells are thin and support diffusion and filtration.

Differentiation

For those with lower abilities:

- Use the Internet interactives or games to explore the human body (see the *BBC* website under the Resources tab for some ideas)

For those with higher abilities:

- Students research the new technologies that help medical science explore the human body without invasive surgery.
- Students research organisms that have an open circulatory system, as opposed to the human closed circulation. Describe the organism and what an open circulatory system involves, and how this impacts on the functioning of the organism.
- Students research how transport occurs in plants. What types of cell/tissues are involved and what organs? How are these different in the root system compared with the shoot system?

Extra activities

Extension activity: Research simple multicellular organisms

Investigate some very simple multicellular organisms such as corals, sea anemones, kelp or jellyfish that are in some senses a transition between unicellular organisms and complex multicellular organisms.

Activity: Summary of inputs and outputs

Students could research the components of a healthy diet and how its components relate to the other organ systems. For example, the importance of vitamin A for eyesight, carbohydrate to provide glucose for energy, calcium for strong bones, iron for carrying oxygen, etc. Students could record their daily intake of food for a number of days and then evaluate their diet.

Activity: Cells, tissues and organs

To build up the understanding of the relationship between cells, tissues, organs and organ systems, students could do research in greater depth into the types and functions of human tissues. They could then use this later in the unit, to analyse the diagram of the structure of the organ skin, and identify where nerve, connective and epithelial tissues occur. Understanding the role of tissues is fundamental to understanding the relationship between cells and organs. Some students may do similar analyses of other organs, such as the heart or lungs.

Activity: Major body systems

This section is just an introduction to organ systems, as they are treated in more detail later in Stage 4 science (in Chapter 2 of the Year 8 student book).

Simple activities such as measuring lung volume or doing aerobic fitness tests such as recovery rates helps students link the organ systems with their own body functioning. This is a good opportunity to further develop skills in preparing labelled diagrams and writing explanations linking structure to function.

Students could research a disease that is related to the failure of an organ and hence the organ system. For example they could look at diseases such as lung cancer, TB or mesothelioma on the effectiveness of the lungs and the respiratory system.

Activity: Summary of body systems

Compare an organism with an institution such as a hospital. For example, the inputs in a hospital are sick patients and the outputs are the recovered people. What are the processes? What types of resources and interactions go on within a building to coordinate the whole process? Can you draw any similarities with tissues, organs and organ systems?

Practical support

Activity 3.3.1 support

1 Many students may not be able to link the inputs to outputs or identify the processes that occur at this stage of their science learning. Refresh respiration and relate this to the input of oxygen and the output of carbon dioxide (and water). Most students can link food inputs to the faeces output, but many biologists regard the digestive tract as external to the body, and that food is only truly inside the body when it has been sufficiently digested to be absorbed into the blood. You may need to explain that the urine output consists of wastes of urea, from the processing of protein for energy and water, and salts depending on inputs and body requirements.

2 Again, you cannot assume that students already have knowledge of the body processes that convert inputs to outputs. Using the example of respiration, you might need to explain how the oxygen gets to body cells and how the carbon dioxide is carried back through the blood to the lungs. You may just choose to name some processes such as absorption, transport and excretion, and link to types of cells that might facilitate absorption (squamous epithelial – very thin).

3 Unicellular organisms do not have the complexity, as there is very little need for transport within the one cell. Materials can be more easily absorbed and excreted. In another sense, unicellular organisms are more complex because they have to carry out all tasks of living things, whereas cells in multicellular organisms are specialised so may not carry out all aspects of life function such as reproduction.

Activity 3.3.2 support

Safety

- Students need to lie on the floor for this activity, so ensure floor surface is clean and free from any spills.
- Care should be taken to avoid treading/trampling injury to students lying on the floor.
- A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Answers

Questions 3.3.1 answers

1 Unicellular and multicellular organisms both need to obtain nutrients, produce and remove wastes, exchange gases, respond to their environment and reproduce.

2 Cells, tissues, organs, organ systems, multicellular organisms

3 Student responses will vary but should refer to pages 123–4 in the student book and may include:

a Red blood cell, muscle cell, nerve cell

b Epithelial, connective and nerve tissue

c Heart, liver, lungs

d Digestive system, circulatory system, respiratory system

4 The tongue is best described as an organ. It is made up of different tissues – taste buds, muscle and connective tissue – which work together to perform specific roles. The tongue is a part of the digestive system, but is also involved in speech.

5

Circulatory – Heart – To transport nutrients to and wastes away from all cells in the body

Nervous – Brain – To detect and respond to changes both within the body and the external environment

Urinary – Kidneys – To filter wastes from the blood and maintain fluid balance within the body

Respiratory – Lungs – To exchange gases (oxygen in and carbon dioxide out) between the body and the external environment

6 a If one system performed all jobs, then if something went wrong all functions would stop and the body would likely die. Specialisation of cells, tissues, organs and organ systems allows their structures to match specific functions and so they can function more efficiently.

b If one system failed, the body would become ill, but would not necessarily die. It gives the body time to recover if one system fails. Some of the organ systems are essential to survival – such as the circulatory, respiratory or nervous systems – and their failure usually results in death.

Resources

Student obook

Weblink: From cells to systems

Students can use this website for revision and testing on cells, tissues, organs and systems.

http://www.bbc.co.uk/bitesize/ks3/science/organisms_behaviour_health/cells_systems/activity/

Weblink: Body tissues guide

This website contains information on the various types of tissue found in humans.

http://www.eoearth.org/view/article/156642/

Weblink: BBC interactive body

Interactive human organs game and other games on various body systems

http://www.bbc.co.uk/science/humanbody/body/index_interactivebody.shtml

Weblink: Body system interactive diagrams

This website contains information and quizzes on all of the body systems.

http://www.innerbody.com/

Worksheet 3.6: Cells, tissues and organs

A printable PDF of Workbook Activity 3.6

Teacher obook

A3. 3.2 Brown paper brainstorm RA

A risk assessment template for students and teachers for Activity 3.3.2

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Workbook answers

Answers to all activities in the *Insight Science 7* student workbook

Weblink: Interactive games

eHow website where teachers can access a number of interactive game ideas about the human body.

www.ehow.com/list_6187090_human-body-interactive-games.html

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Anatomy of skin

Teaching support for pages 126–129

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

SC4-15LW A student explains how new biological evidence changes people's understanding of the world

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

e distinguish between unicellular and multicellular organisms

f identify that different types of cells make up the tissues, organs and organ systems of multicellular organisms

Teaching strategies

Teaching strategy: Anatomy of skin

Students can easily confuse the order of the layers of skin and their key features. Encourage students to create their own mnemonic to help them remember this information.

Differentiation

For those with lower abilities:

- Interactive quiz in *SunSmart Millionaire* website (see Resources tab) helps students remember the parts of skin

For those with higher abilities:

- Students research the latest treatment for burns. Why are burns so dangerous and painful?
- Students research the hole in the ozone layer, how it is caused and how it impacts on the penetration of ultraviolet light through the atmosphere.

Differentiation

For those with lower abilities:

- The *Get Body Smart* site has a simple illustration of skin structure that students can use.

For those with higher abilities:

- Research the skin/epidermis structure of another organism/leaf and compare with human skin.

Extra activities

Starter activity: Discussion

The skin is accepted as being an organ system in itself (integumentary system), but is also referred to as both tissue and an organ. Discuss with the students each of these classifications. Decide which is the most accurate and why.

Activity: Anatomy of the skin

Students use the diagram of the layers and structure of the skin to identify how different tissues are combined to produce such an important organ. Students can research two situations in which protective clothing is needed to prevent damage to the skin in the workplace. The clothing can protect from forms of radiation or from chemicals that damage the body.

Activity: Skin sensitivity

Engage students with a quick investigation. Students can tape two new, clean nails to a ruler so that the points of the nails are about 1cm apart. The points of the nails are then gently touched against the hand of a blindfolded student who has to identify whether they sense one or two points. Students can investigate how far apart the nails need to be before 2 points are consistently detected. They could also investigate the sensitivity of parts of the skin. For example, is the palm of the hand or the fingertips more sensitive? Are the soles of the feet more or less sensitive than the back of the hand?

Alternatively, students place both their hands in a container of room temperature tap water. They then move one hand into warm water and the other into ice-cold water. They return their hands to the tap water container and describe how hot/cold each hand feels.

Extension activity: Research

Students could research fingerprints and their importance in forensic investigations.

Answers

Questions 3.3.2 answers

1 Epidermis, dermis and subcutaneous fat layer

2 The skin acts as a solid barrier to prevent unwanted chemicals and microbes from entering the body, which may potentially make us sick. The skin is vital in preventing excessive water loss and dehydration.

3 Subcutaneous means under the skin. This layer of skin stores energy for the body, provides the body with insulation helping it maintain a relatively constant temperature, and acts as a cushion to help reduce the impact of knocks and bruises.

4 Sebum is the oil that coats the skin and it is produced by oil glands in the skin.

5 We lose approximately 1 g of dead skin cells a day. 1 × 365 days a year = 365 g of dead skin a year. The average life span is around 80 years. So 365 × 80 = 29200 g = 29.2 kg. This is similar to the weight of a dog about the size of a Labrador.

6 Student responses will vary. Insist that they justify their opinion.

7 Student responses will vary. Most students will agree that skin could be an organ or a system, but not really a tissue, because it is made up of distinct tissue types (dermis, epidermis, subcutaneous fat, hair, nerve tissue, etc.).

8 Student responses will vary.

9 Student responses will vary.

Practical support

Literacy builder support

1 Clare's death was caused by melanoma.

2 Student responses may vary, but could include things such as her young age when she died, the fact that if she had really understood what would happen she could have chosen differently, and also the fact that she had taken up a cause with courage to try to prevent other people suffering.

3 Clare had tumours in her armpit, neck, chest and lungs.

4 Clare was treated with immunotherapy and radiotherapy.

5 Clare had malignant tumours because they spread throughout her body.

6 Student responses will vary. Some students may argue that people should still have the choice to take their own risks. Others may argue that people should be protected from such dangers until they are old enough to understand the risks.

Experiment 3.3.1 support

Safety

- Slides and cover slips are made of glass so can be broken.
- A risk assessment should be completed before undertaking this Experiment. A suggested risk assessment template is provided in the teacher obook resources.

Discussion

When using the higher magnification of the stereo microscope rather than the magnifying glass more detail will be apparent. Dead skin cells, hairs, and pores will be visible as well as small beads of sweat on the pores of the skin.

Students may not recognise the prepared slides as skin. A cross section slide of skin will show three distinct layers: the thin epidermis with dead skin cells and a layer of growth, the thicker dermis layer beneath that with connective tissue and blood vessels and the subcutaneous fat layer with large fat cells.

Conclusion

Students should note that the skin's three layers act together to function as a system. The outer epidermis acts to protect the underlying layers, continually producing cells to replace those that are lost on the surface. The dermis' elastic fibres and collagen supports and strengthens the skin. The subcutaneous fat layer acts as a store of energy and provides insulation and cushioning. As a system the skin helps regulate the body temperature, is an important sensory organ, stores food in the form of fat and helps prevent tissue below it drying out.

Resources

Student obook

Weblink: Structure and functions of the skin

This website contains information on the structure and functions of the skin.

http://www.hse.gov.uk/skin/professional/causes/structure.htm

Weblink: SunSmart Millionaire

A learning tool for students to test their sun smart knowledge.

http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/sunsmart/

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3.3 Checkpoint

Teaching support for pages 130–131

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

e distinguish between unicellular and multicellular organisms

f identify that different types of cells make up the tissues, organs and organ systems of multicellular organisms

Working scientifically

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Literacy

Critical and creative thinking

Numeracy

Personal and social capability

Information and communication technology capability

Answers

Checkpoint 3.3 answers

1 Student responses will vary, but may include: Unicellular organisms – amoeba and euglena; Multicellular organisms – humans and the river red gum tree.

2 Body systems: Sets of organs that carry out a major function within the living organism. For example, the digestive system consists of organs such as the oesophagus, stomach, small intestine, pancreas, liver, gall bladder, large intestine, rectum and anus that all work together to break down food so that it is absorbed into the body and transported to where it is either further processed or used. In summary, it helps the body meet its nutritional requirements.

Organs: Sets of tissues that work together to carry out a more discrete function. The stomach is an organ within the digestive system that commences the breakdown of proteins, adds moisture and physically churns the food so that it is more readily converted into small particles that can pass into the blood and be transported to where it is required. Some organs, such as the liver and pancreas, carry out functions that are associated with more than one body system.

3 a The papillae are part of the dermis; they are finger-like projections that help to join the dermis to the epidermis above it.

b The hair roots are found in the dermis.

c You see the epidermis or upper surface of the skin.

d Fat cells are located in the subcutaneous layer.

e Sensory nerves are located in the dermis.

f The top layer of cells in the epidermis is constantly sloughing off and being replaced from below. The cells become part of household dust.

4 a Circulatory system

b Digestive system

c Skeletal system

5 a Circulatory system: heart, arteries, capillaries and veins

b Digestive system: stomach, liver, intestines

c Skeletal system: bones, skull

6 a – Hair; b – Epidermis; c – Dermis; d – Subcutaneous fat layer; e – Sweat gland

7 Far left (different cells): cells. Top left (kidney): organ. Top middle (skin cross section): organ or body system. Top right (heart): organ. Bottom left (soccer girl): organism. Middle bottom (respiratory system): body system. Bottom right (digestive system): body system.

8 Elastic fibres in the dermis allow the skin to return to its original shape after stretching. If they were not present (and students may like to compare skin from young people with that of older people, whose skin has lost elasticity), the skin would break much more easily. This could reduce the protective role of the skin.

9 Amoeba cells appear similar as they are unicellular organisms and carry out all of the necessary functions of living things. Cells in multicellular humans are more specialised – humans are much larger, multicellular organisms and have many types of cells that work together in tissues, organs and body systems to achieve all the functions of living things.

10 Loss of elastic fibres in the dermis of the skin in older people means that the skin loses its ability to return to its original shape after being stretched. This results in the formation of wrinkles.

11 There is no one correct answer to this question, but insist that students justify their opinion. For example: The nervous system is the most important system, because without it you are instantly dead. If other systems such as digestion fail (or for example people are on a hunger strike), they may take days or even weeks to die. The nervous system is important because it controls response to internal and external environment changes.

12 Student responses may vary. For example: Both the human body and machines have inputs and outputs. Both the human body and machines can malfunction, but in the case of the human, the body systems can carry out some repair, and if unsuccessful, medical intervention is necessary or death may result. A machine, such as a car, may have parts that malfunction, but it always requires human intervention for repair. Both humans and machines can respond to changes in the environment, but with machines this is a result of automation or computer control that was designed by humans. The key differences between living humans and non-living machines are the abilities to grow and reproduce.

13 Student responses will vary, but mostly should discuss that fact that not only are humans more complex, they are larger and therefore their body systems will have to work more extensively. Aquatic organisms such as tadpoles may still have many body functions, such as exchange of some gases, and do not require an extensive circulatory system. Some more simple organisms such as earthworms have bodies that are based on repeating segments, which also simplifies the complexity of the body systems.

14 The text cites the average adult skin surface area to be between 1.5 and 2 square metres. Answers will vary depending on the size of a student compared with an adult. Students may have to assume some body parts are regular shapes for their calculations. This may be an opportunity to use spreadsheets to carry out the calculations. This is an ideal activity to assess that students understand the difference between volume and surface area.

15 Student responses will vary.

16 Student responses will vary. For example: Cats would have a skin that contains a greater density of hair follicles and a lot fewer (or no) sweat glands compared to that of human skins. The blood supply around the hair follicles is probably greater as there is more fur growth. There are also probably fewer sensory nerves below the dense covering of fur.

17 ‘Skin hydration’ moisturisers would promote the absorption of water by the cells in either the dermis or subcutaneous fat layers so that their volume was increased. For skin that is wrinkled, because it

has lost elastic fibres, the increased volume would make the skin return to a more stretched condition and appear less wrinkled. Many cosmetics ads are cleverly worded to claim the skin is 'younger looking' rather than actually rejuvenated.

18 Student responses will vary. For example: 'I am in love with my skin because it is so big, it repairs and renews itself constantly and it is what I show to the outside world. The skin is my protector and it gives me a lot of pleasure when I explore things through my sense of touch'.

assess

3.3 Different types of cells assessments

Support

Consolidate

Extend

Resources

Teacher obook

Checkpoint 3.3 Worksheet A

Students who score less than 20 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet A, which is designed for extra support.

Checkpoint 3.3 Worksheet A answers

Answers for Checkpoint Worksheet A

Checkpoint 3.3 Worksheet B

Students who score between 20 and 50 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet B, which is designed for consolidation.

Checkpoint 3.3 Worksheet B Answers

Answers for Checkpoint Worksheet B

Checkpoint 3.3 Worksheet C

Students who score more than 50 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet C, which is designed for extension.

Checkpoint 3.3 Worksheet C answers

Answers for Checkpoint Worksheet C

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3 Chapter review

Teaching support for pages 132–133

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

a identify that living things are made of cells

b identify structures within cells, including the nucleus, cytoplasm, cell membrane, cell wall and chloroplast, and describe their functions

c outline the role of respiration in providing energy for the activities of cells

d identify that new cells are produced by cell division

e distinguish between unicellular and multicellular organisms

f identify that different types of cells make up the tissues, organs and organ systems of multicellular organisms

Working scientifically

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Literacy

Critical and creative thinking

Information and communication technology capability

Answers

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Chapter 3 review answers

1 When calculating the total magnification of a microscope, you multiply the magnification of the eyepiece lens by the magnification of the objective lens.

All living things are made up of cells. New cells are produced by existing cells through a process called mitosis.

Most cells contain smaller structures within them called organelles. Not all cells contain the same components. Plant cells contain organelles such as chloroplasts and cell walls whereas animal cells do not. Bacterial cells do not contain any organelles at all.

Respiration is a process where energy is made available for the activity of cells. This process uses oxygen and sugar and produces a waste gas called carbon dioxide and water.

2 Cells are the smallest unit of life and the building blocks of all organisms.

3 Cells were first seen by Robert Hooke in 1665 after the invention the first microscopes. He describe the honeycomb appearance of a cork specimen as containing 'cells' because the sections reminded him of rooms in a monastery.

4 Plastic is not made of cells. It is a material substance and non-living. It cannot perform any of the requirements of living things, and when examined under a microscope, no cells are visible.

5 Nucleus: The 'control centre' of the cell. Cytoplasm: The jelly-like substance that helps the cell to maintain its structure. Cell membrane: A double-walled region that keeps the cell's internal environment from the external environment. Cell wall: Found only in plants, this helps plant structure, particularly in plants that are not woody. Chloroplast: Found only in plants. This is what makes plants green and where photosynthesis occurs. Mitochondria: The 'power house' of the cell. This organelle creates and stores energy for the cell's use.

6

Organelle	Found in an animal cell	Found in a plant cell
Nucleus	Yes	Yes
Cell wall	No	Yes
Cell membrane	Yes	Yes
Cytoplasm	Yes	Yes
Mitochondria	Yes	Yes
Chloroplast	No	Yes
Vacuole	Yes, usually small and numerous	Yes, usually one large
Ribosomes	Yes	Yes

7 The process by which energy is released from glucose using oxygen and also produces water and carbon dioxide is called respiration. Aerobic respiration occurs in the rod-shaped organelle, the mitochondrion.

8 The products of respiration are water and carbon dioxide. Water is often reused by the cell for other processes, but carbon dioxide is expelled as a 'waste product'.

9 Cells divide in multicellular organisms to allow the organism to grow, repair and replace damaged parts and reproduce. Unicellular organisms divide primarily for reproduction. Significant damage to a unicellular organism usually results in death. Cells reproduce or carry out cell division in a process called mitosis. The resulting cells in multicellular organisms are used for repair and growth. In some cases, multicellular organisms use mitotic cell division for regeneration of parts or reproduction, e.g. tubers on potatoes. The genetic material DNA replicates and then the cell components separate to form two cells genetically identical with the parent cell. In unicellular organisms such as bacteria, cells divide in a process called binary fission as a way of reproduction.

10 Student responses will vary, but should at the very least show the DNA replicating before the cells divide. DNA should end up in both daughter cells. Students with higher abilities may demonstrate the detailed stages, interphase, prophase, metaphase, anaphase and telophase.

11 Unicellular organisms consist of only one cell whereas a multicellular organism consists of more than one cell. Both types of organisms carry out the functions of living things, such as respond, take in nutrition, reproduce, produce wastes and exchange gases. Multicellular organisms mostly consist of different cell types that have differentiated to carry out specialised functions because of their specialised structures.

12 Unicellular organisms need to carry out all of the functions of living things and so must be generalists. Multicellular organisms have specialised cells that become particularly good at one function to allow the organism to function efficiently. The different cells must work together for the organism to survive.

13 Multicellular organisms are made up of many cells. Cells that have specialised to do the same particular job (e.g. to expand and contract) are called a tissue (muscle tissue). When different tissues join and work together to perform a function (connective tissue, arterial tissue and muscle tissue working together to pump blood around the body) they are called an organ. When multiple organs and tissues work together to perform a complex function (the heart, arteries, capillaries and veins work together to bring nutrients to all cells and remove their wastes) they form an organ system. Multiple systems work together to maintain a healthy and functioning organism.

14 Student responses will vary, but must include uncontrolled cell division and growth as the cause of the problems.

15 Epidermal cells, dermal cells, hair cells, sweat gland cells, fat cells, blood vessel cells and nerve cells are all included in skin tissue.

Research

Research tasks are an effective way of assessing learning and other capabilities, and can be used effectively as an assessment task in lieu of or alongside other methods of assessment. The four topics presented give students a choice based on their interests and some control over their learning.

Students may require specific questions and guidelines when doing research.

Stem cells

- What is the difference between adult and embryonic stem cells?
- What are the ethical issues in stem cell research?
- Describe a potential benefit of stem cell research.
- How might medicine be different in 50 years if the development and use of stem cells for the treatment of some diseases became possible?

Two types of cells

- Distinguish the two main groups of prokaryotic cells.
- Describe the environment of an extremeophile, and how it has changed our understanding of living things.
- Construct a Venn diagram that compares the structures and functions of prokaryotic and eukaryotic cells.
- There is a school of thought that mitochondria were once independent prokaryotic cells that were engulfed by another cell but continued to still operate within the cell. What evidence is there to support this idea?

The first cells

- Outline the theory of spontaneous generation.
- Describe the work of Haldane and Oparin who suggested the conditions under which life may have arisen.
- Link the experiments of Urey and Miller with Haldane and Oparin's ideas.
- Contrast the ideas of Haldane and Oparin with either the cosmic ancestry (panspermia) ideas or the idea that life on Earth could have arisen in the deep-sea oceanic volcanic vents.

DNA

- Structured questions are provided in the text for this topic.

assess

Chapter 3 testbank

Each chapter of the *Insight Science 7* student text includes related assessments and testbank questions that are graded for student ability and linked directly to the outcome statement codes in the Australian Curriculum for NSW syllabus.

Assessments

Assessments are auto-marking multiple choice quizzes. Questions are graduated in difficulty so teachers can assign as appropriate to students:

- Support (foundation)
- Consolidate (standard)
- Extend (advanced)

Students can review their quiz results to see which questions they answered correctly or incorrectly. Students can improve their results by attempting the quiz again with the challenge of randomised answer options.

Testbank

Testbank provides teacher-only access to ready-made chapter tests. They consist of a range of multiple choice, short answer and extended response questions with marking guidance for each short and extended response question. Multiple choice questions are auto-graded.

The testbank can be used to generate tests for end of chapter, mid-year or end of year tests. Tests can be printed, downloaded, or assigned online.

Assigning tests

In order to assign work to students, your students must first:

(i) have the obook in their Oxford Digital library;

(ii) have linked to your Oxford Digital account; and

(iii) be added to a class you have created.

1 For a step-by-step guide on **getting started with your class set-up**, click here:
https://obook2.oxforddigital.com.au/teacher/classadmin.html

2 For a step-by-step guide on **assigning assessment for students**, click here:
https://obook2.oxforddigital.com.au/help/assess/Assigning_work_using_assess_teachers.html

Results

Student results can be monitored and graphed, or exported to Excel for incorporation into an LMS.

3 For a step-by-step guide on **using results in assess**, click here:
https://obook2.oxforddigital.com.au/help/assess/Using_results_in_assess_Teachers.html

Resources

Student obook

OXFORD UNIVERSITY PRESS AUSTRALIA & NEW ZEALAND

Flashcard glossary

A review of the key terms used in the chapter.

Worksheet 3.7: Review: Cells

A printable PDF of Workbook Activity 3.7

Teacher obook

Workbook answers

Answers to all activities in the *Insight Science 7* student workbook

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3 MAKING CONNECTIONS

Teaching support for pages 134–135

Syllabus links

Outcomes

SC4-14LW A student relates the structure and function of living things to their classification, survival and reproduction

Knowledge and understanding

LW2 Cells are the basic units of living things and have specialised structures and functions. (ACSSU149)

Students:

a identify that living things are made of cells

b identify structures within cells, including the nucleus, cytoplasm, cell membrane, cell wall and chloroplast, and describe their functions

Working scientifically

SC4-4WS – Questioning and predicting

SC4-5WS – Planning investigations

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Learning across the curriculum

Critical and creative thinking

Literacy

Work and enterprise

Personal and social capability

Teaching strategies

Differentiation

For those with lower abilities:

- Students could work in pairs or small groups, possibly picked by the teacher.
- Encourage students to create a model of a generalised cell.
- Students should only include the cell components covered in the chapter, rather than the additional components listed.

For those with higher abilities:

- Students could work as individuals rather than in pairs or groups.
- Encourage students to create models of specialised cells rather than generalised cells.
- Encourage students to model cell components in roughly the correct scale.
- Insist students include the extra components listed in the student book.
- Students could make models of bacterial cells instead of plant or animal cells.

Assessment

Students could generate their own assessment criteria before they start planning and constructing their models so as to inform some of their decisions. Students will enjoy owning the criteria and then working towards achieving them.

An editable assessment rubric is also available under the Resources tab.

Extra activities

Starter activity: Cell structure and function

Discuss with students the key features of cells and their functions. This could also be done as a ‘celebrity heads’ game or quiz competition.

Activity: Making models

Some students will struggle to know where to begin with this activity. It may be beneficial to bring in some past students’ work or other models to inspire students and get them thinking about how to represent a cell.

Resources

Teacher obook

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Assessment rubric: Making connections

A suggested, fully editable assessment rubric for the Making connections project

OXFORD
UNIVERSITY PRESS
AUSTRALIA & NEW ZEALAND

3 Energy

Teaching support for pages 114–115

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)

Students:

a identify objects that possess energy because of their motion (kinetic) or because of other properties (potential)

b describe the transfer of heat energy by conduction, convection and radiation, including situations in which each occurs

c relate electricity with energy transfer in a simple circuit

d construct and draw circuits containing a number of components to show a transfer of electricity

e investigate some everyday energy transformations that cause change within systems, including motion, electricity, heat, sound and light

PW4 Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120, ACSHE135)

Students:

a identify that most energy conversions are inefficient and lead to the production of heat energy, e.g. in light bulbs

b research ways in which scientific knowledge and technological developments have led to finding a solution to a contemporary issue, e.g. improvements in devices to increase the efficiency of energy transfers or conversions

c discuss the implications for society and the environment of some solutions to increase the efficiency of energy conversions by reducing the production of heat energy

- trace the history of the development of particular devices or technologies, e.g. circuitry through to microcircuitry (additional content)

Working scientifically

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Literacy

Numeracy

Asia and Australia's engagement with Asia

Sustainability

Critical and creative thinking

Information and communication technology capability

Teaching strategies

Introducing Chapter 3

Students should have prior knowledge of energy forms and transfer and transformation processes from their science learning in Stages 1, 2 and 3 (in their primary years). Electric circuits and generation of electricity is included in the Physical World strand of Stage 3. This chapter will build on previous knowledge and skills and extend it to a greater depth.

Energy appears in many different forms, including movement (kinetic energy), heat, potential energy, nuclear and biomass. The wide variety of energy forms allows something to be done, be it due to an object's height, chemical make up, in its motion, its temperature or in the way that it is stretched or compressed.

Energy can be transferred and transformed from one form to another. Electricity is one of the more versatile forms of energy and is examined in detail in section 3.2. Different methods can be used to make devices more energy efficient and this concept is examined in section 3.3.

Teaching tips

Questioning of students or using a pre-test would be useful in revealing student understanding and any misconceptions.

The concept of energy is difficult to communicate to students. The most effective way to introduce the idea of energy is to describe it as the ‘ability to do something’. If there was no energy, then nothing would change. ‘Show me how you look when you’ve got no energy,’ might be a good statement to pose to the class.

The topic of electrical circuits is best approached from a practical point of view with students having as much hands-on experience as possible. The link between a circuit diagram and making a circuit cannot be emphasised enough. Students do not necessarily know how to build a circuit from a diagram and often say ‘we don’t know where to start’. Thorough demonstration is needed with a standard approach being ‘always start at the battery or power supply and work your way around the circuit following the circuit diagram’. The demonstration of building a simple circuit would then clearly show students how to ‘trace’ the diagram (with a finger following the wiring ‘line’) and adding a wire to the circuit, then a light bulb or whatever the first device is etc. Drilling students in this process is time well spent in avoiding wiring mistakes later on. In addition, a standard rule of not turning a circuit on until it has been checked by the teacher (perhaps with the Lab Tech’s assistance in large classes) is a good idea. A ‘wiring licence’ similar to a Bunsen burner licence could be incorporated that tests student abilities with building circuits. Beware the students who prefer to ‘watch’ their companions do the building. All students need to acquire the necessary skills.

Resources

Teacher obook

Teaching program Chapter 3

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Common types of energy

Teaching support for pages 116–123

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems. (ACSSU155)

Students:

a identify objects that possess energy because of their motion (kinetic) or because of other properties (potential)

Working scientifically

Activity 3.1.1

SC4-4WS Questioning and predicting

SC4-8WS Problem solving

SC4-9WS Communicating

Activity 3.1.2

SC4-4WS Questioning and predicting

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Experiment 3.1.1

SC4-4WS Questioning and predicting

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Activity 3.1.3

SC4-4WS Questioning and predicting

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Questions 3.1.1

SC4-9WS Communicating

Learning across the curriculum

Activity 3.1.1

Literacy

Critical and creative thinking

Ethical understanding

Information and communication technology capability

Activity 3.1.2

Literacy

Numeracy

Critical and creative thinking

Experiment 3.1.1

Literacy

Numeracy

Critical and creative thinking

Activity 3.1.3

Literacy

Critical and creative thinking

Questions 3.1.1

Literacy

Numeracy

Critical and creative thinking

Teaching strategies

Introducing section 3.1

Any detailed study of energy begins by identifying the different forms that energy can take. All devices we use transform or modify the energy type from one form to another. Heat is a familiar form of energy to students and is examined in detail in section 3.1.3.

Teaching tips

Some energy forms will be more familiar to students than others (e.g. kinetic over biomass or nuclear) and students may be familiar with an energy example (e.g. fireworks) but not know the name (chemical potential energy). Making these connections and grouping energy examples under headings of their type is important. Students may be aware of nuclear power through TV shows such as The Simpsons.

Common misconceptions

Common misconceptions may include the following.

- ‘There is only one meaning of energy’ – the term ‘energy’ is hard to define because it has many meanings depending on the context in which it is used
- ‘Energy is associated only with movement’ (non-moving objects have potential energy; the composition of an object or its position determines what kind of energy it has)
- ‘Energy is a fuel’ (fuel is a source of energy but is not itself energy)

Differentiation

For those with lower abilities:

a Students could be instructed to focus on the energy forms they are more familiar with such as movement, sound and electricity. This will help boost their confidence.

b Students may benefit from being shown examples of the different energy forms as an ‘energy line-up’ (similar to a criminal line-up) and asked to identify, for example, the chemical energy.

c Some students may need teacher assistance with the calculations in experiment 3.1.1.

For those with higher abilities:

a Students could examine the link between the rubber band boats in activity 3.1.1 and paddle steamers. Both have a similar driving mechanism for example, but are they similar in any other ways and how do they differ?

b Students could investigate the nuclear energy processes occurring in the Sun.

Extra activities

Starter activity: Elastic potential energy

Students could investigate the elastic potential energy of different types and sizes of rubber bands. Students could let go of the rubber band, aiming it towards a wall, to measure the kinetic energy. The elastic potential energy is converted to kinetic energy when the rubber band is released.

Starter activity: Energy drinks

A discussion about energy drinks may be useful to gauge students' perceptions. Most students don't know or understand the risks associated with these drinks, especially in people under 18 years of age.

Starter activity: Sound energy

Increase students' awareness of sound energy by having them:

- compare how sound travels through different objects
- examine and contrast the sounds made by different objects
- demonstrate how sound travels through solids, liquids and gases (specifically via vibrations)
- learn about how the vocal cords produce sound
- explain how the ears transmit sound and how the brain interprets it.

Extension activity: **Movement energy**

Increase students' awareness of kinetic/movement energy by using the following activities.

- Identify objects with kinetic energy in the classroom, outside and at home.
- Identify the differences and similarities between fast- and slow-moving objects.
- Examine and compare how various objects move (e.g. walk, roll, jump). Students could also investigate different types of walking; for example, how a dog walks compared with how a giraffe walks. (A dog has a diagonal walk, in that it uses diagonally opposing legs when walking, namely the front left and right back legs, then the front right and left back legs, and so on. A giraffe, however, moves both legs on one side and then both legs on the other side.)

- Analyse whether still objects are really moving (e.g. a plant, bottle, pencil case).
- Investigate and determine what makes objects move.
- Explain how muscles enable human movement.

Extension activity: Gravitational potential energy

Have students hold a basketball over their heads and release it onto a firm surface. They should note the height it reaches each time it bounces. Ask students why the ball doesn't maintain the same bounce height. (Gravity pulls the ball towards the Earth, creating kinetic energy as the ball drops until it hits the ground, converting the energy back into gravitational potential energy as the ball rises again. This conversion from gravitational potential to kinetic energy is repeated as the ball bounces up and down. For the ball to bounce back to the same height at which it was dropped, would require that all the gravitational potential energy was converted into kinetic energy. This is not the case because gravitational potential energy and kinetic energy are not the only two types of energy involved. Students can be prompted to think of what other energy forms are involved.)

Extension activity: Diet Coke and Mentos geyser explosion

Materials

1.25-L or 2-L bottle of Diet Coke

Half to one pack of Mentos mints

Geyser tube (this is optional but it makes it easier)

Method

Note: Only do this experiment outside.

1 Stand the Diet Coke bottle upright and unscrew the lid. Put the geyser tube on top of it so you can drop the Mentos mints in all at the same time.

2 Drop the Mentos mints into the Diet Coke bottle and move away from the bottle.

3 A huge geyser of Diet Coke should spurt out of the bottle.

4 A 2006 episode of Myth Busters (episode 57, Diet Coke and Mentos) concluded that it is the pitted surface of a Mentos lolly that enables millions of carbon dioxide bubbles to form on the surface of the Mentos and rise through the bottle to produce the geyser.

Extension activity: Energy debate

Students could explore the debate that the planet is running out of energy. Some questions to get students thinking may be:

- If the Earth is running out of energy, why is the planet heating up?
- If energy is always conserved, how can we run out of energy?
- If we are constantly receiving energy from the Sun, how can we be running out?
- Most of our energy sources are from fossilised animals or plants. Why can't we just continue to use these, given they are being continually replaced?

Practical support

Activity 3.1.1 support

Have students brainstorm all the different types of energy they know. This activity should only take 5 minutes. They could then share these ideas with the rest of the class to compile a list.

Safety

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Answers

1 Student answers will vary, but may include:

- kinetic energy (people walking, riding, the car moving)
- elastic potential energy (the girls playing with stretched elastic)
- sound energy (the music from the venue/stage)
- chemical potential energy from burning coal for energy (power plant)
- heat and light energy radiating from the Sun
- electrical energy carried along power lines
- light energy from lampposts
- skydivers have gravitational potential energy.

2 Student answers will vary.

3 X shows chemical energy used by the rowers; Y shows solar energy collected by solar panels; and Z shows chemical energy used by the cyclist.

4 Student answers will vary.

Activity 3.1.2 support

Students should be encouraged to think critically about modifications they could make to improve their boats, and to subsequently test this.

Safety

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Answers

- The boat moved forward once the propeller was released.
- Elastic potential energy is involved when the propeller is wound up; kinetic energy is involved when the propeller is released and the boat moves forward. There may also be some sound energy and some heat energy.
- To make the boat travel further, the propeller could be wound up more (or tighter). This would store more elastic potential energy, which is returned as kinetic energy as the propeller spins and increases the distance travelled by the boat.

Experiment 3.1.1 support

As an extension, students could complete this experiment for a range of items and compare the energy sources for each item, suggesting which food item contains the most energy.

Practical hint

This experiment still works with a regular test tube and 10 mL water. The water almost boils, so using a beaker and 20 mL water allows for a gentler increase in temperature.

Safety

- Students will be working with a flame, so lab coats or aprons and safety glasses must be worn and hair tied back.
- The burning Cheezel may create smoke, so be aware of ventilation in the classroom.
- The needle or pin will be sharp. Remind students to be careful.

A risk assessment should be completed before undertaking this Experiment. A suggested risk assessment template is provided in the teacher obook resources.

Lab tech hint

Instead of using a needle, use a pin and cut the head off with wire cutters. Leave this permanently set up in a cork for use in future classes.

Answers

1 Biofuels can be burned to produce heat energy.

2 Student answers will vary, but typically could be 'one Cheezel provides a small energy source for humans'.

3 This experiment investigates the chemical potential energy stored in a Cheezel.

4 Student answers will vary.

Activity 3.1.3 support

The pitch of a tuning fork depends on the length of the two prongs. Tuning forks are mainly used to tune other musical instruments by providing a standard of pitch; however, they are slowly being replaced by electronic tuners.

Safety

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Answers

- If you blow harder into a recorder, you produce a louder sound.
- A pianist hits the keys harder to produce a louder sound.
- If you want to yell or speak louder, you push more air out of your throat to produce a louder sound.
- Drummers hit the drum skins harder to produce a louder sound.

Answers

Questions 3.1.1 answers

1 Any four of the following (or others) involve potential energy:

- trampoline
- wind-up toys
- bow and arrow
- a child climbing the ladder of a slide
- energy drinks
- fuels (e.g. natural gas and petrol)

2 Any four of the following (or other) devices possess elastic energy:

- an elastic band

- a rubber bouncy ball
- a hair tie
- Lycra bike shorts
- stretching a spring

3 The scientific term for movement energy is kinetic energy.

4 kinetic, sound

5 Student answers will vary but may include walking, running, gesturing, etc.

6 Using a fuel that is 10% ethanol is more environmentally friendly because the ethanol within the petrol results in lower emissions than with normal petrol.

7 Student answers will vary. The main benefits are that there is considerably more energy released from the same mass of uranium compared with coal, and minimal greenhouse gases are released from the use of nuclear energy. The main problems include: exposure to radiation, which can lead to many health problems, including cancer and death; the waste remains radioactive over tens of thousands of years; and that nuclear power can lead to mass destruction if affected by natural disasters, design failure or terrorist and/or irresponsible human behaviour.

8

a The car's brakes will absorb the car's kinetic energy to avoid a collision.

b Airbags and seat belts would absorb the driver's and passengers' kinetic energy in a collision.

9 Uranium contains two to three million times the energy of an equivalent amount of coal.

10 The pitch of a sound corresponds to how often the vibrations occur (i.e. the frequency).

Resources

Student obook

Weblink: Types of energy

http://energyquest.ca.gov/story/index.html

This website contains comprehensive information about all aspects of energy.

Weblink: Examples of types of energy

http://www.zephyrus.co.uk/energy2.html

This website contains basic information about the different types of energy.

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Video link: Biofuel

http://www.pbs.org/wgbh/nova/tech/algae-fuel.html

A video explaining the use of algae as a biofuel.

Weblink: Online tuning fork

http://www.onlinetuningfork.com/

This website contains 3 tuning forks that can be sounded by clicking and other links.

Weblink: Sound energy

http://electronics.howstuffworks.com/speaker.htm

This website contains comprehensive information about how speakers work.

Worksheet 3.1 Different forms of energy

A PDF of Workbook Activity 3.1

Worksheet 3.2 Data analysis: potential and kinetic energy

A PDF of Workbook Activity 3.2

Teacher obook

A3.1.1 Different forms of energy

A risk assessment template for students and teachers for Activity 3.1.1

A3.1.2 Rubber band boats

A risk assessment template for students and teachers for Activity 3.1.2

A3.1.3 Sound energy

A risk assessment template for students and teachers for Activity 3.1.3

E3.1.1 Bio-power

A risk assessment template for students and teachers for Experiment 3.1.1

Weblink: Energy kids

http://www.eia.gov/kids/index.cfm

This website contains comprehensive information about energy along with a teacher's guide.

Workbook answers

Answers to all activities in the student workbook

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Transforming energy

Teaching support for pages 124–129

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)

Students:

e investigate some everyday energy transformations that cause change within systems, including motion, electricity, heat, sound and light

Working scientifically

Activity 3.1.4

SC4-4WS Questioning and predicting

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Experiment 3.1.2

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Activity 3.1.5

SC4-4WS Questioning and predicting

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Questions 3.1.2

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Activity 3.1.4

Literacy

Critical and creative thinking

Experiment 3.1.2

Literacy

Critical and creative thinking

Information and communication technology capability

Activity 3.1.5

Literacy

Critical and creative thinking

Questions 3.1.2

Literacy

Critical and creative thinking

Teaching strategies

Teaching tips

It is important to make sure students know the difference between a transformation and a transfer of energy for this section.

Flow diagrams

Students need to remember that the arrows point in the direction of the change and, in essence, the arrow is showing the transformation between the input and output.

Common misconceptions

Common misconceptions may include the following:

- 'Energy can be created and lost' (energy can neither be created nor destroyed)
- 'Energy is created as the result of an activity' (energy is transferred from one system to another)
- 'Energy types are independent of one another' (energy can change or be transformed from one form into another)

Differentiation

For those with higher abilities:

a Students with higher abilities could investigate remote controls. They could bring in any old remotes they may have at home and carefully dismantle them to identify the components they contain. The same could be done with any old mobile phone. The phones can then be posted off for recycling.

Extra activities

Starter activity

Ask students to create a list of all the things they do for entertainment that require energy. They could then list the energy used and any transformations that occur.

Transformations for motion

Ask students to consider the forms of transport they have used that day, week, month and/or year. Get them to list the energy used for each and any transformations that occur.

Extension activity

As an extension, students could investigate the demand that our current lifestyles have for energy and whether this is sustainable in the long term. Ask students to determine what changes may have to occur to ensure their lifestyle is energy efficient, or at least energy sustainable.

As an extension, students could investigate the total energy required for public transport (bus, train, tram) and divide this by the number of people this form of transport can carry. They could then compare this to the energy required for the equivalent number people to use another source of transport, such as cars. Using this information, students could make suggestions for transport options in the future.

Students could design a transport survey or audit. Students design a questionnaire that investigates the various modes of transport that people use. Students then survey as many participants as possible in order to build up a large pool of useable data. An idea may be to use a free online survey tool like SurveyMonkey. Students then transform the data into a visual medium (a graph) and use it to draw

conclusions about the types of energy conversions that are taking place for most people. An extension of this would be for students to compare the use of various methods of transport with age group to see whether there are any trends or patterns and then attempt to explain these. Students could also form recommendations for the school based on the data (i.e. use of school buses, walking school buses etc.).

Practical support

Activity 3.1.4 support

1

Device	Energy input	Energy output
Drum	Kinetic	Sound
Electric guitar	Electrical	Sound
Light bulb	Electrical	Light
Battery	CPE	Electrical
Car engine	Chemical	Kinetic
Rubber band (or others)	Elastic potential	Kinetic
Gas heater	Chemical	Heat
Solar panel	Light	Electrical
Phone charger	Electrical (or CPE at power station)	Electrical

2 Potential energy is often an input rather than an output. Sound and light are often energy outputs rather than energy inputs.

3 A phone charger converts electrical energy to electrical energy of a different value (or voltage) without changing the type of energy.

4 Student answers will vary.

Experiment 3.1.2 support

The heating element in the jug is a resistor, which is a material that resists the flow of electricity. When electricity flows into the resistor, it is turned into heat. In a commercial electric jug, the heating element is controlled by a thermostat that varies the resistance. The higher the temperature, the lower the resistance and, therefore, more current can flow through the element. The size and shape of a heating element is largely determined by the dimensions of the appliance and the area over which it needs to produce heat. A coiled heating element is far better than a straight one because a coil can contain more metal than a straight length, and so more energy can flow through it, causing a greater heat potential.

Practical hint

If the nichrome wire is long enough, it can have the ends bent so that it can be hooked to the side of the beaker as an alternative to using Blu-Tack.

Safety

- The water and, in particular, the nichrome wire will get very hot. Do not touch them. Allow everything to cool before packing up.

- Do not allow the two alligator clips to touch while the power is on. Connect the alligator clips to the ends of the nichrome wire before turning the power on.

A risk assessment should be completed before undertaking this Experiment. A suggested risk assessment template is provided in the teacher obook resources.

Answers

1 A coiled element can be much longer than a straight one within the same space.

2 If the alligator clips touched there would a ‘short circuit’ and the element would not work. Students might say the electricity would jump from one alligator clip to the other rather than passing through the element.

3 Student answers will vary.

4 The speed of heating the water could be improved by using a higher voltage and/or less water.

Activity 3.1.5 support

Safety

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Answers

- Dynamo: converts mechanical rotation into a pulsing direct electric current (electrical energy)

  Steam engine: kinetic energy in steam is transformed into mechanical energy and then into electrical energy (often this process is started by heating a combustible product such as coal)

  Radiometer: radiant energy into mechanical energy through thermal transpiration

- The devices producing electrical energy are the dynamo and steam engine.
- Real world applications could include:

  Dynamo: invented as a replacement for a battery, used to charge the battery in a car, and can be built into the hub of a bicycle wheel to power lights

  Steam engine: steam turbines create electricity, used as a power source for a train

  Radiometer: a simple way of using light as an energy source; however, some can be used for measuring the power of electromagnetic radiation (these devices can be used for wavelengths, including microwave and infrared)

Answers

Questions 3.1.2 answers

1 A hybrid car contains both a petrol engine and an electric motor, with large banks of batteries.

2 Country trains mostly use diesel because electrical wires over large distances would be impractical and hard to maintain.

3 Energy is vital for transport. Energy conversions are essential in every type of transport to allow movement from one area to another.

4 When a toaster is switched on, electricity passes through a heating element and heats it up. This converts electrical energy into heat energy. This is similar to what happens with a hairdryer; however, a hairdryer also has a fan that spins and blows air over the heating element, generating warm air.

5 Light energy can also be used for entertainment in fireworks, cinema screens, theatre plays and music concerts.

6 The by-products of energy transformations in a car include electrical energy, sound energy and thermal energy.

7 Student answers will vary.

8 Light energy (Sun) → biomass energy (apple on an apple tree) → kinetic energy (biting and chewing the apple) → chemical energy (obtaining nutrients from the apple)

9 Electrical cars are more energy efficient and emit less pollution than petrol cars.

10 Other remote control gadgets include remote control cars, model aeroplanes, game consoles and music entertainment systems.

Resources

Student obook

Weblink: Interactive on potential and kinetic energy

http://www.pbslearningmedia.org/asset/mck05_int_rollercoaster/

This website contains an animation that shows the kinetic and potential energy conversions during a rollercoaster.

Interactive activity: Transformation of energy

This interactive quiz tests students ability to correctly label the energy transformations for 5 devices.

Weblink: hybrid cars

http://auto.howstuffworks.com/fuel-efficiency/vehicles/question262.htm

This website contains information and links that explain how hybrid cars work.

Weblink: Thermal energy interactive task

http://www.bbc.co.uk/bitesize/ks3/science/energy_electricity_forces/energy_transfer_storage/activity/

This website contains an interactive presentation and a short quiz about energy transfers.

Worksheet 3.3 Transforming energy

A PDF of Workbook Activity 3.3

Worksheet 3.4 Research: Energy in a rollercoaster

A PDF of Workbook Activity 3.4

Teacher obook

A3.1.5 Investigating energy transformations

A risk assessment template for students and teachers for Activity 3.1.5

E3.1.2 Making and electric jug

A risk assessment template for students and teachers for Experiment 3.1.2

Workbook answers

Answers to all activities in the student workbook

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Transferring heat energy

Teaching support for pages 130–137

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)

Students:

b describe the transfer of heat energy by conduction, convection and radiation, including situations in which each occurs

e investigate some everyday energy transformations that cause change within systems, including motion, electricity, heat, sound and light

Working scientifically

Experiment 3.1.3

SC4-4WS Questioning and predicting

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Science skills

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Activity 3.1.6

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Deeper understanding

SC4-4WS Questioning and predicting

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Questions 3.1.3

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Experiment 3.1.3

Literacy

Numeracy

Critical and creative thinking

Information and communication technology capability

Science skills

Literacy

Numeracy

Critical and creative thinking

Information and communication technology capability

Activity 3.1.6

Literacy

Numeracy

Critical and creative thinking

Information and communication technology capability

Deeper understanding

Literacy

Critical and creative thinking

Questions 3.1.3

Literacy

Critical and creative thinking

Teaching strategies

Teaching tips

Conduction

Heat is transferred from one object to another when the objects touch each other. This transfer is most effective in solids, but can happen in fluids. For example, a spoon in a cup of hot soup becomes warmer because the heat from the soup is conducted along the spoon.

Convection

Heat is transferred through the mass movement of molecules within fluids. Convection currents circulate the warm and cool molecules: warm molecules are less dense, so they rise, whereas cool molecules sink because of their increased density.

Students should consider some of the reasons that people choose to live in coastal areas. The cooling effects of the sea in summer are quite obvious. In addition to these, are the effects of convection on breezes. During the day there will be an onshore breeze because the cooler air above the sea replaces the rising air that has been heated above the land. The sea requires much more thermal energy to raise its temperature, so the land always heats up faster, heating the air more. At night, the land cools faster because it has less thermal energy, so the airflow will now be offshore, providing a warm breeze as the air above the sea rises (it is now warmer than the land). In this way, the convection currents along the coast moderate extreme temperatures.

Radiation

Heat is transferred through electromagnetic waves, such as the Sun warming the Earth. Radiated heat travels very quickly because it does not rely on the movement of particles to move energy from one place to another. Every student in the room radiates infrared radiation all the time.

Additional information

Thermal equilibrium

'Equilibrium' means 'state of physical balance'. Thermal energy always moves from a hotter object or region to a cooler one; thermal equilibrium means that there is no movement – both objects or regions must be at the same temperature.

Conductors and insulators

Thermal insulators inhibit convection by stopping warm air moving (e.g. trapping air in woollen clothing), conduction by using materials that do not pass on vibrations very effectively (e.g. wood, plastics) and/or radiation by reflecting heat away (e.g. shiny surfaces).

Common misconceptions

A common misconception is that thermal energy and temperature are the same thing. The thermal energy of an object depends on how much the particles in the object vibrate as well as how many particles there are. Temperature is a measure of the average kinetic energy of the particles regardless of how many particles there are. So an object with more particles than another but at the same temperature will have more thermal energy. Equally, an object at a lower temperature can have more thermal energy if there are many more particles (e.g. a warm bath will have much more thermal energy than a red hot poker!).

Differentiation

For those with lower abilities:

a Some students may need to spend more time creating physical models and reinforcing a correct understanding of conduction and convection.

For those with higher abilities:

a Students could design something like a container to hold hot or cold food and use their understanding of conduction and convection to include features of the container that will keep the food hot or cold for longer. Requiring students to justify each of the design features would be a good check of their understanding, and even making such a container out of common materials and testing it would provide a challenge.

Extra activities

Starter activity

Heat a saucepan of water on a hotplate to demonstrate conduction. Add some peas to the water to demonstrate convection. The peas will be pushed around by the convection currents. Radiant heat will be felt to the side of the saucepan or above the element when the saucepan is removed. A glass saucepan makes the peas more visible to students.

Extension activity: Thermometers

A thermometer works because of the fact that liquids will expand as they absorb thermal energy. So the hotter the liquid, the greater its volume and the more it will rise up the tube. A quick practical activity could be to use unmarked thermometers and place them in melting ice, then boiling water, marking the height of the liquid in each case. The thermometer can then be labelled as 0 and 100 degrees at these points. Simple markings can then scale the thermometer into 1 degree (or greater) markings. This process led to the use of centigrade (centi = 100; grade = 'mark') as a unit of temperature. Students should only be using Celsius for their units.

Practical support

Experiment 3.1.3 support

Ensure students have set up their equipment correctly before lighting their Bunsen burner and the clamps are placed so they do not obscure reading the thermometer. One student can be responsible for reading the lower thermometer while another reads the top thermometer. Ensure students are familiar with how to use their stopwatch before they begin heating the water.

Safety

A risk assessment should be completed before undertaking this Experiment. A suggested risk assessment template is provided in the teacher obook resources.

Expected results

Both the top and lower thermometers will read roughly the same temperature, although some may find slight differences depending on the placement of their thermometer.

Answers

1 The water should be the same temperature at the top and the bottom of the beaker because the water is thoroughly mixed and all particles have the same average kinetic energy.

2 Student answers will vary. Although the heat source is at the base of the apparatus, the water heats at the same rate due to convection currents. Water at the bottom should become hotter first and rise, with cooler water at the top sinking to take its place at the bottom.

3 Once the water is boiling, the water will have a temperature of 100°C throughout because all particles have the same average kinetic energy.

4 Heat from the Bunsen burner was transferred from the flame to the beaker by radiation. The heat passed from the beaker into the water via conduction. The heat was spread throughout the water via convection. The water at the bottom of the beaker got hot first and rose because of its lower density, while cooler water from the top of the beaker sank to take its place at the bottom.

Activity 3.1.6 support

Safety

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

A sunny window sill works well.

Expected results

Black paper conducts the most thermal heat, followed by aluminium foil, then white paper.

Answers

- Black paper: the best surfaces for absorbing radiation are matt black surfaces
- Foil: silvered surfaces are the best at reflecting radiation

Deeper understanding

The ways in which the snake cools (e.g. open mouth) allows hot gases to move out by convection, lighter skin reduces heat absorbed by radiation and laying in the shade will increase conduction away from the body to the cooler earth.

Answers

1 A greater surface area means that more of the Sun's energy can be collected by the snake.

2 The snake does store energy in chemical form (from food), but is not able to store thermal energy very well.

3 Opening its mouth further ventilates the snake and allows extra thermal energy to escape its body.

Answers

Questions 3.1.3 answers

1 Student answers will vary.

2 The Sun's radiation can be absorbed by the ground, reflected by the ground or reflected by the clouds.

3 Student answers will vary, but typically may include:

- light: torches, lighthouses, fibre optics, lasers
- infrared radiation: radiator heaters, toasters, ovens
- microwaves: mobile phones, microwave ovens, communication satellites
- radio waves: telescopes, communication devices, radios

4 When a substance absorbs radiation, its temperature increases.

5 Scientists would generally concern themselves with where the energy is going, thus focusing on the heating of an object. The cooling object is the source of energy.

6 Each of the materials used in modern saucepans serves a particular purpose.

- The copper bottom is an excellent conductor of heat, so it is used to maximise the amount of heat that is conducted to the food within the saucepan.
- The steel sides of the saucepan are a reasonably good conductor of heat but are not as soft as copper, so they allow the saucepan to retain its shape over time.
- The plastic handle is light and is a good insulator. This means the handle remains relatively cool so it is safe to pick up with your hands.
- The glass lid is a reasonably good insulator and has the benefit of allowing you to see the food without lifting the lid and letting lots of heat escape.

8 We heat from the bottom to make the most of convection currents.

9 Student answers will vary.

Resources

Student obook

Worksheet 3.5 Transfer of heat energy

A PDF of Workbook Activity 3.5

Teacher obook

A3.1.6 Investigating heating by radiation

A risk assessment template for students and teachers for Activity 3.1.6

E3.1.3 Investigating the transfer of heat energy by convection

A risk assessment template for students and teachers for Experiment 3.1.3

Workbook answers

Answers to all activities in the student workbook

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3.1 Checkpoint

Teaching support for pages 138–139

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)

Students:

a identify objects that possess energy because of their motion (kinetic) or because of other properties (potential)

b describe the transfer of heat energy by conduction, convection and radiation, including situations in which each occurs

e investigate some everyday energy transformations that cause change within systems, including motion, electricity, heat, sound and light

Working scientifically

SC4-4WS Questioning and predicting

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Literacy

Asia and Australia's engagement with Asia

Critical and creative thinking

Information and communication technology capability

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Answers

Checkpoint 3.1 answers

1 Nuclear energy – Energy from atoms

Biomass energy – Energy stored in plants and animals

Elastic energy – The energy stored in a compressed spring

Kinetic energy – Possessed by all moving objects

Gravitational energy – The energy of an object when lifted up

Potential energy – Another name for stored energy

2

a False: springs hold stored energy when they are stretched or compressed

b True

c True

d False: sound energy is a type of kinetic energy

e False: petrol contains chemical energy

3

a kinetic and gravitational potential energy

b chemical energy (biomass energy)

c elastic energy

d chemical energy

e kinetic energy

f sound energy

g gravitational potential energy

4

a a stretched spring or rubber band then released

b a hydroelectric power station

c a generator or a wind-up torch

d solar panels

e a speaker

5 conduction

6 E10 is 90% petrol with 10% ethanol.

7 Sound travels through vibrating particles passing their vibrations onto the next particle, which continues along the chain until the vibrations reach our ear.

8 We can see the flame so that means some of the radiant energy has passed from the flame to our eyes, in this case as visible light.

9 Student answers will vary.

10 The input energy is chemical energy in the fuel. The main form of energy it produces is kinetic. Some of the by-product energies are heat, sound and electrical.

11 When heated from above, the water expands and so cannot fall to spread the heat; instead, it just warms up the top layer.

12 Student answers will vary.

13 Student answers will vary.

14 When heated, the particles in a substance gain more kinetic energy, causing them to move faster and further apart, and so the substance expands.

15 Student answers will vary.

16 Student answers will vary.

17 Student answers will vary.

Resources

Teacher obook

A030, A031, A032 Assess

Checkpoint 3.1 Worksheet A

Students who score less than 18 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet A, which is designed for extra support.

Checkpoint 3.1 Worksheet A answers

Answers for Checkpoint Worksheet A

Checkpoint 3.1 Worksheet B

Students who score between 18 and 36 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet B, which is designed for consolidation.

Checkpoint 3.1 Worksheet B answers

Answers for Checkpoint Worksheet B

Checkpoint 3.1 Worksheet C

Students who score more than 36 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet C, which is designed for extension.

Checkpoint 3.1 Worksheet C answers

Answers for Checkpoint Worksheet C

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Electrical circuits

Teaching support for pages 140–144

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)

Students:

c relate electricity with energy transfer in a simple circuit

d construct and draw circuits containing a number of components to show a transfer of electricity

- trace the history of the development of particular devices or technologies, e.g. circuitry through to microcircuitry (additional content)

Working scientifically

Activity 3.2.1

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Activity 3.2.2

SC4-4WS Questioning and predicting

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Questions 3.2.1

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Activity 3.2.1

Literacy

Critical and creative thinking

Activity 3.2.2

Literacy

Numeracy

Critical and creative thinking

Questions 3.2.1

Literacy

Critical and creative thinking

Teaching strategies

Introducing section 3.2

A good starting point is to turn the lights on in the science room and ask students how flicking the switch makes the lights come on. Develop the idea that electricity needs a pathway of wires in order to reach each light. This will build up the concept of an electric circuit and current travelling along the pathways.

Teaching tips

The most effective way to get students to understand electricity is to create a link to the idea of energy movement and then suggest that this is ‘moved’ by charges in conductors. If these charges are introduced as carts that can carry energy, then it gives us a mental image to hang some of the key ideas onto. If carts flow around a circuit and can be loaded or unloaded with energy, then current is how many carts pass a point in a time period and voltage is how much energy is loaded in each cart. Regular referral back to these ideas allows more complex behaviours in series and parallel circuits to be mentally modelled. Further, a high-powered device must then have lots of energy in each cart and/or lots of carts delivering the energy, a 3-V cell would give each cart twice as much energy as a 1.5-V cell etc.

All students will need assistance with building electric circuits from a circuit diagram. (See ‘Teaching tips’ for Introducing chapter 3, earlier in this document.)

Additional information: Electrical energy

Electrical energy can be demonstrated through a battery in a torch. In batteries, chemicals are used to separate electrons (negative charge) from protons (positive charge). When a battery is connected to an electric circuit (e.g. the torch is switched on), the electrons leave the negative terminal of the battery and move (flow) through the circuit to the positive terminal.

Moving charges

A current was initially thought to be due to the flow of positive charges. Much later it was discovered that the charges that are able to move were negative electrons. As the idea of current flow was established, and most material properties were defined in relation to positive charge size (using the periodic table), the idea of keeping ‘conventional current’ persisted. Hence, conventional current flow is in the opposite direction of real electron flow, but conventional current is the way we indicate current flow on circuit diagrams. It is a contradiction, but that’s the way it is understood and the way it is taught. (Some students quite like the idea that we teach them something that is ‘wrong’.) Some students confuse conventional current flow with electron flow when they establish their internal models of current behaviour, and this needs to be revisited frequently. It may be worth mentioning to these students that positive flow of charge can occur when atoms are free to move (e.g. charged particles in liquids or gases).

Measuring electric current

A good way to describe current flow is to get students to think of a river flowing. If each molecule of water is thought of as an electron, then we can model electron flow as the water flow. The ‘water’ current can be thought of as the number of molecules passing a bridge in a particular period of time, in the same way that the electric current is the measure of the number of electrons moving past a point in the circuit in a given time. Because electrons have such a small charge, counting them individually is impractical, so we group then into larger blocks, or coulombs. In the same way that we measure water in litres, we measure charge in coulombs. The ‘flow of water’ model is limited in the application to circuits and care must be taken to inform students that all models only work up to a point: if you cut a pipe of water, the water spills out; if you cut a wire the electrons just stop moving!

Types of circuit

Importantly, in both series and parallel circuits, no current is lost so all the current leaving the cell returns to it. This means that if the circuit branches (i.e. in a parallel circuit), the current entering the branching point is the same as the total in all the branches leaving that point. As a river splits into two paths, no water is lost, but the total flow in each path adds to give the same amount as the river before the split. Current cannot be ‘used up’ in a circuit (voltage is used up).

Common misconceptions

Common misconceptions include that electric current is a flow of energy (electric current is the flow of charged particles) and that current is used up in a circuit (it remains constant, whereas voltage is used up).

Differentiation

For those with lower abilities:

a Students should be encouraged to look at how many 'loops' are there in a circuit to decide whether it is a series or parallel circuit.

For those with higher abilities:

a Students could be encouraged to build more complex circuits or circuits with combinations of series and parallel components.

Extra activities

Starter activity

A discussion about electrical safety could be carried out to confirm that students are aware of the dangers of electric shock and what the requirements are for electrical safety in the lab. Having circuits checked before switching on, reporting faulty equipment or loose wiring etc., should be emphasised.

Extension activity: Circuit diagrams

Some incorrect circuit diagrams can be drawn on paper or on the whiteboard and students asked to identify the faults. The cell symbol could have a line through the middle, circuits could have gaps or breaks in them, symbols could be drawn incorrectly or ammeters and voltmeters positioned incorrectly.

Extension activity: Student electrician licence

This could be an activity similar to that for students obtain a Bunsen burner licence. To obtain their 'electrician licence', students must correctly wire a simple circuit with a power supply, wires and a light globe. An ammeter and voltmeter should be wired into the circuit correctly. Performed under test conditions, students receive their 'licence' when they complete their circuit correctly.

Extension activity: Battery dissection

A 1.5-V or 9-V battery can be carefully cut in half and demonstrated to students. Similarly, an old car battery could be drained of acid and cut in half and examined.

Practical support

Activity 3.2.1 support

Practical hints

- For best results, clean the copper and galvanised nail with fine sandpaper.
- Ideally, spread the metals as far away from each other as possible in the lemon; the metals must not touch each other.
- More than four lemons may be necessary to get the LED to light up.
- If the LED does not glow, connect the multimeter to demonstrate the lemon battery is creating a voltage.

Safety

The students should wear lab coats or aprons and safety glasses. Juice from the lemons may sting the eyes or cuts.

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Lab tech notes

- This activity can be tricky, so set it up and ensure it is working before the class tries it.
- Test the LEDs to ensure they are working prior to class also.
- Kiwifruit, oranges and grapefruit are alternative fruits that can be used.

Answers

- Batteries consist of two different metals (electrodes) in an acidic solution (electrolyte). The copper and galvanised nail (zinc) act as the two electrodes and the citric acid in the lemon juice works as the electrolyte. The electrolyte (lemon juice) allows electrons to move freely from the nail to the copper electrode.
- The electrical leads acts as conductors to allow electrons to flow from the '–' zinc electrode of the battery towards the '+' copper electrode and then through to the LED.
- In this battery chemical energy is being transformed into electrical energy and then to light energy.

Activity 3.2.2 support

Safety

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Answers

- The bulbs will glow brighter in a parallel circuit (circuit 3) than a series circuit (circuit 2). In a series circuit the voltage or energy transfer across each component of the circuit adds up to the voltage across the power supply; therefore, each bulb will have half the voltage of the power

supply. In a parallel circuit the voltage across each component is the same as that of the power supply.

- The switch in circuit 4 is parallel to one bulb and in series with the other: it will only affect the bulb in series with it; the bulb in parallel is a complete circuit on its own.
- The voltage across each light bulb in circuit 4 is the same as the voltage of the power supply. This tells us that the full energy of the power supply is transferred to each component in a parallel circuit.
- The current or flow of electrons in a parallel circuit branches out after leaving the power supply and recombines before entering back in. The total current through the whole circuit will be the sum of the current through each bulb.

Answers

Questions 3.2.1 answers

1 Electrons travel around a circuit and transfer their energy (electric potential) when they pass through a load or device.

2 Essential components include a power source, a pathway (the wires) and a load (or device).

3 Student answers will vary. Typical answers may include:

Similarities: both contain a power source, one or more pathways (wires) and devices

Differences: series has one pathway or circuit, parallel has more than one pathway

4 The switch controls the current flow, on or off.

5 The two roles of a transistor are to: (i) act as a switch; and (ii) amplify the current and make a larger current flow.

6 Circuit diagrams will vary. It is not possible to turn the bell on while the light bulb is off because it is a series circuit and there is only one path along which the current can flow. Everything is either on or off, but not a mixture of the two.

7 Circuit diagrams will vary.

8 Circuit diagrams will vary but should have the switch somewhere along the path of the light bulb and resistor.

9 The name ‘transistor radio’ implied it contained tiny transistors instead of bulky valves, which made these radios far more portable.

10 The miniaturising of transistors

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Resources

Student obook

Weblink: Electric circuits

http://www.physics-chemistry-interactive-flash-animation.com/electricity_interactive.htm

This website contains interactive animations about all sorts of electric circuits and interactive 'books' of questions.

Video: Demonstration Building a circuit

A video explaining how to correctly connect a simple circuit.

Video: Demonstration Using an ammeter and voltmeter

A video explaining how to correctly use an ammeter and a voltmeter.

Worksheet 3.6 Simple electric circuits

A PDF of Workbook Activity 3.6

Teacher obook

A3.2.1 Lemon batteries

A risk assessment template for students and teachers for Activity 3.2.1

Video: Lemon battery experiment (Oxford digital ID03.07)

A video explaining how to convert an everyday lemon into an energy source.

A3.2.2 Drawing and connecting circuits

A risk assessment template for students and teachers for Activity 3.2.2

Workbook answers

Answers to all activities in the student workbook

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Electrical energy transformations

Teaching support for pages 145–147

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)

Students:

c relate electricity with energy transfer in a simple circuit

e investigate some everyday energy transformations that cause change within systems, including motion, electricity, heat, sound and light

Working scientifically

Activity 3.2.3

SC4-4WS Questioning and predicting

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Questions 3.2.2

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Activity 3.2.3

Literacy

Critical and creative thinking

Questions 3.2.2

Literacy

Critical and creative thinking

Teaching strategies

Teaching tips

Make this section as hands-on as possible by having different types of light globes, batteries and even transformers for students to examine. Compact fluorescent lights (CFLs) come in many shapes and sizes, as do light-emitting diode (LED) lights. A hand-crank generator is an interesting machine to demonstrate to students.

Practical support

Activity 3.2.3 support

Safety

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Answers

Input energy	Output energy	Example 1	Example 2
Electrical	Kinetic	Washing machine	Fan
Electrical	Chemical potential	Battery charger	
Chemical potential	Electrical	Battery	Petrol generator
Electrical	Light	Light bulb	TV
Light	Electrical	solar panels	Remote control
Electrical	Sound	iPod	Radio
Electrical	Thermal	Electric blanket	Toaster

Answers

Questions 3.2.2 answers

1 incandescent, CFLs, LED

2 A step-down transformer will reduce the voltage (or reduce the amount of energy in the electricity).

3 Any two of laptop power cord, MP3 charger, phone charger cord etc.

4 Flowchart answers will vary.

5 CFLs use less energy and last much longer than incandescent bulbs.

6 A battery (group of cells) makes use of a chemical reaction to produce electrical energy. A generator relies on the conversion of kinetic energy into electrical energy.

7 Yes, there have been energy conversions. The solar panels convert the light energy of the Sun into electrical energy. The light bulb then converts the electrical energy into light energy.

8 Incandescent bulbs were phased out because a significant amount of our electricity usage goes into lighting and the new CFL bulbs were very efficient in comparison. The aim was to reduce carbon emissions and lower electricity bills.

Resources

Student obook

Worksheet 3.7 Electrical devices puzzle

A PDF of Workbook Activity 3.7

Teacher obook

A3.2.3 Electrical energy transformations

A risk assessment template for students and teachers for Activity 3.2.3

Workbook answers

Answers to all activities in the student workbook

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3.2 Checkpoint

Teaching support for page 148

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems. (ACSSU155)

Students:

c relate electricity with energy transfer in a simple circuit

d construct and draw circuits containing a number of components to show a transfer of electricity

e investigate some everyday energy transformations that cause change within systems, including motion, electricity, heat, sound and light

- trace the history of the development of particular devices or technologies, e.g. circuitry through to microcircuitry (additional content)

Working scientifically

SC4-4WS – Questioning and predicting

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Learning across the curriculum

Literacy

Critical and creative thinking

Information and communication technology capability

Answers

Checkpoint 3.2 answers

1 LEDs use less energy, last longer and produce extremely bright light.

2

a electrons

b volts

c coulombs per second or amps or amperes

d power source (or power supply)

3 A voltmeter measures the voltage (the difference between two points in an electric circuit).

4 A switch controls the pathway in an electric circuit. If the switch is open, the pathway is broken and no current can flow. If the switch is closed, the pathway is complete and a current can flow.

5

a parallel

b battery (or two cells), wires, resistor, three light bulbs, electric bell

c If A breaks, B will not use any electrical energy and will go out, but C will still use electrical energy and will still work.

6 In order from the one that produces most waste energy to least: incandescent, CFL, LED. They are so different because they work on different principles and contain different components.

7 Electrical energy is very versatile. It can be easily stored and transformed.

8 Connect a series circuit containing a power supply, light bulb and wires. Connect a voltmeter across the light bulb (or in parallel with it). Switch the circuit on and the voltmeter will give the reading, in volts, of the energy used by the light bulb.

9 The electricity in the power lines outside is at a higher voltage than the 240 V required by our houses, so the voltage must be reduced first by a step-down transformer.

10 Student answers will vary.

11 Student answers will vary but basically the car battery provides electricity to all circuits in the car, including the starter motor, spark plugs, radio, lights, horn, wipers, fan, electric windows etc. The car battery is recharged by the car's alternator.

12 Student answers will vary.

Resources

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Teacher obook

A034, A035, A036 Assess

Checkpoint 3.2 Worksheet A

Students who score less than 15 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet A, which is designed for extra support.

Checkpoint 3.2 Worksheet A answers

Answers for Checkpoint Worksheet A

Checkpoint 3.2 Worksheet B

Students who score between 15 and 30 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet B, which is designed for consolidation.

Checkpoint 3.2 Worksheet B answers

Answers for Checkpoint Worksheet B

Checkpoint 3.2 Worksheet C

Students who score more than 30 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet C, which is designed for extension.

Checkpoint 3.2 Worksheet C answers

Answers for Checkpoint Worksheet C

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Energy efficiency

Teaching support for pages 149–150

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW4 Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120, ACSHE135)

Students:

a identify that most energy conversions are inefficient and lead to the production of heat energy, e.g. in light bulbs

Working scientifically

Activity 3.3.1

SC4-4WS Questioning and predicting

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Questions 3.3.1

SC4-4WS Questioning and predicting

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Activity 3.3.1

Literacy

Numeracy

Sustainability

Critical and creative thinking

Questions 3.3.1

Literacy

Numeracy

Sustainability

Critical and creative thinking

Teaching strategies

Introducing section 3.3

Energy efficiency refers to how efficiently the energy is transformed from one form to another. The less energy being wasted during transformation, the more energy efficient an appliance.

Teaching tips

Discuss the energy efficiency star rating system (see Figure 3.57 on page 149 of the Student Book), which students may have seen before. Examine the concept of conservation of energy (energy cannot be created or destroyed), where the total amount of energy in a system remains constant but the energy can be changed into useful forms or 'lost' as non-useful forms. Energy efficiency just means how good an appliance is at converting the energy into the useful form and minimizing the non-useful or 'waste' energy.

Common misconceptions

A common misconception is that energy can be created and destroyed; in fact, the total amount of energy in a system remains constant, but the energy can be changed into useful forms or 'lost' as non-useful forms.

Differentiation

For those with lower abilities:

a It may be beneficial to complete a few more examples with students, and have them apply this knowledge to other situations in their life, such as shopping and test scores. This could then be related back to energy-efficiency calculations.

Extra activities

Starter activity

Students could investigate the energy efficiency of appliances at home and at school. Ask students whether old appliances should be replaced purely on energy efficiency, or are there other costs (e.g. environmental and/or economic) that need to be taken into account?

Practical support

Activity 3.3.1 support

Safety

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Answers

- The number of stars relates to energy efficiency not to energy consumption.
- kWh stands for kilowatt-hour
- Student answers will vary.

Answers

Questions 3.3.1 answers

1 Energy efficiency is the proportion of useful output energy provided by a device compared with the amount of input energy. It is usually expressed as a percentage.

2 By-product energies are not in the same form as the useful output energy, so they are termed ‘wasted’.

3 Energy-efficient appliances cost less to run because they use less input energy for the same amount of output energy. Hence, they are also better for the environment.

4 A 6-star energy rating is rare because in any energy transformation some energy is wasted. No transformation can ever be 100% efficient.

5 Student answers will vary. A typical answer may be: although it is cheaper to buy the 2-star device, it will cost more to run. It is better to spend a bit more now to buy the 4-star device and save on the cost of running it.

Resources

Student obook

Worksheet 3.8 Energy efficiency

A PDF of Workbook Activity 3.8

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Teacher obook

A3.3.1 Energy efficiency ratings

A risk assessment template for students and teachers for Activity 3.3.1

Workbook answers

Answers to all activities in the student workbook

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Efficient energy generation and use

Teaching support for pages 151–154

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW4 Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120, ACSHE135)

Students:

b research ways in which scientific knowledge and technological developments have led to finding a solution to a contemporary issue, e.g. improvements in devices to increase the efficiency of energy transfers or conversions

c discuss the implications for society and the environment of some solutions to increase the efficiency of energy conversions by reducing the production of heat energy

Working scientifically

Activity 3.3.2

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Numeracy builder

SC4-4WS Questioning and predicting

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Questions 3.3.2

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Activity 3.3.2

Literacy

Numeracy

Critical and creative thinking

Numeracy builder

Literacy

Numeracy

Sustainability

Critical and creative thinking

Questions 3.3.2

Literacy

Sustainability

Critical and creative thinking

Teaching strategies

Additional information

Generating electrical energy

The term ‘generating electricity’ is a little misleading; what is happening is that some of the electrons in a material are forced to move. When these are moved in the same direction at the same time, there is an overall ‘flow’ of electrons, which is often referred to as electricity – more precisely, it is an electric current. Importantly, the electrons are already in the material before the process of generating electricity begins. Whenever we generate electricity, there is always heat energy lost to the surroundings, so there is always a ‘loss’ of useful energy. We try to minimise this ‘energy loss’ in many ways to make the process

more efficient. Ultimately, even the energy that is transformed into electrical energy ends up as thermal energy in the atmosphere.

Differentiation

For those with higher abilities:

a Students could be encouraged to investigate more complex cost comparisons, like that explained in the 'Numeracy builder' activity

Practical support

Activity 3.3.2 support

Safety

Turn the kettle off and allow steam build up to escape before checking the temperature of the boiled water.

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Practical hint

The power rating can be found on the bottom of most kettles.

Discussion

Kettles with the same power rating are used to heat the same amount of water to the same temperature; the faster this occurs, the more efficient the kettle. For this to be a fair test, the final water temperature must be the same in both kettles. Repeat trials allow the accuracy and reliability of the experiment to be assessed.

Answers

- The fastest kettle to boil is the most efficient.
- Keeping the conditions the same allows for a fair test between the two kettles to be conducted.
- The water temperature should be checked to make sure that both kettles shut off at the same temperature.
- All practical experiments should be repeated to check the reliability of the method.

Answers

Questions 3.3.2 answers

1 Student answers will vary, but could include installing CFLs or LED lights, using solar panels, turning off lights and heating and/or cooling when not in the room etc.

2 A generator uses the kinetic energy of either a magnet or electrical wiring to force electrons to start moving.

3 kilowatt-hours (kWh)

4 Student answers will vary.

5 The efficiency of solar panels can be affected by any dirt or debris that blocks the panels of sunlight. Therefore, solar panels should be wiped clean regularly with non-abrasive cleaning agents.

6 Student answers will vary, but should include the fact that the MARS wind turbines can be moved easily to other locations, they can be raised to different heights to catch the wind, they are cheaper to build than wind towers and they operate in slower wind speeds.

7 Student answers will vary. Considerations for the location of a wind farm should include locating it: in a windy area with steady winds rather than turbulence; relatively close to where the power would be used; where it won't make a negative visual impact; where it won't impact on flora and fauna etc.

8 If a device is cost-effective it produces the best result for the money spent.

9 The term 'pays for itself' means that any upfront expenses that need to be paid (e.g. to buy and install solar panels) will be completely offset in the long term because of the productivity of the system (i.e. production of electricity).

Resources

Student obook

Video link: Energy let's save it

http://learn-energy.managenergy.net/kidscorner/animations/ec_cartoon_an.html

This video shows an animated cartoon family wasting energy and how their wastage can be easily overcome.

Worksheet 3.9 Group research activity: Increasing efficiency

A PDF of Workbook Activity 3.9

Teacher obook

A3.3.2 Which is the more energy efficient

A risk assessment template for students and teachers for Activity 3.3.2

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Workbook answers

Answers to all activities in the student workbook

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3.3 Checkpoint

Teaching support for page 155

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW4 Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120, ACSHE135)

Students:

a identify that most energy conversions are inefficient and lead to the production of heat energy, e.g. in light bulbs

b research ways in which scientific knowledge and technological developments have led to finding a solution to a contemporary issue, e.g. improvements in devices to increase the efficiency of energy transfers or conversions

c discuss the implications for society and the environment of some solutions to increase the efficiency of energy conversions by reducing the production of heat energy

Working scientifically

SC4-4WS Questioning and predicting

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Literacy

Numeracy

Critical and creative thinking

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Information and communication technology capability

Answers

Checkpoint 3.3 answers

1 initial cost and energy efficiency

2 light energy → electrical energy

3 For safety reasons, so the blades safely clear the ground and to effectively harness the cleaner (less turbulent) stronger wind.

4 Coal is more reliable. Winds do not always operate 24 hours a day, 7 days a week, even in usually windy areas. The wind always fluctuates in strength and direction, depending on the prevailing weather pattern.

5 Energy efficiency is the proportion of useful output energy provided by a device compared with the amount of input energy. It is usually expressed as a percentage.

6

a efficiency = 12 ÷ 20 × 100 = 60%

b efficiency = 500 ÷ 600 × 100 = 83% or 83.3%

7 The missing units of energy have been transformed into other non-useful types of energy (typically heat, sound etc.).

8 Student answers will vary.

9 Student answers will vary.

10 Student answers will vary.

11 Student answers will vary. An expectation that all people will change their current lighting is not realistic because people have different needs and attitudes. People may not change their current lighting system because:

- they think it will be too expensive to replace their current light bulbs
- they don't have enough time
- they are indifferent to the cost
- they need their current lighting for particular reasons.

12 Student answers will vary.

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Resources

Student obook

Weblink: Electromagnetic spectrum

http://missionscience.nasa.gov/ems/01_intro.html

This website contains comprehensive information about the electromagnetic spectrum and its components.

Teacher obook

A038, A039, A040 Assess

Checkpoint 3.3 Worksheet A

Students who score less than 12 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet A, which is designed for extra support.

Checkpoint 3.3 Worksheet A answers

Answers for Checkpoint Worksheet A

Checkpoint 3.3 Worksheet B

Students who score between 12 and 24 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet B, which is designed for consolidation.

Checkpoint 3.3 Worksheet B answers

Answers for Checkpoint Worksheet B

Checkpoint 3.3 Worksheet C

Students who score more than 24 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet C, which is designed for extension.

Checkpoint 3.3 Worksheet C answers

Answers for Checkpoint Worksheet C

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3 Chapter Review

Teaching support for pages 156–158

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)

Students:

a identify objects that possess energy because of their motion (kinetic) or because of other properties (potential)

b describe the transfer of heat energy by conduction, convection and radiation, including situations in which each occurs

c relate electricity with energy transfer in a simple circuit

d construct and draw circuits containing a number of components to show a transfer of electricity

e investigate some everyday energy transformations that cause change within systems, including motion, electricity, heat, sound and light

PW4 Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120, ACSHE135)

Students:

a identify that most energy conversions are inefficient and lead to the production of heat energy, e.g. in light bulbs

b research ways in which scientific knowledge and technological developments have led to finding a solution to a contemporary issue, e.g. improvements in devices to increase the efficiency of energy transfers or conversions

c discuss the implications for society and the environment of some solutions to increase the efficiency of energy conversions by reducing the production of heat energy

- trace the history of the development of particular devices or technologies, e.g. circuitry through to microcircuitry (additional content)

Working scientifically

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Literacy

Numeracy

Critical and creative thinking

Answers

Chapter review answers

1

kinetic, destroyed, transformed

transferred, convection, circuits, components

heat, efficiency, LEDs, wasted, more economical

2

a energy possessed by an object that is raised above the surface of the earth, e.g. any raised object

b a biomass energy source that is burned to power machines, e.g. E10, ethanol etc.

c energy possessed by a moving object, e.g. any moving object

3 Energy can be stored by stretching, squashing or raising an object to a height. It can also be stored in chemicals.

4 The spring has more advantages because it can be stretched or compressed. A string can usually only be stretched and only by small amounts before breaking.

5

a chemical → kinetic

b electrical → kinetic

c Student answers will vary. Typical answers may include the following

Petrol-driven advantages: can be refuelled with fuel carried in the vehicle or easily available at petrol stations; usually cheaper to buy petrol-driven cars than electric

Electric-driven advantages: power source (electricity) is usually cheaper than petrol

d A hybrid car contains both a petrol engine and an electric motor, with large banks of batteries.

6 An energy flow diagram has one conversion only: input energy → output energy. The energy chain shows all stages of the conversion; for example: chemical → electrical → kinetic → sound.

7 Student answers will vary.

8 Student answers will vary. All three are energy transfer processes for heat. Conduction relies on the contact of materials to transfer the heat. Convection relies on the circulation of the fluid via convection currents to transfer the heat. Radiation transfers heat via electromagnetic waves and does not rely on particles at all.

9 This is conduction. The surface of the hot brick is in contact with water molecules, which are made to move faster. The fluid is not initially getting hotter by circulating molecules (so it is not convection). There are no electromagnetic waves involved (so it is not radiation).

10 Conduction occurs between the heating element and the water molecules in contact with the element. Convection occurs in the water in the jug.

11 Electrical energy is the energy of electricity (carried by charged particles).

12 Circuits carry moving electrons that contain the electrical energy.

13 Student answers will vary. In thermal conduction, heat is passed from hot molecules to cooler molecules because of the contact between them. In electrical conduction, electric charge (electrons) is easily passed along a material that is a good conductor. Hence they are similar, but different processes.

14 Different people have different drawing skills and their pictures of the same circuit may look quite different. Diagrams are used so everyone draws the same thing for the same circuit.

15 Student answers will vary.

16 In a series circuit, the electrical energy of the power supply is shared between the two light bulbs. In a parallel circuit the electrical energy of the power supply is supplied to each light bulb separately.

17 Student answers will vary. The improvements have been made to increase the energy efficiency of the device.

18 Student answers will vary. Basically research continues into the design of solar panels to increase their energy efficiency.

19

a electrical energy → sound energy

b electrical energy → heat energy (and kinetic energy)

c electrical energy → sound energy

d sound energy → electrical energy

20 Electrical energy is transformed into higher or lower amounts by a transformer (e.g. from 240 V to 1000 V or from 240 V to 5 V). It is then transported along power lines supported by large frames.

21 A by-product is a non-useful form of energy.

22 Student answers will vary.

23 efficiency = 150 ÷ 200 × 100 = 75%

24 efficiency = 30 ÷ 40 × 100 = 75%

25 LED lights are becoming more popular because they:

- have a high energy efficiency (reduced power consumption)
- have a long lifespan
- can operate on a low-voltage power supply
- come in a wide range of available colours
- produce only a small amount of heat

26 Light bulbs in order of energy efficiency (most to least): light-emitting diode (LED), compact fluorescent lamp (CFL), incandescent

27 Student answers will vary.

28 Number of bulbs needed if they last 10 000 hours each = 10 bulbs

Base cost to buy the bulbs = $4.00 × 10 bulbs = $40.00

Energy use in kWh = (15 W ÷ 1000) × 100 000 hours = 15 000 kWh

Cost to run = 15 000 × $0.15 = $2250.00

Total cost for buying and running = $40 + $2250 = $2290

29 Student answers will vary.

30 Student answers will vary, but may include: less carbon emissions, unlimited supply (we won't run out of wind); possibly lower running cost (although coal is very cheap)

Resources

Student obook

Flashcard glossary

A review of the key terms used in the chapter

Worksheet 3.10 Review: Energy

A PDF of Workbook Activity 3.10

Teacher obook

T007 Testbank questions

Workbook answers

Answers to all activities in the student workbook

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3 Making Connections

Teaching support for pages 160–161

Syllabus links

Outcomes

SC4-11PW A student discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

Knowledge and Understanding

PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)

Students:

a identify objects that possess energy because of their motion (kinetic) or because of other properties (potential)

e investigate some everyday energy transformations that cause change within systems, including motion, electricity, heat, sound and light

PW4 Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120, ACSHE135)

Students:

a identify that most energy conversions are inefficient and lead to the production of heat energy, e.g. in light bulbs

b research ways in which scientific knowledge and technological developments have led to finding a solution to a contemporary issue, e.g. improvements in devices to increase the efficiency of energy transfers or conversions

Working scientifically

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

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SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Literacy

Numeracy

Critical and creative thinking

Information and communication technology capability

Teaching strategies

Teaching tips

This section transfers students' existing knowledge of how energy transforms to an unfamiliar context. Completing this activity should further consolidate students' understanding of the topic and test their awareness. For students to complete this task, they need a comprehensive understanding of this chapter. In particular, they need to understand how devices transform energy from one form to another – in this case, using the potential elastic energy in the mousetrap to propel a simple machine (a car). Many videos and instructions on how to build mousetrap cars are available online. Students could conduct research as part of their planning and designing stage. After constructing their car, they should test and improve it until they are happy with their mousetrap car. At the conclusion of the task, the class could have a race to determine, for example, which car is the fastest, most streamlined or best designed.

Safety

A risk assessment should be completed before undertaking this Activity. A suggested risk assessment template is provided in the teacher obook resources.

Resources

Teacher obook

Design your own mousetrap car

A risk assessment template for students and teachers for the Student Design Task

Making Connections Rubric Chapter 3: Energy

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Chapter 3: Understanding and managing ecosystems

Teaching support for pages 82–83

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

SC5-15LW A student explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

a recall that ecosystems consist of communities of interdependent organisms and abiotic components of the environment (ACSSU176)

b outline using examples how matter is cycled through ecosystems such as nitrogen (ACSSU176)

c describe how energy flows through ecosystems, including input and output through food webs (ACSSU176)

d analyse how changes in some biotic and abiotic components of an ecosystem affect populations and/or communities

e assess ways that Aboriginal and Torres Strait Islander peoples' cultural practices and knowledge of the environment contribute to the conservation and management of sustainable ecosystems

f evaluate some examples in ecosystems, of strategies used to balance conserving, protecting and maintaining the quality and sustainability of the environment with human activities and needs

- debate why any investigation relating to biological research and involving or affecting animals must be humane, justified and ethical (additional content)

Working scientifically

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Aboriginal and Torres Strait Islander histories and cultures

Sustainability

Critical and creative thinking

Ethical understanding

Information and communication technology capability

Literacy

Numeracy

Personal and social capability

Civics and citizenship

Work and enterprise

Intercultural understanding

Teaching strategies

Introducing Chapter 3

The links between the biosphere, ecosystems and other spheres of the planet were introduced in Oxford Insight Science 8, Chapter 1. This chapter builds on that knowledge and explores these connections further in terms of the cycling of matter and the flow of energy through ecosystems. There is also a

greater focus on the sustainable management of ecosystems and balancing the needs of the ecosystems with the needs of people. Traditional and Indigenous management of ecosystems is also explored, especially in terms of its integration with modern conservation techniques.

This chapter builds upon Stage 4 outcome SC4-15LW: A student explains how new biological evidence changes people's understanding of the world.

Teaching tips

The content of this chapter allows for a variety of hands-on activities and for links to be made with other concepts and chapters:

- Conditions of the environment can be measured and analysed.
- Populations can be measured, and data collected over time.
- Controlled experiments allow life processes, like photosynthesis and competition between species, to be understood.
- Photographs and text allow students to begin to explore remote ecosystems of Australia and the cultural practices of Indigenous Australians in land management at those places. The use of Aboriginal language further develops appreciation of Indigenous cultural knowledge.
- Students can research initiatives in their local area for greater sustainability of households, businesses or local governments. They consider what personal adjustments to their lifestyle would be appropriate to minimise their impact on the environment.

Extra activities

Starter activity: Brainstorm prior knowledge

Because this chapter follows closely on from Oxford Insight Science 8 Chapter 1 Ecosystems, it would be beneficial for students to revisit the main concepts from that chapter before beginning this one. Key assumed knowledge for this chapter includes:

- basic understanding of abiotic and biotic components of ecosystems
- basic understanding of energy and food interactions of food chains and food webs
- some examples of human activities and their impacts on natural environments
- some examples of management strategies for sustainable ecosystems.

Activity: Ecosystem communities

Using one example of an ecosystem, such as rainforests, grasslands, fresh water lakes, streams or another ecosystem of their choice, students list species within that ecosystem's community. A projected image of the ecosystems would facilitate engagement, or students could undertake their own image search for their chosen ecosystem. Remind students to consider organisms at all the trophic levels, including decomposers and detritivores.

assess

Each chapter of the *Insight Science 9* student text includes related assessments and testbank questions that are graded for student ability and linked directly to the outcome statement codes in the Australian Curriculum for NSW syllabus.

Assessments

Assessments are auto-marking multiple choice quizzes. Questions are graduated in difficulty so teachers can assign as appropriate to students:

- Support (foundation)
- Consolidate (standard)
- Extend (advanced)

Students can review their quiz results to see which questions they answered correctly or incorrectly. Students can improve their results by attempting the quiz again with the challenge of randomised answer options.

Testbank

Testbank provides teacher-only access to ready-made chapter tests. They consist of a range of multiple choice, short answer and extended response questions with marking guidance for each short and extended response question. Multiple choice questions are auto-graded.

The testbank can be used to generate tests for end of chapter, mid-year or end of year tests. Tests can be printed, downloaded, or assigned online.

Assigning tests

In order to assign work to students, your students must first:

(i) have the obook in their Oxford Digital library;

(ii) have linked to your Oxford Digital account; and

(iii) be added to a class you have created.

1 For a step-by-step guide on **getting started with your class set-up**, click here:
https://obook2.oxforddigital.com.au/teacher/classadmin.html

2 For a step-by-step guide on **assigning assessment for students**, click here:
https://obook2.oxforddigital.com.au/help/assess/Assigning_work_using_assess_teachers.html

Results

Student results can be monitored and graphed, or exported to Excel for incorporation into an LMS.

3 For a step-by-step guide on **using results in assess**, click here:
https://obook2.oxforddigital.com.au/help/assess/Using_results_in_assess_Teachers.html

Resources

Student obook

Flashcard glossary

A review of the key terms used in Chapter 3.

Teacher obook

Chapter 3 Teaching program

A fully editable teaching program for this chapter, mapped to the NSW Syllabus

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Cycles of matter

Teaching support for pages 84–88

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

a recall that ecosystems consist of communities of interdependent organisms and abiotic components of the environment (ACSSU176)

b outline using examples how matter is cycled through ecosystems such as nitrogen (ACSSU176)

Working scientifically

Activity 3.1.1

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

SC4-8WS Problem solving

Questions 3.1.1

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Activity 3.1.1

Critical and creative thinking

Literacy

Personal and social capability

Deeper understanding: Termites recycle carbon

Critical and creative thinking

Literacy

Questions 3.1.1

Critical and creative thinking

Sustainability

Literacy

Teaching strategies

Introducing Section 3.1

Section 3.1 introduces the links between the biosphere, lithosphere, hydrosphere and atmosphere through the biogeochemical cycles. Focusing on the abiotic conditions of nutrient availability and chemical concentration, students examine the nitrogen and carbon–oxygen cycles and the roles of living organisms in maintaining the cycles.

Teaching tip

In this chapter, students are required to deconstruct ecosystems into their components and are introduced to the overall workings of these systems in terms of inputs, outputs and processes. To assist students to see the 'bigger picture', encourage students to consider all the inputs and outputs of the particular ecosystem they are examining and identify the links with other processes.

Common misconceptions

The community of organisms is living. The biotic environmental components, although associated with the organisms of the community, are not the organisms themselves. Biotic components are things like population size, predator–prey relationships, mating behaviours etc. In the same way, the abiotic factors are not directly associated with living organisms, but include things like wind speed, water availability, nitrogen soil concentration etc.

Differentiation

For students with higher abilities:

- determine the meaning of the terms ‘dynamic’, ‘unit’, ‘input’, ‘interactive’ ‘processes’ and ‘output’ in reference to ecosystems
- if intense bushfires can badly affect soil bacteria populations, predict the effect of such bushfires on ecosystems aside from the immediate loss of life in the community of organisms above ground.

Additional information: Carbon

Most of the solar energy incident on the leaves of plants is not transformed into chemical potential energy of glucose molecules. Some is reflected back into the atmosphere and some is transformed into thermal energy and the leaf becomes warm. Of the light energy that finds its way to a chloroplast of a leaf, only the red and blue wavelengths are used in photosynthesis; the other wavelengths are transmitted through the leaf and are perceived by us as filtered light.

Extension activity

In small groups, students make board games of the carbon–oxygen cycle. Their games traverse the biosphere, atmosphere and lithosphere and follow the movement of a carbon or oxygen atom. Chance cards written for each game can provide changed environmental conditions that can either slow or accelerate progress in the game. Students then play the there own board games and those designed by other small groups.

The design component of this activity may be best suited to students with higher abilities, but all students should be involved in the construction and playing of the game. Students can also peer assess the learning value and fun factor of each game.

Extra activities

Starter activity: Investigating nitrogen

Set students the task of finding out whether humans can take in nitrogen gas from the atmosphere into their bloodstream. Suggest students find out the composition of air that is breathed in compared with air that is breathed out.

Students can also research the mass of nitrogen of the human body, comprised of nitrogen within compounds. They should assess the importance of nitrogen to the functioning body and then relate these findings to the nitrogen cycle.

Extension activity: Nitrogen formulas

Students can investigate and write chemical formulas for all substances containing nitrogen in the nitrogen cycle. They can also research the role of leguminous plants in the nitrogen cycle.

Practical support

Activity 3.1.1 answers

1 Student responses will vary, but will typically include food, shelter, water, appropriate mates etc.

2 Biotic resources may include canopy cover, the availability of nesting hollows, home range of predator, competition for food etc. Abiotic resources may include rainfall, humidity and wind speed.

3

Photosynthesis

Inputs: sunlight energy, carbon dioxide, water

Outputs: oxygen, glucose

Respiration

Inputs: oxygen, glucose

Outputs: carbon dioxide, water, energy

Growth

Inputs: food material, nutrients

Outputs: new cells, increased organic matter

Decomposition

Inputs: organic material

Outputs: basic chemicals

4 Photosynthesis and respiration could be drawn as a circle, where the outputs of one process become the inputs of the other and so on. Growth and decomposition could also be drawn as a circle.

Deeper understanding support

After reading this article, student can debate whether termite mounds are an abiotic or biotic environmental component.

Answers

Questions 3.1.1 answers

1 Nitrogen-fixing bacteria absorb nitrogen compounds form the atmosphere and convert them into a soluble compound that plants can absorb from the soil water. Lightning also converts atmospheric nitrogen compounds to a soluble form that can be absorbed into the soil.

2 Photosynthesis is the only natural process that removes carbon dioxide from the atmosphere.

3 Photosynthesis and respiration are the major processes of the carbon–oxygen cycle and could be considered opposites, although the reactions are not the same or reversible. The chemical equation is a summary of a number of step-by-step reactions for both processes.

4 The savannah grasslands of Australia are usually too dry to sustain fungi and other decomposers of plant material. Without decomposers, carbon cannot be recycled. The termites become a moist habitat for the fungi and bacteria to live in.

5

	Nitrogen cycle	Carbon cycle
Plants	• take up soil nitrates • are eaten by animals	• fix CO_2 from air
Bacteria	• some fix N_2 from air • others change waste to soluble nitrogen compounds • others return nitrogen to the air	• change waste to CO_2

6 On farms, nitrogen is lost in the plant and animal bodies that are exported to cities before they can die and decompose locally to return nitrogen compounds to the soil. In cities, nitrogenous waste from humans is dumped into the oceans and lost. Thus, the nitrogen cycle is broken. Nitrogen compounds obtained from industry are imported onto farms and used as fertiliser to replace the nitrogen that has been lost. Run-off from farms often contains excess nitrogen fertiliser, which gets into streams and promotes algal growth.

On farms and in cities, carbon stores of fossil fuels are obtained from the lithosphere and burned to provide energy. This increases the carbon dioxide in the atmosphere and skews the carbon cycle.

7 Nitrogen is captured from the air by bacteria and from soil water by plants. Carbon is captured from the air by plants and is used in plant cells in photosynthesis.

Resources

Student obook

Weblink: Carbon cycle

This website is an interactive of the carbon cycle where students can click on the different labels to view short video clips or images about different parts of the cycle.

http://www.sciencelearn.org.nz/Contexts/The-Ocean-in-Action/Sci-Media/Animations-and-Interactives/Carbon-cycle

Weblink: Nitrogen cycle

This website has an interactive animation of the nitrogen cycle.

http://nortonbooks.com/college/biology/animations/ch38a02.htm

Weblink: Phosphorus cycle

This website has an interactive animation of the phosphorous cycle.

http://www.sumanasinc.com/webcontent/animations/content/phosphorouscycle.html

Workbook Activity 3.1 Cycles of matter

A PDF of Workbook Activity 3.1

Teacher obook

Workbook answers

Answers to all activities in the student workbook.

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Energy in ecosystems

Teaching support for pages 89–91

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

a recall that ecosystems consist of communities of interdependent organisms and abiotic components of the environment (ACSSU176)

c describe how energy flows through ecosystems, including input and output through food webs (ACSSU176)

Working scientifically

Activity 3.1.2

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Experiment 3.1.1

SC4-4WS Questioning and predicting

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Activity 3.1.2

Critical and creative thinking

Literacy

Numeracy

Personal and social capability

Experiment 3.1.1

Critical and creative thinking

Literacy

Personal and social capability

Work and enterprise

Teaching strategies

Teaching tip

Students should be familiar with the concept of energy from previous years; however, they may find it difficult to apply these ideas to ecosystems. Encourage students to consider the source of energy for the process and how it is transformed and transferred in each case.

Additional information: Flow of energy through ecosystems

The law of conservation of energy applies here. Energy transformations do not destroy energy, but change some of it into thermal energy, which is transferred to the atmosphere and then to space.

As energy is passed along a food chian, 90% of the energy at each stage is lost in the life processes of each organism and as heat, with only 10% passed on in the body of the organism consumed. This means that there is less and less energy available to support higher-order consumers. Fewer higher-order consumers can survive compared with producers or organisms on lower trophic levels.

Common misconceptions

Many students think that energy is recycled, just as matter is recycled, in ecosystems. It is important to make the distinction between the cycle of matter within ecosystems and the flow of energy through ecosystems. The vast majority of energy is lost from ecosystems in the form of heat.

Additional information: Starch and photosynthesis

Glucose molecules are linked together to form a storage molecule called starch. Starch can be broken up into glucose molecules, if required, for respiration.

Answers

Activity 3.1.2 answers

- Less energy is available the higher up the food chain you go, so there is not enough energy at these higher levels to support the same number of consumers as producers. The number of organisms at each subsequent trophic level must decrease as a result of the reduced energy available at each level.
- The 'left over' energy from the sun is converted into ambient light and heat.
- The herbivore only received 10% of the available energy from the plant (6 mL), or 0.3% of the original energy from the sun (10% of 3%). The 'left over' energy (54 mL) was used by the plant for growth, development and other cellular processes, and lost to the atmosphere as heat.

Practical support

Experiment 3.1.1 support

Safety

- Ensure students are aware of the flammable nature of methylated spirits and ensure that all heating is undertaken using hot plates rather than Bunsen burners.
- Write a risk assessment for this practical and have a clear understanding of the material Safety Data Sheets for methylated spirits and iodine solution, and the risks involved in using them.
- A risk assessment should be completed before undertaking this Experiment. A suggested risk assessment template is provided in the teacher obook resources.

Practical hints

- Geraniums work very well in this experiment and they can be easily propagated from cuttings.
- Place plants in the dark by covering them with box 2–3 days before they are required.
- Placing the plants near a bright lamp helps give a strong positive to the starch test.

- Placement of the plant in the dark ensures that cell respiration of the plant will use up all the starch storage granules to keep the plant alive. Any starch detected after the period in the dark will be due to immediate photosynthesis in the light.
- Exposure to sunlight should not be prolonged, otherwise there would be enough time to translocate sugars from photosynthesising parts of the plant to non-photosynthesising (covered in alfoil) parts of the same plant.

Clean up

Allow hot plates and methylated spirits to cool before handling. Methylated spirits and iodine can be disposed of down the sink.

Discussion

1 The plant without any exposure to sunlight (plant A) is the control.

2 The dependent variable is the production of starch, as indicated by a positive iodine test.

3 The controlled variables are those that are kept constant, such as the type of plant, their size, shape and the conditions under which they were kept, the time of exposure to sunlight and procedures for detecting starch in leaves.

4 Photosynthesis is a process in which light energy is converted to chemical energy and used to produce organic compounds, such as starch.

5 This experiment is qualitative. The amount of starch in the leaves after testing involves a textual description of colour intensity and distribution. There is no numerical measurement of the amount of light energy used or starch produced.

6 Student responses will vary, but encourage the students to use logical reasoning for their improvements.

Extra activities

Activity: Starch

Display an image of a light micrograph and/or an electron micrograph showing starch granules in a leaf. Stress that large starch molecules are very insoluble and hence clump together as granules.

In a teacher demonstration, make a starch suspension from powdered starch. Add a few drops of iodine solution to a sample of your starch suspension and the same number of drops of iodine solution to a distilled water sample of the same volume.

Extension activity: Light intensity

Students can investigate the effect of light intensity on the rate of photosynthesis.

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Student design task

Teaching support for pages 92–94

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

a recall that ecosystems consist of communities of interdependent organisms and abiotic components of the environment (ACSSU176)

c describe how energy flows through ecosystems, including input and output through food webs (ACSSU176)

Working scientifically

Student design task

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Questions 3.1.2

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Student design task

Critical and creative thinking

Literacy

Numeracy

Personal and social capability

Work and enterprise

Questions 3.1.2

Critical and creative thinking

Literacy

Teaching strategies

Common misconceptions

Respiration and photosynthesis are not one-step reactions. They are each a series of reactions that are summarised in an overall equation. Although the reactants and products in respiration and photosynthesis are inversions of each other, the series of reactions within each is different. Each reaction happens within its own specific organelle.

Differentiation

Students with higher abilities could be asked to:

- research how respiration and photosynthesis follow different chemical pathways
- draw a mind map to show how photosynthesis and respiration are related to ecosystems.

Practical support

Student design task

Is chlorophyll necessary for photosynthesis?

- A variegated plant will have to be de-starched for 2 days before exposure to the light. This is because glucose and starch are present in the white sections of the leaf, translocated from green photosynthetic sections of the same leaf.

Do increased levels of carbon dioxide increase the rate of photosynthesis?

- Varying the concentration of bicarbonate ions in a number of different solutions provides different concentrations of CO_2 in solution available for photosynthesis.

  Bicarbonate ions release carbon dioxide gas into the water as follows:

  $$HCO_3^- + H^+ \rightarrow CO_2 + H_2O$$

- *Spirogyra* may not be available. As an alternative, you could use a hole-punch on leaves of a terrestrial plant to produce leaf samples of the same size.
- Students do not have to collect the oxygen gas; they can qualitatively or quantitatively assess the rate of oxygen bubble production.

Safety

A risk assessment should be completed before undertaking this Student Design Task. A suggested risk assessment template is provided in the teacher obook resources.

Answers

Questions 3.1.2 answers

1 Matter is composed of atoms. Energy has the capacity to cause change to objects (i.e. to do work on objects).

2 Energy flows to Earth from the Sun, then along food chains. It is eventually lost to space as heat. Matter passes into an ecosystem from the atmosphere, hydrosphere or lithosphere. This matter is passed along food chains, then recycled back to where it came from.

3 Energy is used to build compounds and new cells, to help parts of the body communicate with each other, to assist cell or body movement and to transport molecules around the body.

4 High-energy organic compounds, like glucose, are used in respiration.

5 $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

6 Organisms are constantly carrying out cellular functions, such as growth, repair and movement. These activities, as well as any other activities of the cell, require energy. Thus, cellular respiration is a fairly continuous process to provide the energy required for the life-sustaining functions of the cell and organism.

7

CO_2: obtained from the atmosphere through stomata on leaves

H_2O: obtained from the soil water through the roots of plants

Solar radiation: from the sun

8 All ecosystems need energy contained within organic molecules. Photosynthesis within producers provides these molecules to most ecosystems.

9 Each reaction uses the products of the other reaction as reactants.

$$C_6H_{12}O_6 + 6O_2 \underset{\text{Respiration}}{\overset{\text{Photosynthesis}}{\rightleftharpoons}} 6CO_2 + 6H_2O$$

The energy captured by one reaction (photosynthesis) is released by the other reaction (respiration).

Resources

Student obook

Video link: Energy flow in coral reef systems

This website contains a video about how energy from sunlight is transferred through the inhabitants of the reef ecosystem.

http://www.pbslearningmedia.org/resource/hew06.sci.life.reg.foodweb/energy-flow-in-the-coral-reef-ecosystem/

Interactive activity: Cellular respiration equation

This interactive is a quiz about the cellular respiration equation.

Video link: Photosynthesis

This website has a video about the process of photosynthesis.

http://science.howstuffworks.com/life/29603-assignment-discovery-photosynthesis-video.htm

Interactive activity: Photosynthesis equation

This interactive is a quiz about the photosynthesis equation.

Workbook Activity 3.2 Energy in ecosystems

A PDF of Workbook Activity 3.2

Teacher obook

A3.1.2 Modelling energy transfers in the environment RA

A risk assessment template for students and teachers for Activity 3.1.2

E3.1.1 Starch production and light LAB TECH

A risk assessment template for the preparation of ingredients by the Lab Technician for Experiment 3.1.1

E3.1.1 Starch production and light RA

A risk assessment template for students and teachers for Experiment 3.1.1

Student Design Task – Understanding photosynthesis RA

A risk assessment template for students and teachers for the Student Design Task

Workbook answers

Answers to all activities in the student workbook.

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Relationships in ecosystems

Teaching support for pages 95–102

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

a recall that ecosystems consist of communities of interdependent organisms and abiotic components of the environment (ACSSU176)

c describe how energy flows through ecosystems, including input and output through food webs (ACSSU176)

Working scientifically

Experiment 3.1.2

SC4-4WS Questioning and predicting

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Activity 3.1.3

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Questions 3.1.3

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Experiment 3.1.2

Critical and creative thinking

Literacy

Numeracy

Personal and social capability

Work and enterprise

Activity 3.1.3

Critical and creative thinking

Information and communication technology capability

Literacy

Personal and social capability

Questions 3.1.3

Critical and creative thinking

Literacy

Teaching strategies

Teaching tips

Most students will be able to provide animal-based examples fairly readily for each type of interaction covered in this section. Challenge students to think of plant- and/or microorganism-based examples as well.

There are many excellent documentaries that explore relationships within ecosystems. Most students find video clips very engaging and so the use of some of these can be very beneficial.

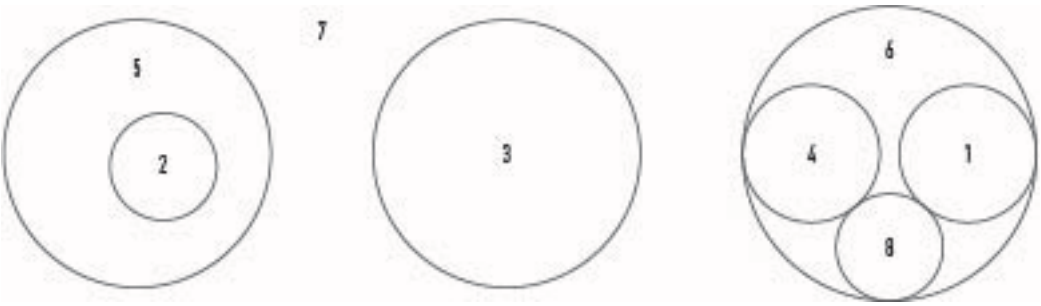
Differentiation

Ask students with lower abilities to examine all the photographs of relationships between species on pages 96–99 of the Student Book and to justify, in their own words, the stated relationship classification.

Extra activities

Activity: Venn diagrams

Identify the numbered sets in the Venn diagram to explore the classification of relationships between organisms of different species.



1, parasitism; 2, symbiosis; 3, commensalism; 4, predator–prey; 5, mutualism; 6, detrimental; 7, relationships between organisms of different species; 8, competition and inhibition.

Students can also draw their own Venn diagrams (or other graphic representation) of each of the relationships covered in this section.

Extension activity: Solitary animals

Some organisms do not live with others of their species. Ask students to research examples of solitary species and collect images. Do members of the species ever get together? Ask students to describe any situations or conditions when this may occur. Get students to explain why a solitary existence, in each case, is an adaptation for survival.

Activity: Classifying relationships

Ask students to classify the relationship between the savannah termite (from the previous section) and the microorganisms that live in its gut and to justify their answers. (Answer: symbiosis. The termites could not digest their food without the microorganisms, and the microorganisms could not live outside the body of the termite because the savannah is too dry.)

Ask students to classify the relationships of other species listed below with humans and to justify their decisions:

- domestic cat (mutualism)
- cockroaches (commensalism)
- mosquitoes (parasitism)
- dust mites (commensalism)
- tapeworm (parasitism)
- sharks (competition)
- locust (competition)
- cholera bacterium (parasitism

Activity: Graph interpretation

Many students have difficulty interpreting graphical information. Asking students the following questions informally or as a specific task can help students identify aspects of graph interpretation.

Get students to examine Figure 3.19 on page 97 of the Student Book.

1 What two trends can the students observe between the numbers of predators and the numbers of prey? (Answer: Prey numbers are always higher than predator numbers. Peaks in predator numbers follow the peaks in prey numbers.)

2 Explain both the trends you observed. (Answer: Energy available to prey is higher than energy available to predators. Fewer predators can be supported. Because prey is food for predators, as prey populations increase, more and more predators can be supported. The time lag between the peak in prey numbers and the peak in predator numbers is due to the difference in the time at which increased food becomes available and the time to develop reproductive maturity of the predator.)

Extension activity: Classifying relationships

Ask students to research relationships between organisms in Australian ecosystems:

- mistletoe and gum tree (parasitism)
- mistletoe bird and mistletoe (mutualism)
- bellbird and other small bird species (competition)
- bellbird and psyllid bugs (mutualism)

- psyllid bugs and gumtrees (parasitism)
- cleaner fish and whale shark (mutualism)
- remora and shark (parasitism)
- barnacle and the whale (commensalism)
- koel and native birds (parasitism)

Ask students to classify the following relationships in an agricultural ecosystem:

- cows and willy wagtails (mutualism)
- humans and wheat (mutualism)
- honey bees and flowering plants (symbiosis)

Ask students to classify the following relationships in an urban ecosystem:

- dogs and ticks (parasitism)
- rats and humans (commensalism)
- foxes and domestic cats (competition)

Practical support

Experiment 3.1.2

Safety

Observe safety instructions on the bag of potting mix. Some potting mix labels warn about breathing in the dust and air released from the bags when opened because they may contain harmful bacteria.

A risk assessment should be completed before undertaking this Experiment. A suggested risk assessment template is provided in the teacher obook resources.

Practical hints

- Ensure good-quality potting mix is used for germination and that conditions in the garden bed or pots are at their optimum.
- Ensure watering is regular and not too much. Ask students to record when plants are watered and how much water is used.

- A wide variety of seeds in pot or plot C is required. This will give interesting results over time. There will be different germination times, and the size of the seeds and plants will add to competition.
- This experiment needs to be performed over 3 weeks or more if possible because some results will not be apparent until the plants have had time to grow.

Expected results

- The plants in A should be much the same size at germination as B; however, as the plants grow, crowding and competition for nutrients, water and sunlight should stunt or slow the growth of plants in A compared with B.
- The plants in C will exhibit a variety of results. There should be some dominant plants initially because germination times will differ between plants; then, the size, speed of growth and other physiological traits will come into play.

Discussion

1 Assumptions could include larger seedlings being considered more successful than smaller ones, any difference in seedling size being related to growing conditions and not natural differences between individuals, that minerals are evenly available to all seeds, that there is the same solar access for all pots, that watering of the soil will be even, that all seeds have the same (genetic) potential to grow in this environment and that they have had the same shelf life.

2 Reliability can be improved by repeating the experiment a number of times to achieve the same results. Validity can be improved by ensuring all variables, except the one being tested, are controlled in the experiment. For example: ensure that there is thorough mixing of soil before dividing it into pots; place the pots in the same location, with appropriate separation to ensure the same solar access; use a calibrated watering device that will deliver a fine spray of the same volume of water evenly over the pots every time; repeated runs of the experiment and the reporting of results averaged across these different would control for genetic diversity between seeds; and using seeds with the same use-by-date on the packet should help control for seed age. (Seeds use food stored inside them for cell respiration during storage. If too much time elapses, they run out of food to fuel germination.)

3 Student responses will vary, but encourage them to be logical and helpful.

4 Student responses will vary, but encourage them to refer specifically to their results. Some evidence may include: variation in timing of germinations after watering; early germinated seeds may produce leaves that shade later germinating seeds (A and C); some seedlings may be tall and spindly, standing taller than the rest and thus getting better access to sunlight (A and C); and

seedlings in B may have a greater success rate because they are separated from each other and thus have more equal and sufficient access to resources such as sunlight, water and minerals.

5 Other factors that may affect the growth of seeds could include soil water and minerals, the presence of pests and/or insects, the age of the seeds, the amount of sunlight and temperature.

6 Student responses will vary, but encourage them to be logical extensions of the existing experiment.

7 Student responses will vary, but may likely relate to animal species.

Activity 3.1.3 support

As extension tasks:

- ask students to classify the pollinator–pollinated relationship and describe the conditions under which it could be classed as symbiosis
- discuss the consequences for loss of biodiversity if one of the species in such a relationship becomes extinct.

Answers

Activity 3.1.3 answers

Student responses will vary, but should emphasise the following key points:

- Pollination is an example of mutualism. The pollinator receives a food reward in the form of pollen and nectar. The plant increases its likelihood of fertilisation by having a ‘courier’ to carry the pollen from the male parts of one flower to the female parts of another flower.
- The two main groups of pollinators are insects and birds (or other vertebrates).
- Most grasses and cereal crops are pollinated by the wind. Flowering plants in which the flower is very small or nondescript are usually pollinated by the wind. Bright coloured flowers with nectar are used to attract living pollinators.

Questions 3.1.3 answers

1

Similarity: in both relationships one organism benefits, whereas the other is harmed

Difference: prey species die outright, hosts of parasites usually live for a relatively long time

2 Intraspecific competition is the interaction between individuals of the same species over limiting resources like food, shelter, water or mates.

3

	Mutualism	Symbiosis	Commensalism	Predator–prey	Parasitism	Competition
Species A	Benefited	Benefited	Benefited	Predator: benefited	Host: harmed	Harmed
Species B	Benefited	Benefited	Harmed	Prey: harmed	Parasite: benefited	Harmed

4 This is parasitism. The mistletoe plant cannot survive without the nutrients provided by the host plant. The host plant usually gets sick as a result of the mistletoe, and the infected branch can often die. Well-adapted parasites do not kill their hosts. However, some do, and thus kill themselves in the process.

5 This is commensalism. The epiphyte benefits from being higher in the canopy (access to more sunlight and probably protected from ground predators), whereas the tree is neither harmed (the epiphyte is not taking anything from the tree) nor benefited (the epiphyte is not giving the tree any advantage at all).

6 A variety of different organisms in an ecosystem enable all processes that are necessary for a balanced ecosystem to exist. Producers convert sunlight energy into usable chemical potential energy, consumers ensure that energy and the nutrients are moved through the ecosystem and decomposers return the matter back to the ecosystem to be reused.

7 Student responses will vary but may include disease, hunting of native animals, clear fell forestry, toxic chemical drift from farms or cities and intense bushfires, which could all cause extinction. If a species is reduced in distribution due to habitat destruction, then this now endangered species could be wiped out with a disease or with climate change.

8 Growth in predator populations happens after an increases in prey populations. Predator animals usually complete their reproductive cycle after the prey species has completed theirs. This time lag allows prey populations to recover and grow, and then provide food for the growing predator populations. If there are plenty of prey individuals, the greater energy resource will allow the predator population to increase. Greater predator numbers will control the larger population size of the prey species and reduce it again. With less food and energy available to the predator species, their population will also decrease after a lag. The benefits to the prey species is that their population is controlled so that overpopulation cannot occur, which would result in extreme competition for food and water resources.

9 If ecosystems are unbalanced, big changes to populations can result and may disrupt the ecosystem. For example, an increase in rainfall may cause more grass to grow, resulting in an increase in herbivores. The increase in herbivores causes the plants to be overgrazed at a rate faster than the grass can regrow. Trampling by herbivores also prevents new seeds from germinating and results in soil erosion, further preventing the growth of producers. Without producers, the whole ecosystem could collapse.

10 Ecological balance is important because all organisms rely on each other as well as the right set of abiotic conditions. A significant change in biotic factors can influence abiotic factors, and vice versa. A change in one condition can have a domino affect on other factors, both abiotic and biotic. Without balance, energy cannot flow effectively through the ecosystem and, potentially more importantly, matter will not be cycled properly.

Resources

Student obook

Video link: Microscopic organisms on the Great Barrier Reef

Catalyst video about cleaner fish removing microscopic parasites and diseased or dead tissue from larger sharks and rays.

http://www.abc.net.au/catalyst/stories/2929830.htm

Video link: Malaria parasite

This video shows how the plasmodium parasite operates inside the body to cause malaria.

http://videos.howstuffworks.com/discovery-health/40843-monsters-inside-me-malaria-video.htm

Weblink: The importance of pollinators

This website is a practical science resource for understanding pollinator partnerships and building biodiversity stewardship for students.

http://australianmuseum.net.au/Welcome-to-Plant2pollinator

Workbook Activity 3.3 Relationships in ecosystems

A PDF of Workbook Activity 3.3

Workbook Activity 3.4 Food chains and food webs

A PDF of Workbook Activity 3.4

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Teacher obook

E3.1.2 Observing competition

A risk assessment template for students and teachers for Experiment 3.1.2

Workbook answers

Answers to all activities in the student workbook.

3.1 Checkpoint

Teaching support for pages 103–105

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

a recall that ecosystems consist of communities of interdependent organisms and abiotic components of the environment (ACSSU176)

b outline using examples how matter is cycled through ecosystems such as nitrogen (ACSSU176)

c describe how energy flows through ecosystems, including input and output through food webs (ACSSU176)

Working scientifically

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Sustainability

Critical and creative thinking

Literacy

Numeracy

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Answers

Checkpoint 3.1 answers

1 Abiotic factors are the non-living conditions of an ecosystem, whereas biotic factors are those associated with the living community of the ecosystem.

2 All three are interspecific relationships. In mutualism, both organisms benefit. In parasitism, one benefits and one is harmed. In commensalism, one benefits and one is unaffected.

3 Photosynthesis is a chemical reaction by which plants transform the solar energy of the Sun into chemical potential energy of glucose molecules by chemically combining water and carbon dioxide.

4 Plants use nitrogen in the form of soil nitrates and ammonium, which can be incorporated into plant protein.

5 Eutrophication is an imbalance of nitrates and phosphates in waterways that results in an explosion of populations of cyanobacteria, resulting in algal blooms.

6 Plants growing on the forest floor compete for light with plants of the same species and with plants of different species. Animals compete within their own species for mates, and compete with other species for common food sources.

7 Energy flows from the Sun to Earth, then along food chains. It is eventually lost to space as heat. Matter passes into an ecosystem from the atmosphere, hydrosphere or lithosphere. This matter is passed along food chains. It is then recycled back to where it came from.

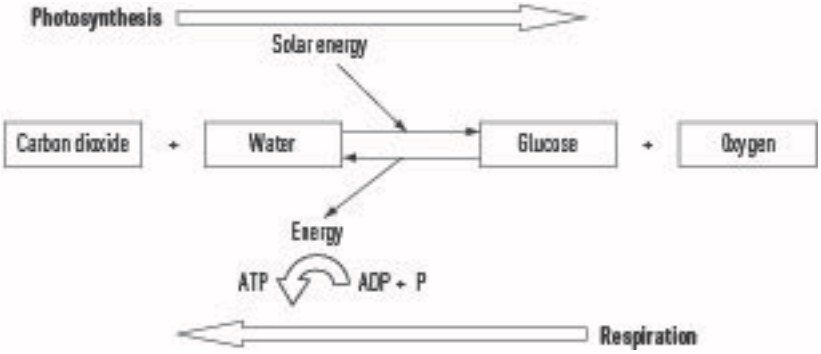
8 Photosynthesis transforms the solar energy of the Sun into chemical potential energy of the glucose molecule. Respiration transforms the chemical potential energy of glucose into a variety of other energy forms, such as heat, kinetic, sound and light (bioluminescence for use in a cell).

9 Student responses will vary, but may include: cell movement, the synthesis of complex molecules for simple components, the secretion of molecules to the cell surface, replicating DNA, the synthesis of new organelles, cell division, active transport and cell-to-cell communication.

10 The rest of the energy is lost as heat.

11 Nitrogen-fixing bacteria, such as those found in the root nodules of legumes, incorporate N_2 from the air into forms accessible to host plants. Denitrifying bacteria in the soil use nitrates for metabolism and release N_2 back into the atmosphere.

12 Student responses will vary, but should include reference to the summarised chemical equations for both processes being the reverse of each other, the cyclic nature of ATP formation and decomposition, the input of solar energy and the output of various forms of energy, including heat.



13 Student responses will vary.

14 Multiple species pollinators are best. If one species is reduced in numbers, the other species will continue the work of pollination to ensure that plant reproduction occurs.

15

a predator (humpback whale) and prey (krill)

b predator (seal) and prey (penguin); also interspecific competitors for krill

c With fewer fish to eat, the fur seals will rely more heavily on krill and penguins. There may not be enough food to sustain the seal population, which would slowly decline.

d With fewer fish eating krill, there may be more food for the humpback whales; however, fur seals will be relying more heavily on krill as a food source, so there may not be any real change to humpback whale populations.

16 A rechargeable battery contains chemical potential energy. Chemical reactions can release this energy as electrical energy into an appliance to do work. In recharging the battery, the reactions in the battery are reversed when electricity is put into it. A plant contains chemical potential energy in the form of glucose molecules. Respiration is a chemical reaction in which this energy is transformed into a useful form cells use to do work, and carbon dioxide and water are released into the atmosphere. Solar energy can then allow the plant to 'recharge' by making glucose out of the carbon dioxide and water.

17

Processes		
Make nitrogen available to living things	Decrease the amount of nitrogen to living things	Brought about by human activity
• Lightning reacts N_2 in the air with water and oxygen to form soluble nitrates in rainwater • Decomposers act on dead remains and wastes to release minerals, including ammonia • Ammonia in animal wastes is changed into soluble nitrate by soil bacteria • Bacteria in root nodules of legumes incorporate N_2 from the air into forms accessible to host plants	• Denitrifying bacteria in the soil use nitrates for metabolism and release N_2 into the atmosphere • Leaching of soil depletes it of minerals, including nitrites and nitrates	• Humans add nitrogenous fertiliser to farmland that can be washed into surrounding natural ecosystems • Humans dispose of their nitrogenous waste into streams or oceans

18

a Student responses will vary, but may include that *Lottia* is a herbivore and eats microalgae. *Acmaea* is a competitor for the microalgae, but is chased away by the larger and more aggressive *Lottia*. *Acmaea* is forced to eat algal cells contained in the saltwater spray on the edge of the rock platform.

Alternatively, *Lottia* and *Acmaea* are competitors for the same resource, the microalgae. *Lottia* may release a chemical that inhibits the growth of *Acmaea.* The chemical is at the highest concentration immediately around the *Lottia.*

b Student responses will vary, but may include moving an *Acmaea* into the territory of the *Lottia*. The consequences could be observed using a camera mounted on a tripod, with photographs taken at regular intervals so that interactions between the limpet species could be investigated.

Alternatively, the *Acmaea* could be grown on a simulated rock platform with and without *Lottia* in an experiment outlined in the table below.

Experimental variable	Dependent variable	Variables that need to be control
Presence or absence of Lottia	No. *Acmaea* growing on the rock	• Amount of microalgae available • Water salinity • Water temperature • Water movement

19 Student responses will vary. An example of an investigation could be:

- weighing the plant and the soil–pot combination before set up
- placing the plant into the soil in the pot, and then placing the potted plant in a sunny position
- weighing the water added to the pot at each watering, and calculating the total mass of water added
- after the plant has grown, removing it from the pot and weighing it
- weighing the soil–pot combination after the plant has been removed
- comparing the weight increase in the plant with the mass of the water added and with the changes in mass of the soil–pot combination
- repeating the experiment

A control could be a soil–pot combination of known mass that has the same known masses of water added to it at the same intervals. This pot should be kept in the same sunny position as the test pot and re-weighed after the same lapse of time.

The purpose of the control is to determine the change in mass over time of the pot without the plant. By comparing these results to those of the experimental run, you can determine the mass changes associated with a growing plant.

The hypothesis would be that mass increases in the plant would be predominantly due to the combination of CO_2 from the air and water drawn in from the roots, and that mass decreases from the soil would be minimal and tiny in comparison with the mass increases for the plant.

20

Activity	Classification	Justification
Use a household compost bin to fertilise a home vegie garden	Increase recycling of matter	Minerals released by compost promote the growth of vegetables, instead of being lost to landfill if placed in the rubbish
Put recyclable plastic into the recycling bin		Instead of making new plastic, old plastic can be remoulded and reused
Use a washing line to dry clothes instead of an electric clothes dryer	Minimise flow of energy	Solar energy already landing on the house can be used to generate electricity instead of sourcing electrical energy from the grid

Catch a bus to school instead of being driven in a car by a parent		Less petrol is used per person in public transport because many people are transported at once

Resources

Teacher obook

Checkpoint 3.1 Worksheet A

Students who score less than 20 in the Student Book Checkpoint should be directed to complete Worksheet A, which is designed for extra support.

Checkpoint 3.1 Worksheet Answers

Answers for Checkpoint Worksheet A

Checkpoint 3.1 Worksheet B

Students who score between 20 and 40 in the Student Book Checkpoint should be directed to complete Worksheet B, which is designed for consolidation.

Checkpoint 3.1 Worksheet Answers

Answers for Checkpoint Worksheet B

Checkpoint 3.1 Worksheet C

Students who score more than 40 in the Student Book Checkpoint should be directed to complete Worksheet C, which is designed for extension.

Checkpoint 3.1 Worksheet Answers

Answers for Checkpoint Worksheet C

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Population dynamics

Teaching support for pages 106–109

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

d analyse how changes in some biotic and abiotic components of an ecosystem affect populations and/or communities

- debate why any investigation relating to biological research and involving or affecting animals must be humane, justified and ethical (additional content)

Working scientifically

Activity 3.2.1

SC4-4WS Questioning and predicting

SC4-9WS Communicating

Numeracy builder

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Activity 3.2.1

Sustainability

Critical and creative thinking

Ethical understanding

Personal and social capability

Civics and citizenship

Numeracy builder

Critical and creative thinking

Numeracy

Teaching strategies

Introducing Section 3.2

Section 3.2 looks at the work of ecologists in terms of investigating the changes in ecosystems and populations. Sampling techniques are examined and there is plenty of scope for students to try out these techniques at school or in local parks and gardens. Students also investigate a number of different natural and human factors that cause changes in ecosystems and to populations.

Teaching tips

A key concept for this section is that population sizes are constantly changing as conditions within their ecosystem change. Many students tend to focus on the ‘here and now’ and struggle to consider the bigger picture of ecological change and population dynamics. Encourage students to think about the sensitivity of ecosystems and that population estimates can indicate ecological changes outside those within the research population.

Extra activities

Starter activity: Brainstorm

Ask students to brainstorm populations of organisms in their locality that have surges and declines in population size over the year. List these and note the time of the year when the changes happen. Ask the students to explain these annual surges and declines in population sizes.

For example:

- cockroaches appear in late spring and disappear in winter
- blowflies appear in summer

- moss in the schoolyard grows during cool, wet periods.

Activity: Estimating stationary populations

During a cool, wet period, find a population of moss in the playground. Peg a string around it to form a rectangle or a square, so that the moss population is fully within the area. A regular shape enables a quick area calculation. There are inevitably some moss-free areas inside the rectangular stringed-off area. This is a necessary part of the procedure.

Students photograph the stringed-off area, measure its outer dimensions and calculate its area. Students should then measure the diameter of a cross-section of a large test tube, and work out its area. Both of these areas should be expressed in the same units.

Divide students into groups. Each group of students should throw a 20-cent piece into the quadrat to randomly select a quadrat in the area, and then use the large test tube to cut a circular sample of moss from that site. This is a circular quadrat. If the 20-cent piece lands on an area free of moss, no sample need be taken, and a reading of zero moss plants for that quadrat is assumed.

Back in the laboratory, students tease out the sample into individual moss plants using tweezers, under a stereomicroscope. Moss plants are counted, and entered into a spreadsheet of class results, enabling an average number of moss per circular quadrat to be calculated.

To calculate an estimate of the total population of moss plants, use the following equation:

$$\frac{\text{Average no. of plants per quadrat} \times \text{Total area of sample zone}}{\text{Area of quadrat}}$$

Students should wear gloves when collecting and handling the moss, and wash their hands at the end of the activity.

Extension activity: Rabbit populations

Students can research the introduction of rabbits into Australia, specifically the reasons for their introduction, an explanation for their population growth, the extent of their spread across Australia (distribution) and the ecological problems they caused. Ask students to find out the estimated size of the population at its maximum. How would this estimate have been calculated? Ask students to investigate methods of controlling population size.

Answers

Activity 3.2.1 answers

1 Birth rate, death rate, immigration and emigration contribute to changes in population size. Students may come up with more specific examples.

2 New births or new people entering the population will increase population size, whereas deaths and people leaving will reduce population size. The population in Australia (and the world) is increasing; so, the number of deaths is outweighed by the number of births. Migration into and out of Australia is fairly minor in comparison. Almost all changes to human populations are a result of human activities; however, some deaths may be attributed to illness or old age.

3 Student responses will vary, but encourage the students to back up their opinions with evidence and logical reasoning.

Numeracy builder answers

$$\frac{N_1 \times N_2}{M_2} = \frac{48 \times 42}{8}$$
$$= \frac{2016}{8}$$
$$= 252$$

The population of ring-tailed possums is estimated to be 252 individuals.

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Student design task

Teaching support for pages 109–110

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

d analyse how changes in some biotic and abiotic components of an ecosystem affect populations and/or communities

- debate why any investigation relating to biological research and involving or affecting animals must be humane, justified and ethical (additional content)

Working scientifically

Student design task

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Questions 3.2.1

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Student Design Task

Sustainability

Critical and creative thinking

Literacy

Numeracy

Personal and social capability

Work and enterprise

Questions 3.2.1

Critical and creative thinking

Literacy

Numeracy

Practical support

Student design task

Students may require significant planning time for this activity. It may be best to break the task into smaller components with quick teacher checks at each stage to ensure students are on task.

Students may need to be guided in a design of the population estimation exercise. A discussion about animal ethics should be had before students design their experiment. Each small group should get teacher clearance for their experiment before beginning.

Safety

A risk assessment should be completed before undertaking this Student Design Task. A suggested risk assessment template is provided in the teacher obook resources.

Answers

Questions 3.2.1 answers

1 A census records information about every individual in a population.

2

a quadrat sampling

b quadrat sampling

c capture–recapture

3

a Plants don't move but can cover large areas, so quadrat sampling is most appropriate. The quadrats may be large (e.g. 10 m × 10 m).

b Periwinkles are animals, but they don't move very much and there may be large numbers of them, so quadrat sampling is appropriate. The quadrats are likely to be small, perhaps 50 cm × 50 cm.

c The lizards can move about over a fairly large area. Capturing and recapturing lizards in the same area will give an indication of population size.

4 Populations are usually estimated rather than having every individual counted because it is usually too difficult to locate and count every individual in the population. This may because the individuals are too small or difficult to find, or that there are simply too many and it would take too long.

5

a Estimated total population of 20 individuals: $\frac{8 \times 10}{4} = 20$

b Repeating the experiment a number of times over a period of time (a few days) and then averaging the estimated totals would increase the accuracy of the estimation.

6 Population growth is not always desirable. Populations can outgrow the resources available to them, which increases competition both within and between species. When this happens the population, or even the ecosystem, can collapse.

7 Student responses will vary, but may include: size of the predator population, the abundance of food sources, availability of shelter during the day and water availability.

8

Advantages: very effective for plants or animals that don't move very much; relatively quick, easy and cheap to undertake; can be very accurate if the area of the habitat in known

Disadvantages: not appropriate for very large organisms or animals that move quickly or cover large distances; can be difficult to carry out on uneven surfaces

Resources

Student obook

Weblink: Loss of biodiversity

This website contains information about biodiversity and the threats it faces.

http://www.globalchange.umich.edu/globalchange2/current/lectures/biodiversity/biodiversity.html

Workbook Activity 3.5 Investigation: Biotic and abiotic features

A PDF of Workbook Activity 3.5

Teacher obook

Student Design Task – Estimating populations RA

A risk assessment template for students and teachers for the Student Design Task.

Workbook answers

Answers to all activities in the student workbook.

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Natural factors affecting populations

Teaching support for pages 111–112

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

d analyse how changes in some biotic and abiotic components of an ecosystem affect populations and/or communities

Working scientifically

Questions 3.2.2

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Questions 3.2.2

Sustainability

Critical and creative thinking

Literacy

Teaching strategies

Teaching tips

Relating natural factors that affect populations to a species that students are familiar with will help with the understanding of general concepts. Koala populations are under threat for a number of different

reasons that can be investigated and used as examples for both natural and human factors affecting population change. These changes can also be linked to extinction.

Extra activities

Starter activity: Brainstorm

For each of the following extreme natural events, ask students to brainstorm populations that may be affected:

- a tropical cyclone in Cairns
- an intense bushfire in the Royal National Park
- an Antarctic storm that lashes the NSW coast
- drought in the Murray–Darling Basin
- no snow falls in the NSW alpine region
- an increased ocean temperature at the Great Barrier Reef

Activity: Koala case study

Each student uses the koala as a case study and presents information on factors affecting the size of koala populations in NSW under the headings Limiting resources, Seasonal change, Introduced species, Disease and Extreme natural changes.

Students could be grouped to investigate one of the key areas listed above.

Students may find the following key words helpful as a starting and focal point for research: diet, flood, road kill, hunting, predators, chlamydia, urban sprawl, endangered, reproductive cycle, climate change, coal mine expansion, drought, forestry, land clearance (farms), eucalyptus evolution.

Students could find maps showing the distribution of the koala and estimates of the total population. Students could include in their report an assessment of the effect of a possible extinction of the koala in Australia.

Sample response

Koalas live almost entirely on the leaves of four species of gum trees. They spend most of their time in the trees, grazing at night and sleeping during the day. Land clearing for farms or urban sprawl has removed habitat for the koala, as has clear fell forestry. Expansion of coal mining has led to removal of eucalypt forests that are home to the koala. Hunting koala for fur early last century wiped koalas out of

South Australia, and they had to be imported from other states to replace populations. Climate change is causing changes to eucalypt leaves, making them less digestible for the koalas, as well as causing the animals heat stress. Recent mega fires are changing forests and kill many koalas in the fast-moving firestorms. Koalas are susceptible to the sexually transmitted disease chlamydia, which can cause female infertility and thus interrupt reproductive cycles.

Extension activity: Researching population blooms

There are some populations of organisms that are on the increase due to changes in the environment. Students can investigate the following organisms and the reasons why their populations can suddenly increase:

- blooms of jellyfish
- algal blooms

Extension activity: Extinction events

Students can research one of the main mass extinction events in the history of the Earth (e.g. Permian or Cretaceous events), and find out:

- the relationship between extinction and population size
- evidence for the mass extinction event
- evidence for a probable cause of the event
- the range of species affected
- why the extinction of one species may lead to the extinction of another in a mass extinction event
- the role of rapid extreme natural changes in the event.

Answers

Questions 3.2.2 answers

1 Limiting resources prevent a population from increasing. A limited resource is one that has a finite amount that will likely run out over time if not managed sustainably.

2 Light availability is a limiting resource. There is more than enough light to go around, but plants overshadow each other if the population becomes too dense. So, the greater the population, the less

light individual plants can capture. Plants that don't get enough light die off and allow other taller individuals to survive without increased competition for space and water from other plants.

3 Student responses may vary but should include whales, fish and land mammals like the African herbivores.

4 A bushfire burns the undergrowth, which allows more sunlight to reach the ground. The ash from burned plants and animals contains nutrients, increasing the fertility of the soil. Furthermore, some plants require fire treatment for their seeds to germinate. All these factors increase the ability of seedlings to germinate and grow, increasing plant populations after a fire has passed through.

5 Populations with low genetic diversity are extremely similar in their ability to fight disease. If the disease is one that the population has immunity to, it is not a problem. However, if it is a new disease, or one that the population does not have immunity against, it can wipe out the entire population. A population with high genetic diversity is more likely to have some individuals who can fight the new disease and become immune. Many individuals may die, but some will survive to rebuild the population.

6 Seasonal changes often affect producers: for example, lots of plant growth in spring and summer, but little growth in autumn and winter. Huge increases in food draw more consumers into the area, whereas significant decreases in food availability drive populations away.

7

Factors Affecting Population Size	
Biotic	Abiotic
Disease	Rainfall
Predator population	Air temperature
Prey population	Storm severity
Human activities (e.g. logging, land clearing)	Soil minerals

Resources

Student obook

Video link: Natural impacts on populations

This video shows how a contagious disease is spreading across Tasmania and affecting many Tasmanian devils.

http://video.nationalgeographic.com/video/kids/animals-pets-kids/mammals-kids/taz-devils-kids/

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Human factors affecting populations

Teaching support for pages 113–116

Syllabus links

Outcomes

SC5-15LW A student explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

d analyse how changes in some biotic and abiotic components of an ecosystem affect populations and/or communities

Working scientifically

Questions 3.2.3

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Literacy builder

SC5-4WS Questioning and predicting

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Deeper understanding

Sustainability

Literacy

Questions 3.2.3

Sustainability

Critical and creative thinking

Information and communication technology capability

Literacy

Literacy builder

Critical and creative thinking

Literacy

Sustainability

Ethical understanding

Civics and citizenship

Teaching strategies

Teaching tips

Students could be grouped to become ‘experts’ in one of the human factors affecting population. They can research the factor and its effects on populations in their textbook and online, as well as outline some management strategies that may be covered later in the chapter. This would help compact the curriculum. Students can then report back to the class. PowerPoint presentations with a lot of graphics, together with a concise coherent speech by each group of presenters, would make this come alive.

Extra activities

Starter activity: Research

Choose one introduced species in Australia and have students find out about two native species that have been adversely affected by the introduction of this species.

Extension activity: Research

Students can choose one form of chemical pollution caused by humans. They should outline the human need(s) met by using these chemicals, the adverse effect(s) on the environment caused by the release of the chemicals and any measures used to limit or prevent their further release.

Students can go online to examine lists of endangered species and biospheres. They can then research the animal species across the biospheres that are currently endangered. Causes can be analysed in terms of limiting resources, seasonal change, introduced species, disease, extreme natural changes and human impact. Students should discuss efforts to prevent extinction in each case.

Practical support

Deeper understanding

Students can:

- analyse factors affecting the size of the population of Davies' waxflower using the headings Limiting resources, Disease and Human impact
- discuss whether this plant could be vulnerable to extreme natural changes.

Students can also write a piece similar to that presented on Davies' waxflower, but about the iconic Wollemi Pine. They can present their information on a single A4 piece of paper and include:

- a suitable title
- appropriate and engaging images of the plant
- images of the environs of the Wollemi National Park and district
- captions for the images
- a history of the discovery of the plant
- reasons for secrecy about the current distribution of the plant
- scientific explanations for the current very narrow distribution
- strategies now in place to prevent extinction of the Wollemi Pine
- a discussion about whether this plant could be vulnerable to extreme natural changes.

Answers

Literacy builder answers

1 Hundreds of migrating species rely on the Arctic regions for their food, shelter and a place to breed. If conditions change significantly, these species will become seriously threatened. Increased melting of sea and glacial ice during winter is causing a global sea level rises. It also has the

potential to change the ocean temperature and disrupt local ocean currents. Changes to oceanic currents can cause further climate change.

2 Migration to the Arctic increases populations, whereas emigration back to other parts of the world decreases populations. Global warming is contributing to a loss of sea ice and tundra habitats, causing decreases in polar bears and other species reliant on these habitats for food. Contaminants and habitat fragmentation also reduce population size and biodiversity.

3 Melting of ice caps due to global warming has the capacity to radically change environmental conditions across the globe. Sea level rise is a global phenomenon and will likely inundate Pacific islands and low-level coastal land on continents, causing displacement of people and native organisms, as well as lowering global food production. The disturbance of ocean currents by a fast injection of glacial ice into the oceans and its subsequent melt could radically change ocean circulation patterns and hence weather across the world.

4 The global warming causing the melting of the ice caps is caused by carbon emissions released as a result of human activities across the world. Control of this phenomenon will require global cooperation to reduce these emissions, change those human activities responsible and slow the warming of the planet.

Questions 3.2.3 answers

1 Biological control is the careful introduction of a natural predator to control the populations of a pest (often introduced) species.

2 Student responses will vary, but may include: competition for water in the Murray–Darling Basin; over-fishing the oceans; competing for space for farmland with native producers; and the use of wood for building and fuel over native hollow nesters.

3 The enhanced greenhouse effect is the increased amount of thermal energy that is trapped in the atmosphere due to increased concentrations of carbon dioxide and other greenhouse gases.

4 Student responses will vary, but encourage them to use evidence and logical reasoning to justify their opinion.

5

Davies' waxflower: to uncover all the environmental influences on the survival of this species a number of different scientists would have had to collaborate, including soil scientists, microbiologists, river flood plain ecologists and botanists.

Arctic: to unpack all the changes to Arctic sea ice and the impact of these changes on oceans and climate, a number of scientists would have had to collaborate, including glaciologists, marine scientists, oceanographers and meteorologists.

6 The fox is a competitor species for native carnivores, and is a voracious hunter of many animals. It has few natural predators in Australia, the Wedge-tailed Eagle being the most common. The fox has reduced the populations of native carnivores and herbivores. It has had a direct impact on potoroo and bilby populations.

Resources

Student obook

Weblink: Changes in ecosystems

This website has a video about toxic runoff damaging the Great Barrier Reef.

http://www.reuters.com/video/2011/05/22/great-barrier-reef-threatened-by-toxic-f?videoChannel=2602&videoId=200443653

Weblink: Bushfires in Australian ecosystems

This website has information on the role of bushfires in the Australian landscape.

http://www.csiro.au/resources/BushfireInAustralia

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3.2 Checkpoint

Teaching support for page 117

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

SC5-15LW A student explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

d analyse how changes in some biotic and abiotic components of an ecosystem affect populations and/or communities

Working scientifically

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Sustainability

Critical and creative thinking

Ethical understanding

Literacy

Civics and citizenship

Work and enterprise

Answers

Checkpoint 3.2 answers

1 Student responses will vary, but may include the following: rabbits cause soil erosion and displace native herbivores; cane toads, with no natural predators and the potential to eat most small animals, have made many native species endangered; and lantana has invaded bushland, displacing endemic shrubs.

2 Student responses will vary, but may include the following: releasing carbon dioxide into the air by combusting fossil fuels continues to warm the planet, resulting in reductions in biodiversity; overuse of river water for irrigation in farmlands has damaged river ecosystems like the River Red gums; and land clearing removes native ecosystems and contributes to reductions in biodiversity.

3 Student responses will vary, but should make clear links between increased food and other resources due to seasonal changes, which will attract more individuals, resulting in an increase in populations. A lack of food and other resources will cause individuals to move out of the ecosystem and decrease populations.

4 Quadrat sampling is only appropriate for small, sessile or sedentary organisms. Organisms that are large or move around significantly are not appropriate to sample with quadrats.

5 Eutrophication is the excessive nutrient availability that leads to algal bloom and oxygen depletion in aquatic ecosystems.

6 When climate changes, many species must leave their native habitat and move to cooler regions to which they are more suited. If species are mobile, and if wildlife corridors allow for safe migration, organisms may be able to successfully relocate to a new place with the climate regimen of their former location. This could happen for mobile animals, and even for plants with effective seed or spore dispersal mechanisms.

7 Food production has to increase to feed the growing human population. If farms cannot be made more productive per hectare, then more land clearing to create more farmland will be required. This removes native ecosystems and causes reductions in biodiversity. All the problems with agriculture for neighbouring native ecosystems are multiplied: pesticide drift, fertiliser in runoff, soil erosion.

8 Humans may need to weigh up the competing drives for population increase and the maintenance of a diversity of ecosystems on the planet. A sustainable planet will likely require a slower growth of human populations.

Methods of food production for humans could be changed so no more land clearing is required; examples include culturing algae in vats, hanging gardens or roof-top gardens in cities and home vegie gardens with chickens or other small livestock. Agriculture may continue to increase yields per hectare, but this is unlikely.

9 Student responses will vary, but encourage them to use logical reasoning to explain and justify their opinion.

10 Student responses will vary.

Resources

Teacher obook

Checkpoint 3.2 Worksheet A

Students who score less than 10 in the Student Book Checkpoint should be directed to complete Worksheet A, which is designed for extra support.

Checkpoint 3.2 Worksheet Answers

Answers for Checkpoint Worksheet A

Checkpoint 3.2 Worksheet B

Students who score between 10 and 20 in the Student Book Checkpoint should be directed to complete Worksheet B, which is designed for consolidation.

Checkpoint 3.2 Worksheet Answers

Answers for Checkpoint Worksheet B

Checkpoint 3.2 Worksheet C

Students who score more than 20 in the Student Book Checkpoint should be directed to complete Worksheet C, which is designed for extension.

Checkpoint 3.2 Worksheet Answers

Answers for Checkpoint Worksheet C

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Indigenous land management

Teaching support for pages 118–123

Syllabus links

Outcomes

SC5-15LW A student explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

e assess ways that Aboriginal and Torres Strait Islander peoples' cultural practices and knowledge of the environment contribute to the conservation and management of sustainable ecosystems

Working scientifically

Activity 3.3.1

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Science Skills

SC5-5WS Planning investigations

SC5-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Literacy builder

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Questions 3.3.1

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Activity 3.3.1

Sustainability

Critical and creative thinking

Literacy

Science skills

Aboriginal and Torres Strait Islander histories and cultures

Critical and creative thinking

Information and communication technology capability

Literacy

Literacy builder

Sustainability

Critical and creative thinking

Aboriginal and Torres Strait Islander histories and cultures

Literacy

Civics and citizenship

Questions 3.3.1

Aboriginal and Torres Strait Islander histories and cultures

Sustainability

Critical and creative thinking

Information and communication technology capability

Literacy

Civics and citizenship

Teaching strategies

Introducing Section 3.3

In this section, students investigate some modern and traditional sustainable management strategies through specific case studies. Students also explore the basic concepts behind the development of management strategies and how the integration of traditional Indigenous practices with modern ecological evidence, as well as international cooperative conservation efforts, are becoming more and more common.

Teaching tip

Students could research activity in their local area to make a greater personal connection with this topic. Students can research Indigenous history and land use of their local area by:

- contacting their local Indigenous land council or local Elders
- inviting local Elders to address their class, grade or school
- visit places of Indigenous significance, such as rock carvings, middens or headlands
- visit the local library to look at local collections
- visit museums, either in person or online
- do a web search of articles on the Indigenous history of the local area or the region.

Practical support

Science skills support

Show a video clip of Aboriginal fish traps in action. Clips are fairly easily found on the Internet.

Students can:

- find some images of Aboriginal fish traps and label them to identify components of the traps and to communicate how they work using the observations of R. H. Mathews (1901).
- find three articles on Aboriginal fish traps and outline the information that is consistent in all three articles

- assess the significance of the 40 000-year history of the use of the fish traps.

Literacy builder support

Some suggested responses to the questions are given below.

1 Local Indigenous communities have traditional knowledge about their lands that has been honed by a cumulative 40 000 years of custodianship and passed down from generation to generation. This long-term occupation and work with the land has been, by definition, sustainable. This knowledge can be shared with other custodians today.

2

Collaboration: people with a diverse range of skills need to work together to solve complex problems of land management. Aboriginal people, scientists and farmers all have different perspectives. All their ideas together give a total picture of land management today.

Communication: people with different perspectives on land management need to be able to articulate their ideas to others and be receptive of the ideas of others. Then, a management plan, which is an authentic synthesis of ideas, can be drawn up.

3 Indigenous people have strong connections to the natural landscape, having been its custodians for over 40 000 years. They hold the cultural knowledge of the intrinsic value of the land, and should inform any considerations of changing, developing or restoring landscapes into the future.

Extra activities

Activity: Future eaters

Watch and discuss the documentary ‘Future Eaters’, the ABC documentary series.

Activity: Additional questions about the Kakadu ecosystem

1 Ask students to research the names and features of some of Australia’s extinct megafauna, such as giant short-faced kangaroos, marsupial ‘lions’, giant horned tortoises and rhinoceros-sized wombats called Diprotodons.

2 Ask students to explain why vegetation built up in the environment after the extinction of the herbivorous megafauna. (Answer: Without the grazing of these giant creatures, the plant populations grew relatively unchecked.)

3 Ask students to outline reasons for the traditional land management practice using fire. (Answer: Regular burning removed the vegetation and dead vegetation, and opened up the land for native species to thrive. It prevented intense bushfires fires.)

4 Ask students to research why the Asian buffalo was introduced into Kakadu. (Answer: The buffalo were originally introduced as grazing animals for meat. They soon spread into natural ecosystems, particularly northern flood plains, where they found abundant vegetation and occupied a niche once held by the mega fauna.)

5 Ask students to research the reasons for the eradication of the Asian buffalo from Kakadu. (Answer: the buffalo were destroying wetlands with their cloven hoofs and harbouring diseases that could affect native species and livestock.)

6 Ask students to assess the return of the use of fire in land management in Kakadu. (Answer: An increase in the abundance of wetland species has been observed.)

Extension activity: Critical and creative writing

The Australian continent has not always been this dry. There have been wetter periods in the history of the continent during which Lake Eyre would have looked very different.

Ask students to imagine a wetter climate for Australia and to describe how the river systems feeding the lake and Lake Eyre itself would function differently in such a climate. Students should write a couple of paragraphs to describe the differences that would be observed.

Sample response

In wetter conditions, the rivers feeding Lake Eyre would be perennial streams (i.e. running with water all the time and never dry). Lake Eyre would be wider and deeper, containing large populations of fish year round. The salinity of the lake would not reach levels that were toxic to the fish. Populations of birds could become perennial. The region around the lake would have woodland accessing a high water table.

Answers

Activity 3.3.1 answers

- rainfall at the river sources in Queensland, the salt layer in lake sediment, high exposure to sunlight, flat topography and low rainfall locally
- ‘Sustainable’ means it will be still functioning for generations to come.
- If the pattern of drought and flooding rains continues into the future, Lake Eyre will continue its cycle of dry lakebed and full lake gradually evaporating to a dry lakebed again. This cycle could be

changed if the flow of rivers feeding the lake is reduced even further. Climate change has the capacity to reduce rainfall, and farmers increasingly use the river water for irrigation. Global warming may accelerate evaporation, rendering the lake inhospitable to fish in a shorter time. Then, the ecosystem would be unsustainable.

Questions 3.3.1 answers

1 Gradual burn off of native grasses in successive small patches of land early in the dry season ensures that there is little fuel in these ecosystems for damaging hot fires later in the year and opens up the land to a variety of species. In addition, there is easier access for hunting.

2 The early European explorers lacked local knowledge about where and when the food would be available, lacked the flexibility to embrace new food sources, were ignorant about water holes and their food searches were compromised by low water availability.

3 *Mudja* in the undergrowth provides lots of fuel for bushfires. The more grass, the hotter and more intense the fires burn, which could destroy more plants and animals on the surface as well as killing seeds in the ground below. Bushfires of this intensity can devastate an ecosystem. Controlling the *mudja* with frequent small burns means that it doesn't build up to dangerous densities.

4

a Student responses should include the facts that Aboriginal people moved from place to place according to the seasons and food supply and, because they were totally dependent on their local ecosystem for all their food and shelter, they were acutely aware of the limitation of supplies. If they spent too long in one area, then the environment would suffer; the environment was not stripped of resources so it could sustain Aboriginal people in the next year when they returned.

b Student responses should include the fact that Aboriginal people use small fires to remove thick undergrowth. This allows animals and plants access to new growth for food, seeds to germinate and humans access to animals for hunting. Removal of fuel loads from forests avoids hot damaging fires in summer weather. This protects native ecosystems from super fires, which organisms are not adapted to, and hence maintains biodiversity.

5 Student responses will vary, but may include the following:

Ecosystem	Biotic	Abiotic
Puli	Euro, antechinus, wallaby	Shade, water
Puti	Many tree species, grasses, variety of mammals, honey ants	High sunlight, seasonal rain
Pila	Desert grasses (e.g.	High sunlight, low seasonal

	spinifex), insects, reptiles	rainfall
Karu	Trees, variety of mammals	High water table
Tali	Dune grasses, insects and reptiles	High sunlight, low soil water, shifting sands

6 Aboriginal people needed to see differences between ecosystems in Uluru and Kata Tjuta to understand the cycles of growth and activity in the context of the seasons. In this way they could predict food and water availability, and plan their movements to provide food for their families.

7

Plant food sources: bush onion, desert raisin, bush plum, quandong, seeds of native grasses, wattle seeds, nectar from grevillea

Animal food sources: honey ants, witchetty grubs, kangaroo, goannas and their eggs, bird eggs

8 Student responses will vary.

9

Aboriginal	European
Nomadic	Settled
Variety of species	Monoculture
No fertilisers	Require fertilisers
Fire, no tilling	Land clearing and tilling
Native species	Introduced species

Resources

Student obook

Weblink: Scientists in the field

This website contains 13 videos that introduce key scientists and their research.

http://learner.org/courses/envsci/video/index.php#

Weblink: Traditional Indigenous bush food

This website has a two-page downloadable PDF about the bush foods found in Uluru-Kata Tjuta National Park.

http://www.environment.gov.au/resource/bush-foods-uluru-kata-tjuta-national-park

Workbook Activity 3.6 Research: Managing sustainable ecosystems

A PDF of Workbook Activity 3.6

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Teacher obook

Workbook answers

Answers to all activities in the student workbook.

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Sustainability and ecosystems

Teaching support for pages 124–126

Syllabus links

Outcomes

SC5-15LW A student explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

f evaluate some examples in ecosystems, of strategies used to balance conserving, protecting and maintaining the quality and sustainability of the environment with human activities and needs

Working scientifically

Activity 3.3.2

SC5-5WS Planning investigations

SC5-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Questions 3.3.2

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Activity 3.3.2

Critical and creative thinking

Information and communication technology capability

Literacy

Work and enterprise

Ethical understanding

Civics and citizenship

Sustainability

Deeper understanding

Literacy

Work and enterprise

Ethical understanding

Civics and citizenship

Intercultural understanding

Sustainability

Questions 3.3.2

Sustainability

Critical and creative thinking

Information and communication technology capability

Intercultural understanding

Literacy

Civics and citizenship

Teaching strategies

Teaching tips

The concept of balancing sustainability with the needs of human populations can be an interesting and opinionated topic. Encourage students to discuss and debate their opinions, but to use evidence and

logical reasoning to justify their position. A number of class debates could be set up around this section of the unit. Suggested debate topics include: 'That world human population growth is not sustainable', 'That all ecosystems in Australia should be managed using sustainable management practices' and 'That management of ecosystems should be a cooperative international effort'.

Extra activities

Starter activity: Defining sustainability

Students can use the Internet to collect many definitions of the word 'sustainability'. They should then brainstorm a meaning that the class can agree on and that is applicable to human activity in ecosystems.

The definition should include: capability of being continued with minimal long-term effect on the environment; conserving an ecological balance by avoiding depletion of natural resources; using renewable resources in the interests of future generations; being mindful of the continuance of the human species in harmony with the biosphere

Activity: Local environment strategies

Students can analyse and weight up the benefits and limitations of the strategies listed in Table 3.4 on pages 124–125 of the Student Book. To further their understanding of these strategies and their place in the conservation and sustainable management of ecosystems, students can choose a rationale for each strategy as listed in the table below. A class or small group discussion around each rationale will be engaging.

	Rationale for sustainability
A	Protects biodiversity
B	Reduces adverse effects on natural ecosystems
C	Less carbon emissions, slowing global warming
D	Protects resources for coming generations
E	Less land clearing
F	Motivates community action

Extension activity: Discussion

Students can discuss how each of the following would increase the sustainability of a household, in terms of the rationales for sustainability listed in the activity above.

- passive solar architecture (C, E)
- smaller houses (C, E, D)
- home insulation (C, D)

- water recycling (A, B, D, E)
- local food not imported food (C)
- fewer consumer goods (C, D)

Answers

Questions 3.3.2 answers

1 Environmental sustainability is the balance between using components of an ecosystem for human needs and the impact taking those resources has on the ecosystem so that the resources are available for generations to come.

2 Every time paper is recycled, the quality of the product is reduced because the treatments start to break down the fibres of the paper.

3 Bush regeneration allows native plants and animals to return to a disturbed area.

4 The Rio+20 conference was a meeting between a number of different countries to discuss and plan ways to reduce poverty while increasing the sustainable use of water, energy and food.

5 Student responses will vary, but may include the following.

- When humans settle a new area they take familiar species with them; examples include rabbits and foxes (for hunting) and plants (blackberry). This provides competition for native species and disrupts the balance in ecosystems. It may cause extinctions of native species.
- Mining for minerals in rocks and soil involves removal of the overlying ecosystem and depletion of minerals from the lithosphere. After mining is over and the ecosystem is 'restored', the terrain is altered, hydrology sometimes changed and replacement plants may struggle to survive. Short-term gains may seem more important, but without sustainable use, the resources will run out and future generation will have nothing.

6 Student responses will vary, but may include recycling tins, bottles and paper at home and at school; switching off lights when not in classrooms; organising safe use of public transport at the school instead of being driven in a car; and getting involved in Clean Up Australia Day.

7 Student responses will vary, but encourage them to justify their opinion with evidence and logical reasoning. For example, modern life can be sustainable, we certainly have the knowledge and technology to make it so. In Australia most humans live in cities, and so food must be transported to these cities from surrounding regions. However, backyard vegie gardens and community gardens

are becoming more common. In cities, less energy is used for transportation as a result of mass transit in public transport. Consumer goods can be shared and recycled.

8 Student responses will vary, but may include the following.

Local: each citizen reducing his/her carbon footprint, reducing the waste he/she causes to go into landfill, reducing consumption of the Earth's resources

Global: agreements between countries to reach targets for emissions reductions or waste reduction; providing aid to developing countries to foster education could reduce global population growth

9 Permaculture involves growing a range of compatible species together to maximise recycling of nutrients and minimise energy input. Permaculture usually operates on a small scale. Modern monoculture involves the mass production of one species, with large energy and fertiliser inputs and large waste outputs.

10 Student responses will vary depending on the recommendation they choose, but may include: 'change the amount we produce and consume'. This involves using less of the world's resources, preserving them for future generations.

3.3 Checkpoint

Teaching support for page 127

Syllabus links

Outcomes

SC5-15LW A student explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

e assess ways that Aboriginal and Torres Strait Islander peoples' cultural practices and knowledge of the environment contribute to the conservation and management of sustainable ecosystems

f evaluate some examples in ecosystems, of strategies used to balance conserving, protecting and maintaining the quality and sustainability of the environment with human activities and needs

Working scientifically

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Aboriginal and Torres Strait Islander histories and cultures

Sustainability

Critical and creative thinking

Information and communication technology capability

Literacy

Ethical understanding

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Civics and citizenship

Work and enterprise

Answers

Checkpoint 3.3 answers

1 Introduced water buffalo ate the native grasses and stopped these grasses from growing to such a level that they choked lakes and streams. The water buffalo performed the same role in the ecosystem that the extinct megafauna once did.

2 Maintaining biodiversity in Kakadu for the traditional owners is important in order to restore the ecosystem to balance and ensure the ongoing health of the forests and wetlands.

3 The Anangu use food availability and food sources as a way of classifying habitats.

4 Abiotic factors could include high temperatures, low water availability, bush fires and limited shade.

5 Student responses will vary, but may include walking to school or using public transport; buying locally grown food; switching off lights when not in use; and recycling tins, bottles and paper.

6 Both places have flat terrain and hot climates. Kakadu gets a lot of rain in the wet season, whereas Uluru is arid and dry.

7

Experimental validation: you would need data on number of species and the sizes of populations of those species in different sites in the alpine herb fields before burning. You would need to collect the same data after burning. You would need to compare the before and after burning data sets to form a conclusion.

Literary validation: you could locate a number of other articles about the same topic and compare information, as well as investigate the sources of information for the article/s.

8 Student responses will vary, but encourage them to justify their opinion with evidence and logical reasoning. One response may be the clearing of land of scrub and woodland for pastures for farming. This has lowered the water table and possibly altered rainfall patterns across the continent. Cloven-hoofed sheep and cattle have caused soil erosion and soil compaction.

9 Fire is a natural part of the ecosystem that enables native species to regenerate. The heat and smoke stimulate seeds to germinate and the flames remove the undergrowth to allow for seedling growth.

The ash contains minerals, which promote the growth of many plant species. Regular and controlled burning can prevent devastating intense natural bushfires from destroying habitats. The use of fire has led to the artificial selection of fire-resistant species. Introducing water buffalo adds a large herbivore to the ecosystem to compete with native herbivores. No native predators are large enough to hunt water buffalo, so there would be little natural population control. Thus, the buffalo would out-compete native herbivores. The hard hooves of the buffalo also cut up and compact the soil and increase soil erosion compared with soft-footed native herbivores. The buffalo has a profound negative effect.

10 The cane toad was introduced to keep the population of cane beetles under control. The cane toad was able to switch its diet to many native species and has since migrated away from the cane fields of Queensland, increasing its population size without any natural predator. The cane toad is causing reductions in the populations of many native species. It has been very unsuccessful as a biological control agent.

The cactus moth was introduced to control the prickly pear cactus, which was spreading across Australia. It has been very successful in that it has not affected native species but has had a devastating effect on the introduced cactus populations.

11 If you eat corn, all the energy in the body of the corn plant is available to you. When you eat a cow that has eaten a corn plant, only 10% of the energy in the body of the corn plant is available to you. So, to feed a meat eater, a larger acreage of farmland is needed to supply the same amount of food and/or energy to the human consumer. Farms are not ecologically neutral (i.e. there are negative ecological consequences to their operation, such as soil erosion, eutrophication and carbon emissions). In addition, the transport of food products must be taken into account when calculating an ecological footprint.

12 If ecosystems are not managed sustainably there will be species losses and the ecosystems will become unstable, and potentially fail. Humans are just one species on this planet. It is unethical of us to risk the loss of other species and whole ecosystems as a consequence of our activities.

Successful human habitation on this planet requires the modulating effect of natural ecosystems on climate. To risk the success of these ecosystems into the future is to put human habitation at risk. This would also be unethical.

13 Student responses will vary. However, features common to a good poster include: being able to glean the meaning while standing at a distance; clear and large font; diagrams large and clear; broad concepts communicated rather than the minutiae; and an emphasis on visual, rather than written, communication.

14 Student responses will vary, but encourage students to be creative while being practical. Small achievable and gradual changes are more likely to be successful than huge radical changes.

15 Seed banks are places to store a variety of seeds from plants around the world. The biodiversity of the plant kingdom is at risk due to many endangered ecosystems and changed farming practices. In many countries, farmers are growing fewer varieties of higher-yielding plants to increase profits. Many varieties of plants are no longer cultivated. Land clearing puts some plants on the endangered list. To prevent the loss of these plants forever, seed banks have been set up. Seeds can be made available for bush regeneration or local food production.

Resources

Teacher obook

Checkpoint 3.3 Worksheet A

Students who score less than 12 in the Student Book Checkpoint should be directed to complete Worksheet A, which is designed for extra support.

Checkpoint 3.3 Worksheet Answers

Answers for Checkpoint Worksheet A

Checkpoint 3.3 Worksheet B

Students who score between 12 and 24 in the Student Book Checkpoint should be directed to complete Worksheet B, which is designed for consolidation.

Checkpoint 3.3 Worksheet Answers

Answers for Checkpoint Worksheet B

Checkpoint 3.3 Worksheet C

Students who score more than 24 in the Student Book Checkpoint should be directed to complete Worksheet C, which is designed for extension.

Checkpoint 3. 3 Worksheet Answers

Answers for Checkpoint Worksheet C

3 Chapter Review

Teaching support for pages 128–131

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

SC5-15LW A student explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

a recall that ecosystems consist of communities of interdependent organisms and abiotic components of the environment (ACSSU176)

b outline using examples how matter is cycled through ecosystems such as nitrogen (ACSSU176)

c describe how energy flows through ecosystems, including input and output through food webs (ACSSU176)

d analyse how changes in some biotic and abiotic components of an ecosystem affect populations and/or communities

e assess ways that Aboriginal and Torres Strait Islander peoples' cultural practices and knowledge of the environment contribute to the conservation and management of sustainable ecosystems

f evaluate some examples in ecosystems, of strategies used to balance conserving, protecting and maintaining the quality and sustainability of the environment with human activities and needs

Working scientifically

SC5-4WS Questioning and predicting

SC5-5WS Planning investigations

SC5-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Aboriginal and Torres Strait Islander histories and cultures

Sustainability

Critical and creative thinking

Information and communication technology capability

Ethical understanding

Work and enterprise

Literacy

Civics and citizenship

Answers

Chapter 3 Review answers

1 non-living; living; abiotic; organisms; community

carbon; matter; oxygen; respiration; nitrogen

energy; photosynthesis; glucose

population; management; sustainable.

2

Terrestrial: soil pH, soil moisture, wind speed, air temperature; soil composition

Aquatic: water pH, salinity, turbidity, tidal range, wave action, bank soil composition

3 Student responses will vary, but may include the following: trees can increase shade and reduce evaporation from the surface layers of soil; deep roots of trees can access water in aquifers and the

resulting transpiration causes cloud formation and rain; cattle release methane into the atmosphere and this can add to the enhanced greenhouse effect.

4

Biotic factors: food availability, intraspecific competition, mate availability

Abiotic factors: land space, rainfall, access to clean drinking water, availability of shelter, availability of soil minerals and petrochemicals

5 The school and its grounds is the habitat for the community of students, teachers, cleaners, office staff, birds, mice, insects and possums. The habitat provides energy in the form of electricity, food from the canteen and shelter. The community population increases as new Year 7 students arrive and decreases when Year 12 students graduate. However, there is no (or very little) recycling of matter within the school itself.

6 Decomposers act on organic molecules in dead remains and wastes of animals and plants, breaking them down into simple chemicals. Decomposers return carbon to the atmosphere as they respire. They release soluble forms of nitrogen into the soil (nitrates and ammonium), as well as minerals.

7 Oxygen gas and carbon dioxide both exist naturally in the atmosphere, which makes both gases available for respiration and photosynthesis. Photosynthesis binds carbon dioxide with water to form glucose and oxygen, whereas respiration breaks down glucose to carbon dioxide and water.

8 Nitrogen is found in the atmosphere as N_2, in the biosphere in protein DNA and other biological molecules, and in the soil as ammonia, nitrites and nitrates. Soil nitrates form as a consequence of lightning allowing the atmospheric nitrogen to chemically combine with water and oxygen in rainwater. Soluble nitrates are taken into plants in soil water and incorporated into biological molecules. When plants or animals (who eat the plants) die, their remains are processed by soil bacteria into soluble nitrates. Denitrifying bacteria return some bacteria to the atmosphere.

9 Matter can neither be created nor destroyed, but atoms can be infinitely recycled as they are combined into new compounds then broken down again. Producers bind matter into complex compounds that are passed along food chains until they reach decomposers. The decomposers break the complex molecules back down into simple compounds and release them back into the ecosystem. Energy can neither be created nor destroyed and can also be converted into different forms and transferred along food chains. However, once it is transformed into heat, is very difficult to capture and store. This energy is lost to the atmosphere and eventually to space. This means a continual input of energy from the Sun is required to balance the continual loss of energy in the form of heat.

10 Sunlight is incident on our planet. Some of this sunlight is used by plants to make the high-energy organic molecule glucose. In this process, called photosynthesis, carbon dioxide and water are chemically combined. This glucose is the source of raw materials to build the plant, and the ultimate source of energy for all plant processes.

Energy in glucose is released for the plant (and for the animal that eats the plant) in a process called respiration. In this process, glucose is combined with oxygen in a reaction that releases energy and generates carbon dioxide and water as by-products.

11 A food web is a diagrammatic representation of the flow of food and/or energy through an ecosystem. Arrows show the direction of the flow of food and/or energy and link a prey to its predator.

12

a With very limited amounts of grass remaining, the crickets will not have enough food to support a large population, which will decrease. With fewer crickets, the Frill-necked lizard population will also decline over time. Fewer lizards will result in a decline in kookaburra populations.

b The loss of grass will likely cause a slight decline in dingo populations. Although the termites will survive to support the echidna populations, both kangaroos and wombats, which make up a large proportion of the dingo diet, will decline due to loss of grass. This reduction in food sources will likely reduce dingo populations.

c Kangaroos, wombats and crickets all rely on grass as a food source, and so are in interspecific competition.

d Without any grass to eat, termites will need to eat more eucalyptus and wattle tree foliage. This may cause additional strain on the recovering trees, but is unlikely to kill large established individuals.

13 If a herbivore is introduced, native herbivore populations will decrease due to competition. Native predator populations may increase due to an additional food source. If a carnivore is introduced, the native carnivore populations would decrease due to competition and the herbivore prey will also be reduced.

14 Student responses will vary, but should include: a specific set of step-by-step instructions outlining a control condition, variables to be controlled and methods of qualitative and/or quantitative data collection; involvement of the Kakadu community in local surveillance and/or trapping and reporting back to determine the distribution of cane toads in the region; comparison of the number

of species and the size of the populations of native species in cane toad-affected regions versus regions where the cane toads have not reached; and comparison of these modern data with historical data on native populations, which describe a pre-cane toad era.

15 Student responses will vary, but an example answer may be the effects of ocean temperature on coral. An increase in ocean temperature of even 0.5°C can cause coral to bleach (i.e. for the symbiotic algae to leave the coral polyps). Without the algae to photosynthesise, the coral cannot gain enough energy and will die. Other examples include increased rainfall and sunlight in the summer months can promote producer growth, providing a huge food source for migratory animals, thus increasing local population sizes.

16 Student responses will vary, but should involve the knowledge of intraspecific and interspecific interactions and relationships to predict how abiotic changes will affect changes in the community.

17 Student responses will vary, but may include the use of fire, which has reduces the overgrowth of plants and allows new growth of seedlings and buds. This provides food for animals, access for humans and prevents super hot fires burning with larger fuel loads at a later date.

18 Using fire, Aboriginal people can control the growth of vegetation after the wet season. Benefits include the increased germination of seeds and the new growth of seedlings and shoots. Kangaroos and other animals enjoy this softer vegetation, and so hunting opportunities increase. With a reduction in vegetation, access for humans for hunting is increased. Fuel loads of dead vegetation are kept low so that natural bushfires are less severe. The risk is that if the fire is not properly managed, it can get out of control and spread.

19 Student responses will vary, but encourage them to use evidence and logical reasoning to justify their opinions.

20 Motivation can diminish with time, particularly if you cannot see immediate environmental benefits from your behaviour changes. Sustainable behaviour often does not benefit that individual, but rather future generations.

21 Modern technology is responsible for the plethora of consumer goods, which use a lot of the Earth's resources in their manufacture and require huge landfill sites after they are discarded. Some technologies pollute the atmosphere and waterways (e.g. coal-burning power stations or mining). However, solar panels can generate electricity for a very small ecological footprint, and domestic water tanks and pumps can help reduce the need to harvest water from streams and lakes.

22 Bike lanes encourage greater bike use by residents, reducing carbon emissions from transport.

Some councils require development applications over a certain size to have a solar hot water system included in the plans. In addition, some councils have installed solar hot water systems in the showers in public changing rooms associated with pools or sporting fields. These measures reduce the electricity use of many houses and council properties in the municipality.

Other councils have built water tanks under ovals to irrigate the oval or playing fields with rainwater rather than mains water. This reduces runoff into the oceans and allows precious mains water to be used for drinking

23 Organic agriculture would solve the problems of diminishing global resources of fertilisers (e.g. guano deposits mined on the island of Nauru) and the energy costs of artificial fertiliser production, which contribute greenhouse gases to the atmosphere. However, the mass production of food in industrial-scale agribusiness farming has required an excess of fertiliser, which may be difficult to replace with organic fertilisers. However, we dispose of huge quantities of human waste into oceans. This waste could be used as organic fertiliser.

Currently there are huge quantities of organic waste (food and garden waste) produced in the cities, which is put into landfill. These wastes could be channelled into agriculture as fertiliser if appropriate technology was developed.

Resources

Student obook

Workbook Activity 3.7 Review: Understanding and managing ecosystems

A PDF of Workbook Activity 3.7

Flashcard glossary

A review of key terms used in Chapter 3.

Teacher obook

Workbook answers

Answers to all activities in the student workbook.

3 Making Connections

Teaching support for pages 132–133

Syllabus links

Outcomes

SC5-14LW A student analyses interactions between components and processes within biological systems

Knowledge and Understanding

LW2 Conserving and maintaining the quality and sustainability of the environment requires scientific understanding of interactions within, the cycling of matter and the flow of energy through ecosystems

Students:

a recall that ecosystems consist of communities of interdependent organisms and abiotic components of the environment (ACSSU176)

d analyse how changes in some biotic and abiotic components of an ecosystem affect populations and/or communities

Working scientifically

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-9WS Communicating

Learning across the curriculum

Critical and creative thinking

Information and communication technology capability

Literacy

Numeracy

Personal and social capability

Work and enterprise

Teaching strategies

Teaching tips

This field trip investigation could be completed at any stage throughout this chapter. It could be used as an inquiry-based task or as a summative task.

To complete the task in a timely fashion, it will probably be best for students to work in small groups. The task would be best completed as an organised excursion to a particular ecosystem. Rocky foreshores, temperate forests, rainforests and arid zones are all fairly easily accessible. Local parks or gardens are also appropriate locations.

Not all schools will have all the suggested equipment, or in the required quantities for all students or groups to have access to all equipment at the same time. Simply substitute or skip the abiotic factors that are not appropriate for the chosen ecosystem or cannot be tested. However, a classroom demonstration of the correct use of each piece of equipment is vital before allowing students to attempt to use the equipment in the field.

Allow students time to plan their investigation before going into the field to collect data. It may be best for teachers to check and approve students' plans before allowing them to collect their data. Teachers will also need to be aware of any safety issues for the chosen ecosystem and to take appropriate steps to minimise any risks by briefing students and planning the excursion.

Assessment

Students could generate their own assessment criteria before they start planning and conducting the investigation so as to inform some of their decisions. Students will enjoy owning the criteria and then working towards achieving them.

An editable assessment rubric is also available through the teacher obook.

Safety

A risk assessment should be completed before undertaking this Field Trip. A suggested risk assessment template is provided in the teacher obook resources.

Resources

Student obook

OXFORD
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Video demonstration: Fieldwork

This video shows students how to use their observation skills when on a field trip.

Teacher obook

Field Trip RA

A risk assessment template for students and teachers for the Field Trip

Assessment rubric: Making connections

A suggested, fully editable assessment rubric for the Making Connections project.

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3 Chemical reactions

Teaching support for pages 104–105

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

a recall that all matter is composed of atoms and has mass

b identify a range of compounds using their common names and chemical formulae

c classify compounds into groups based on common chemical characteristics

d investigate a range of types of important chemical reactions that occur in non-living systems and involve energy transfer, including:

- combustion (ACSSU179)
- the reaction of acids including metals and carbonates (ACSSU179)
- corrosion
- precipitation
- neutralisation
- decomposition

e identify some examples of important chemical reactions that occur in living systems and involve energy transfer, including respiration and reactions involving acids such as occur during digestion (ACSSU179)

f construct word equations from observations and written descriptions of a range of chemical reactions

g deduce that new substances are formed during chemical reactions by rearranging atoms rather than creating or destroying them

Additional content

- balance a range of common chemical equations

Working scientifically

SC4-4WS Questioning and predicting

SC4-5WS Planning investigations

SC4-6WS Conducting investigations

SC4-7WS Processing and analysing data and information

SC4-8WS Problem solving

SC4-9WS Communicating

Learning across the curriculum

Literacy

Numeracy

Critical and creative thinking

Information and communication technology capability

Teaching strategies

Introducing Chapter 3

This chapter revisits the idea of chemical change that was introduced in Chapter 5 of *Oxford Insight Science 8* and examines what a new substance is and how it is created during a chemical reaction. Word equations are formally introduced, although students will have seen them throughout the series, and the basics of chemical formulae and equations are also touched upon. Students then compare and contrast common types of reactions and learn how to identify some key characteristics to classify types of reactions.

The idea of energy being 'stored' in chemical bonds is conceptually challenging; however, the use of analogies and graphics will assist understanding. This will also provide a link to the chapter on energy and its transformation, covered at this year level (Chapter 4). The concept of matter conservation is reinforced in the descriptions of reactions of acids and the importance of combustion reactions to modern life. This topic also links the combustion of glucose in respiration and the digestion of food in studied in earlier years.

This chapter continues to build on Stage 4, Outcomes SC4-16CW: A student describes the observed properties and behaviour of matter, using scientific models and theories about the motion and arrangement of particles, and SC4-17CW: A student explains how scientific understanding of, and

discoveries about, the properties of elements, compounds and mixtures relate to their uses in everyday life.

Teaching tips

This chapter provides a large number of practical experiments as well as a range of hands on activities. It is unlikely that most classes will have the time to carry out every experiment, but it is important to pick a variety of experiments that demonstrate different types of reactions where possible. Many of the reactions are fairly common and will likely have video clips available to show the class, who can perform basic Predict/Observe/Explain analysis about the experiments.

The experiments can also be used as an inquiry task before students cover the relevant theory as a way to start discussion, or as consolidation after they are comfortable with the theory. If there is time, students could be given a range of experiments to perform or observe without knowing what type of reaction was taking place, and use their knowledge and understanding of classifying types of reactions to identify each reaction.

Demonstrating the rearrangement of atoms during a chemical reaction with molecular modelling kits can really assist visual and kinaesthetic learners. It can also help students understand the law of conservation when they are balancing chemical equations.

Ask the students to keep a glossary of key words as they work through the chapter. It is a great literacy strategy to help students through the topic.

Differentiation

For those with lower abilities:

- Avoid the sections, activities and questions about chemical equations and ask students to focus on word equations.
- Students who are not confident with basic chemistry concepts may need to revise these ideas before going on. See Resources listed below for suitable website links.

For those with higher abilities:

- Present students with a ‘mystery’ reaction and ask them to classify it, stating their evidence.

Resources

Teacher obook

Science Projects for kids: Chemical reactions

http://lifestyle.howstuffworks.com/crafts/other-arts-crafts/science-projects-for-kids-chemical-reactions.htm

A page from the How Stuff Works website with numerous links to a range of basic chemical reactions that students could carry out and evaluate.

Ducksters Chemistry for Kids

http://www.ducksters.com/science/chemistry/

A website that provides information about basic chemistry that could be useful for students with lower abilities, or those who may need to revise some of the more basic concepts.

About Education: Printable Chemistry Worksheets

http://chemistry.about.com/od/testsquizzes/a/worksheets.htm

A range of chemistry-related worksheets with provided answers. Basic concepts worksheets could be used to support students with lower abilities while other topics could be used to extend students with higher abilities.

Mr Kent's Chemistry Page

http://www.kentchemistry.com/moviesfiles/movieindex.htm

A range of short video clips and animations demonstrating chemistry concepts.

Awesome Science Teacher Resources

http://www.nclark.net/ChemicalReactions

A page with numerous links to worksheets and activities based on chemical reactions.

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Chemical reactions and chemical formulas

Teaching support for pages 106–111

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

a recall that all matter is composed of atoms and has mass

b identify a range of compounds using their common names and chemical formulae

f construct word equations from observations and written descriptions of a range of chemical reactions

g deduce that new substances are formed during chemical reactions by rearranging atoms rather than creating or destroying them

Working scientifically

Activity 3.1.1

SC4-8WS – Problem solving

SC4-9WS – Communicating

Activity 3.1.2

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Activity 3.1.3

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Science skills

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

Questions 3.1.1

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Activity 3.1.1

Critical and creative thinking

Activity 3.1.2

Numeracy

Critical and creative thinking

Activity 3.1.3

Numeracy

Critical and creative thinking

Science skills

Numeracy

Critical and creative thinking

Teaching strategies

Introducing section 3.1

'Changing Matter With Chemical Reactions' explores the process of a chemical reaction and the behaviour of the atoms involved in detail. The uses of word and chemical equations are discussed, although it is important to note that all content, activities and questions about chemical equations are additional content. Students are introduced to molecular and ionic compounds, their key characteristics, naming conventions and chemical formulae. While students are not necessarily expected to be able to construct chemical formulae or write balanced chemical equations (additional content), they are expected to be able to recognise and identify common formulae.

Teaching tips

It may be beneficial to start this topic with Activities 3.1.2 and 3.1.3 as a form of revision of some basic chemistry concepts that should be prior knowledge for this chapter. Observation skills will be important

as well, so encourage the students to make numerous detailed observations about every experiment they do.

Some students may find the concept of ionic and covalent bonding difficult to visualise. There are numerous clips available online that have great animations demonstrating how these compounds are formed.

Common misconceptions

Some students find it difficult to write worded equations about the reactions they observe because they often miss a reactant or product. Encourage students to make detailed observations and to use their equation to explain the observations. For example, any gas (bubbles) produced is often ignored as a product or assumed to always be oxygen gas. A pop test can be used to determine the gas produced. Collect the gas in an inverted test tube and use a glowing ember to test the gas. A pop means hydrogen, a relight match means oxygen, and a fast snuff means carbon dioxide.

Differentiation

For those with lower abilities:

- Students who really struggle with the naming conventions and writing chemical formulae for ionic and molecular compounds could learn to recognise and identify common compounds through matching activities which focus on match the formula with the correct name.

For those with higher abilities:

- Students can hone their formula writing and compound naming skills with additional questions like those in the Science Skills activity. See the Resources tab for some worksheet weblinks.

Extra activities

Starter activity: What do you remember about chemistry so far?

This chapter relied on prior knowledge and understanding of atoms, compounds and the differences between chemical and physical reactions. Students will benefit from a revision activity that summarises these key concepts. Ask students to brainstorm what they remember about chemistry in small groups. They can write lists of facts that can then be contributed to a mind map about chemistry on the board.

Activity: Writing word equations from observations

Students can carry out basic experiments or watch recorded clips of experiments and write word equations based on their observations. Some basic experiments may include things like adding vinegar to baking soda.

Practical support

Activity 3.1.1 support

Some students may find this activity difficult to tackle constructively. Some may find it easier to complete a table with each piece of evidence in one column, one column for strengths one for weaknesses, and one column for a rating scale of effectiveness as a convincing argument.

Activity 3.1.2 support

This activity is designed to both revise the terminology used in earlier chapters and introduce the idea that chemicals exist in three-dimensional space. The revision of the terms ‘molecule’, ‘compound’ and ‘element’ is an opportunity to introduce the chemical formulas of common molecules such as oxygen (O_2), nitrogen (N_2), hydrogen (H_2), and common compounds such as carbon dioxide (CO_2), hydrochloric acid (HCl), water (H_2O) and the metal salt sodium chloride (NaCl).

The importance of an atom occupying a three-dimensional space (from the previous chapter) needs to be reinforced and extended to include molecules. Creating models, using different coloured modelling clay to represent each element, will aid this. More advanced students can relate the size of an atom to its position in the periodic table.

1

a oxygen

b methane, carbon dioxide

c argon

2 a chemical formula; a diagram may get too large or have unseen atoms at the rear

3 methane

Activity 3.1.3 support

Observation is a skill that many students need to practise constantly. Students can become complacent with their observations of experiments. This activity will hone their skills. It may be beneficial to run a competition for the most number of pertinent observations. Encourage students to think about more than just the flame – e.g. change in size of the candle over time, changes to the wick, sound, behaviour of the wax, etc.

A reliance on the visual can be avoided by encouraging students to close their eyes to observe the candle. It is important to differentiate between an observation and an inference. ‘The wick is burning’ is often an inference to seeing the light being produced. A more correct observation is that light and heat are being produced near the wick. It is the evaporated wax that burns, not the wick.

Observations of chemical reactions, identifying types of reactants and products and how they are formed help classify reactions. A burning candle is an example of a combustion reaction. Some observations may include:

- A burning candle is an exothermic reaction. Energy is released in the form of heat and light.

- Combustion reactions are examples of fast reactions.
- The reactants of a burning candle are paraffin vapour (a hydrocarbon) and oxygen from the air. Both are consumed to produce carbon dioxide and water vapour. Because it is an incomplete reaction soot (carbon) and carbon monoxide are also produced.
- Energy is needed to start this reaction. When a lit match is placed near the candlewick the wax melts, is drawn up the wick by capillary action and vapourises. When the vapour is heated to above its flash point it will ignite.

Answers

Science Skills: Naming compounds and writing chemical formulas answers

Part A: Ionic compounds

1 a Calcium bromide, $CaBr_2$

b Sodium nitride, Na_3N

Part B: Molecular compounds

1 a Disulphur decafluoride

b SF_6

Questions 3.1.1 answers

1 A reactant is an ingredient of a reaction – a starting substance. A product is a new substance that is formed during the reaction – a final substance.

2 A chemical equation tells us exactly what reactants were involved and what new substances were formed. It also tells us where the atoms were before and after they rearranged during the reaction.

3

	Elements involved	Electrons	Physical structure	Chemical formula
Ionic	Metals and non-metals	Are donated and accepted to form ions	Crystal lattice	Tells us the ratio of atoms in the lattice
Molecular	Non-metals and non-metals	Are shared between atoms	Discrete molecules	Tells us the exact number of each atom in the molecules

4 s: solid, l: liquid, g: gas, aq: aqueous solution (dissolved in water)

5 a Dinitrogen tetrehydride

b Sodium oxide

6 a Molecular because it only contains non-metals.

b Ionic because it contains a metal and non-metal

7 N_2O_4

8 Many compounds that contain more than two elements can be very awkward to write out. Chemical formulae are very succinct, and in the case of ionic compounds, also clearly identify the ratio of the elements involved.

Resources

Teacher obook

About Education Printable Chemistry Worksheet

http://chemistry.about.com/b/2013/04/15/printable-chemistry-worksheets-chemical-names-and-formulas.htm

Formula writing and compound naming worksheets with answers

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Conservation of mass

Teaching support for pages 112–116

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

a recall that all matter is composed of atoms and has mass

b identify a range of compounds using their common names and chemical formulae

f construct word equations from observations and written descriptions of a range of chemical reactions

g deduce that new substances are formed during chemical reactions by rearranging atoms rather than creating or destroying them

Additional content

- balance a range of common chemical equations

Working scientifically

Experiment 3.1.1

SC4-4WS – Questioning and predicting

SC4-5WS – Planning investigations

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Science skills

SC4-7WS – Processing and analysing data and information

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Questions 3.1.2

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Experiment 3.1.1

Literacy

Numeracy

Critical and creative thinking

Science skills

Numeracy

Critical and creative thinking

Teaching strategies

Teaching tips

Conservation of mass is a fundamental concept of science and it is vital that students can confidently apply it to explain different situations. Many students will find it easier to understand if it is demonstrated with tangible objects like molecule modelling kits.

- Start with very simple reactions, like the decomposition of hydrogen peroxide (H_2O_2) into water (H_2O) and oxygen (O_2). Students will see that there is not enough of the oxygen atoms used to make the reactants to make all of the products. $H_2O_2 \rightarrow H_2O + O_2$
- Ask students to suggest how to get more oxygen atoms in the reactants without adding a new substance (they need two molecules of peroxide). The oxygen problem has been solved, but now there are two spare hydrogen atoms and an extra oxygen atom. $2H_2O_2 \rightarrow H_2O + O_2$
- Students should quickly be able to see that that the leftover atoms in the product side of the reaction will make another water molecule and balance the equation. $2H_2O_2 \rightarrow 2H_2O + O_2$
- This kinaesthetic/visual demonstration shows the clear links between the law of conservation of mass and the process of balancing chemical equations.

Additional information: Balancing chemical equations

A systematic approach to balancing equations is useful. Spending time checking the formulas of the reactants and products will prevent equations that are impossible to balance later. Many reactions at this stage include using metals; students may need to be reminded that metals can be written as a single atom, for example magnesium can be Mg, sodium can be Na.

Common misconceptions

Following on from writing word equations from observations, differences in apparent mass of reactants and products can sometimes be accounted for by escaped gases. This can provide a good discussion point for experimental method and the need for replicating experiments to ensure the reliability of data. In a school laboratory setting it is often very difficult to capture all gases released as a product. Using the mean of results and excluding outliers can improve data.

Differentiation

For those with lower abilities:

- Focus on the concept of conservation of mass rather than balancing chemical equations. Encourage students to articulate the law in their own words verbally before getting them to write it down.
- For those who need assistance balancing chemical equations, the use of molecular modelling kits or molecule cards (see Extra Activities) can help consolidate the techniques for visual and kinaesthetic learners.

For those with higher abilities:

- See the weblinks in the Resources tab for some challenging balancing equation worksheets.

Extra activities

Starter activity: Conservation of Lego

The key concept in the section is the law of conservation of mass. While there is a lot of content, questions and activities targeted at scaffolding the techniques of balancing chemical equations, it is vital that students are comfortable with conservation of mass before attempting balancing equations.

You will need:

- instructions to build a small Lego model. There are a number of YouTube clips for mini Lego models
- enough Lego for each student or group to build the designated model(s)
- electronic balances.

What to do:

1 Provide each student or group with their Lego pieces and the instructions to build the model. Ensure that they have exactly the pieces required for the model, no more, no less.

2 Have students weigh and record the total mass of their pieces, correct to at least 1 decimal place.

3 Students can then build their models.

4 Once built, students then reweigh the model and record the mass correct to at least one decimal place.

5 Compare the two masses and discuss.

Activity: Kinaesthetic modelling of chemical reactions

Write and draw three copies of the reactant molecule (NaN_3) and product molecules (Na and N_2) on individual pieces of card. Start with one card for each molecule representing the chemical equation. Students can add the number of atoms on each side of the equation. If another atom is needed, a whole card/molecule must be added and the number of atoms tallied again.

This can be repeated with other chemical reactions:

$MoO_3 + 3\ H_2 \rightarrow Mo + 3\ H_2O$

$2\ Cu + S \rightarrow Cu_2S$

$C_3H_6O + 4\ O_2 \rightarrow 3\ CO_2 + 3\ H_2O$

$2\ C_2H_6 + 7\ O_2 \rightarrow 6\ H_2O + 4\ CO_2$

Extension activity: Evaluating models

If students have completed the starter and additional activities listed above, they can compare and evaluate the two models for their appropriateness and effectiveness of demonstrating the conservation of mass and why chemical equations need to be balanced. If there is time, encourage students to suggest improvements to one of the models, or come up with a new model. Students can then create their version of the model.

Practical support

Experiment 3.1.1 support

Safety

Do a risk assessment. Vinegar and sodium bicarbonate (acid and base) are common household chemicals but will irritate the eyes if contacted. Wear safety goggles and lab coats.

Practical hints

- Choose flasks with small necks. Pre-stretch the balloon.
- Ensure students know how to use the balances carefully and correctly.

Lab tech notes

- Use as many balances as possible, to reduce waiting times. There is a lot of weighing and the balances will be in high demand.

- 100 ml narrow neck flasks work well. The flasks need to be a suitable size to allow the thermometer to sit in enough liquid and the balloon will easily fit over the narrow neck.

Discussion

1 Part A should show a loss of mass due to the gaseous product of the reaction being allowed to escape. Most students will expect that Part B will show no difference between initial and final mass because the balloon seals the flask and it is a closed system – however, this is never the case. As well as experimental error in transferring all of the mass of sodium bicarbonate to the balloon there is the effect of buoyancy. Archimedes' principle tells us that any object submersed in fluid (in this case air) will displace the volume of fluid equal to the volume of the object. The balloon displaces its volume of air and is buoyed up. Mass is conserved but the weight decreases due to buoyancy.

2 Bubbling of the reactants and the balloon inflating are evidence that a gas was being produced.

3 The temperature should decrease a couple of degrees. The reaction of sodium bicarbonate and vinegar is endothermic; it absorbs heat energy from its surroundings.

4 The reaction of sodium bicarbonate and vinegar (acetic acid) produces sodium acetate, water and carbon dioxide. Carbon dioxide will turn limewater milky

5 The balloon was added to prevent the gas (carbon dioxide) from escaping. This allows the mass of carbon dioxide to be measured.

7 The experiment design could be improved by weighing the balloon with the sodium bicarbonate already added to it, thus eliminating the transfer error. Carrying out the experiment in a rigid container can eliminate the effect of buoyancy. Reliability is improved by repetition of the experiment showing consistent results.

Note: Many students do not realise that gas has a mass. A simple way to demonstrate this is to set up some tipping scales with an empty balloon on one side and the blown-up balloon at the other. The blown-up balloon will be heavier than the empty balloon.

Answers

Science Skills: Balancing Chemical Equations answers

1 Sodium azide → sodium + nitrogen

2 $NaN_3 \rightarrow Na + N_2$

3 Na × 1, N × 3 → Na × 1, N × 2

4 $2NaN_3 \rightarrow 2Na + 3N_2$

Questions 3.1.2 answers

1 A new substance is created in a chemical change.

2 The atoms are rearranged in a chemical reaction rather than created and/or destroyed.

3 a Subscript numbers indicate the number of atoms of a particular element in a molecule or in the ratio of a crystal lattice.

b Coefficient numbers indicate the number of molecules required for the reaction to occur.

4 The compounds formed as products are different to those in the reactants. Different compounds have different properties even though they may use the some of the same atoms because they have different bonds. The bonds between the atoms determine the properties such as solubility (how easily it dissolves), conductivity (how easily it conducts electricity), the melting point and boiling point.

5 Unbalanced chemical reactions suggest that some atoms must be created and/or destroyed during the reaction, which is not possible and therefore incorrect.

6 a $2Na + 2H_2O \rightarrow 2NaOH + H_2$

b $2H_2 + O_2 \rightarrow 2H_2O$

c $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

d $Mg + 2HCl \rightarrow H_2 + MgCl_2$

e $NaOH + HCl \rightarrow NaCl + H_2O$

7 a sodium + water (dihydrogen oxide) → sodium hydroxide + hydrogen

b hydrogen + oxygen → water

c methane + oxygen → carbon dioxide + water (dihydrogen oxide)

d magnesium + hydrochloric acid → hydrogen + magnesium chloride

e sodium hydroxide + hydrochloric acid → salt (sodium chloride) + water (dihydrogen oxide)

Resources

Teacher obook

The Chem Team

http://www.chemteam.info/Equations/WS-Balancing.html

A range of more challenging problems for balancing chemical equations. Worked solutions are provided.

Mr Kent's Chemistry Page

http://www.kentchemistry.com/Worksheets/Regents/Units/MathofChem/WSBalancing21.pdf

A printable worksheet with balancing equation problems of increasing difficulty. Answers are provided.

About Education: How to balance equations

http://chemistry.about.com/od/chemicalequations/a/How-To-Balance-Equations.htm

Links to four balancing equations worksheets with answers provided.

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Checkpoint 3.1

Teaching support for page 117

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

a recall that all matter is composed of atoms and has mass

b identify a range of compounds using their common names and chemical formulae

f construct word equations from observations and written descriptions of a range of chemical reactions

g deduce that new substances are formed during chemical reactions by rearranging atoms rather than creating or destroying them

Additional content

- balance a range of common chemical equations

Working scientifically

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Learning across the curriculum

Numeracy

Critical and creative thinking

Answers

Checkpoint 3.1 answers

1 All matter is made up of atoms.

2 The total mass of reactants must equal the total mass of products.

3 Atoms are rearranged rather than created and/or destroyed during the reaction.

4 a Carbon × 6, hydrogen × 8, oxygen × 7

b hydrogen × 12, oxygen × 6

5 Common signs of a chemical reaction include the production of a gas, a permanent colour change, precipitation and change in temperature.

6 Sodium is a highly reactive metal that can burst into flame or explode when in contact with other substances. A secondary reaction is required to lock the sodium into a stable and safe compound.

7 Advantages: balanced chemical equations show the ratio of reactant molecules required for the reaction to take place and exactly how the atoms are rearranged to form the products.
Disadvantages: It uses chemical symbols for the elements and subscript and coefficient numbers to indicate the specific numbers of atoms and molecules respectively, which requires people to be familiar with the conventions to understand them.

8 Alchemists observed that chemical reactions resulted in new substances being formed. However, they did not understand that rearranging existing atoms was forming new compounds. The atoms themselves were not changing. Gold is a pure substance where every atom is a gold atom. Trying to create gold from other substances requires the actual atoms to be changed, which is extremely difficult and requires nuclear reactors.

9 a The apparent additional mass of the products comes from the ignored reactant oxygen which is in the air around the nail.

b The hydrogen gas that is released also has mass, which is a part of the total mass of the products.

10 a The three carbon atoms in propane are separated and each combine with two oxygen atoms to form carbon dioxide.

b There are three carbon atoms in propane, each of them must be ‘used’ to form carbon dioxide, so there are three carbon dioxide molecules formed for every propane molecule that is decomposed.

c Carbon atoms cannot be created or destroyed during a chemical reaction, only rearranged and bonded to different atoms. So, the net mass of carbon in the reactants must equal the net mass of carbon in the products.

Resources

Teacher obook

Checkpoint 3.1 Worksheet A

Students who score less than 10 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet A, which is designed for extra support.

Checkpoint 3.1 Worksheet A answers

Answers for Checkpoint Worksheet A

Checkpoint 3.1 Worksheet B

Students who score between 10 and 20 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet B, which is designed for consolidation.

Checkpoint 3.1 Worksheet B answers

Answers for Checkpoint Worksheet B

Checkpoint 3.1 Worksheet C

Students who score more than 20 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet C, which is designed for extension.

Checkpoint 3.1 Worksheet C answers

Answers for Checkpoint Worksheet C

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Reactions involving acids and bases

Teaching support for pages 118–124

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

b identify a range of compounds using their common names and chemical formulae

c classify compounds into groups based on common chemical characteristics

d investigate a range of types of important chemical reactions that occur in non-living systems and involve energy transfer, including:

- combustion (ACSSU179)
- the reaction of acids including metals and carbonates (ACSSU179)
- corrosion
- precipitation
- neutralisation
- decomposition

f construct word equations from observations and written descriptions of a range of chemical reactions

Additional content

- balance a range of common chemical equations

Working scientifically

Deeper understanding

SC4-7WS – Processing and analysing data and information

Activity 3.2.1

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Experiment 3.2.1

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Experiment 3.2.2

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Experiment 3.2.3

SC4-4WS – Questioning and predicting

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Activity 3.2.2

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Activity 3.2.3

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

Questions 3.2.1

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Deeper understanding

Literacy

Critical and creative thinking

Activity 3.2.1

Numeracy

Critical and creative thinking

Experiment 3.2.1

Critical and creative thinking

Experiment 3.2.2

Numeracy

Critical and creative thinking

Experiment 3.2.3

Numeracy

Critical and creative thinking

Activity 3.2.2

Critical and creative thinking

Information and communication technology capability

Activity 3.2.3

Critical and creative thinking

Teaching strategies

Introducing section 3.2

This section promotes the scientific skill of pattern recognition and requires students to identify trends and key characteristics of reactions and use them to classify types of reactions. This ability will enable students to predict the outcomes of particular similar reactions and to write accurate word equations. From there, students will be more able to write accurate balanced chemical equations.

Teaching tip

Some rote learning is required for students to recall the chemical formula for a range of common compounds, so it will be useful to have students make sets of flashcards with the compound name on one side and the formula on the other.

Additional information: What are acids and bases?

When dissolved in water, some substances disassociate and release H+ or OH- ions. When hydrogen ions (H+) are released, the substance forms an acid. When hydroxide ions (OH-) are released a basic solution is formed. Another way of describing acids is as substances that lose or donate a hydrogen ion (proton). Bases are substances that gain or accept protons. Both explanations for acids are the same, but use different descriptions of the hydrogen ion. However, not all bases release hydroxide ions, so widening the definition to include proton acceptance covers bases like ammonia.

Additional information: pH scale

The p in pH stands for ‘potential’ and the H stands for hydrogen. This originates from the French term *pouvoir hydrogen* or ‘hydrogen power’. It is a measure of how easily a molecule gains or loses a hydrogen atom. All acid molecules have at least one hydrogen atom to lose. If that hydrogen atom is lost very easily then the acid will have a low pH. If a molecule strongly attracts a hydrogen atom from an acid, then it is said to be a strong base and has a high pH.

Common misconceptions

- Students often have the misconception that acids are more dangerous than bases. It is important to emphasise that both are equally dangerous. Many commercial oven or drain cleaners are very strong bases that can cause chemical burns on skin or in airways.
- Many of these reactions have ‘salt’ as a product. This is referring to the chemistry term ‘metal salt’, not to the common table salt (sodium chloride) that students will often assume. A metal salt is an ionic compound composed of a metal element and a non-metal element. This includes the common sodium chloride, as well as potassium dichromate, iron disulfide and copper sulfate.

Differentiation

For those with lower abilities:

- Display pH scales similar to Figure 3.16 around the room and emphasise that red usually indicates an acid, while blue indicates a base. Give students lots of practice reading the scale and opportunities to test substances to compare to the colour indicator charts.
- The Bitesize clip about acids, bases and metals (see Resources for the weblink) provides a simple and interactive overview about acids, bases and indicators.

For those with higher abilities:

- Students can compare and contrast the three types of acid reactions listed in the Student Book.

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Extra activities

Starter activity: What are acids and bases?

Activity 3.2.1 could be run as a starter activity before delving into the theoretical content. Most students will be vaguely familiar with the concept of acids and bases and so should be able to predict whether each substance they test will be an acid or a base.

Practical support

Deeper understanding: Treating ant bites

It is the large meat ants, in the family *Dolichoderinae*, that bite their victims and then spray methanoic acid (also known as formic acid). This surface acid is what causes the redness and itching.

Fire ants often bite their victims and then arch their backs to inject the toxin under the skin. They will do this several times from the one bite, causing a circular pattern of stings around the one area. This makes the stings difficult to treat. The presence of a protein other than the toxin can cause a severe allergic response: anaphylaxis. Treatment for this must be sought from medical professionals immediately – baking soda will have no effect.

Wasp and bee stings contain a base and acid respectively and are injected under the skin, rapidly spreading to surrounding tissue. It is therefore difficult to reach these areas to neutralise these reactions.

Activity 3.2.1 support

Lab tech notes

- An alternative to the white tile is spotting tiles, particularly for liquid samples.
- Making a solution of bicarbonate soda in water and soap powder in water can give great liquid examples of alkali. Dilute of half a teaspoon of powder per 500 mL of water.

Experiment 3.2.1 support

Red cabbage contains an anthocyanin called flavin, which turns red in the presence of acids.

Safety

- Wear safety goggles and lab coats; long hair should be tied back. Ensure all safety procedures for the lighting and use of the Bunsen burner are followed.
- Boiling water may cause burns and scalds. Do not remove the hot beaker and cabbage water from the tripod for at least 15 minutes to ensure the beaker is cool enough to handle. Heatproof gloves may be worn.

Practical hints

- Universal indicator can be used alongside the red cabbage indicator to give a more accurate reading of a sample's pH, and as a guide for the students to relate the colour changes with the cabbage indicator.
- One large beaker of cabbage can be boiled prior to class or at the start of class to avoid the smell, and everyone operating a Bunsen burner. It also saves time. If the whole class is doing the activity, ask the students to start boiling the cabbage at the start of class. Use boiling water from an electric jug to save time.
- Making a solution of bicarbonate soda in water and soap powder in water can give great liquid examples of alkali. Dilute half a teaspoon of powder per 500 mL of water.
- Spotting tiles can be used instead of test tubes.

Lab tech notes

The cooked cabbage can be buried in the garden or put into compost.

Clean-up

Set up a sieve in a large container and strain the cabbage water and cabbage through the sieve. Tip cabbage water down the sink, followed by water.

Expected results

- Acids will turn the cabbage water to a pink colour.
- Bases will turn the cabbage water to a green colour.
- Neutral samples will give no change.

Discussion

1 purple

2 a red

b greenish-yellow

c purple

Experiment 3.2.2 support

Safety

1 M hydrochloric acid and 1 M sodium hydroxide are corrosive chemicals. Refer to the risk assessment and material safety data sheets for each chemical used. Wear safety goggles, lab coats and ensure long hair is tied back. Gloves may be worn but if not, and spillage occurs on the skin, wash the affected area immediately with running water.

Clean-up

The neutralised chemical produced can be collected and passed to the lab technician to dispose of appropriately.

Expected results

5 mL of 1 M sodium hydroxide is needed to neutralise 5 mL of 1 M hydrochloric acid.

Discussion

1 The measuring cylinder must be rinsed to remove any hydrochloric acid so that it will not neutralise the sodium hydroxide that will be measured next.

2 The presence of the indicator would make it difficult to observe the salt remaining after the water evaporated.

3 Crystallisation with the use of a Bunsen burner could be done.

4 Tasting the salt is not wise because the equipment in the laboratory may be contaminated with hazardous chemicals.

5 The salt crystals have smooth surfaces and sharp edges, suggesting they are arranged in an organised lattice manner.

Experiment 3.2.3 support

Safety

Hydrochloric acid is corrosive to skin and eyes. Wear goggles and lab coats while conducting this experiment.

Practical hints

Thermometers can be used to measure the temperature of each test tube.

Class clean up

Return hydrochloric acid to the waste vessel provided. Hydrochloric acid should be neutralised before disposing of down the sink.

Expected results

The rate of reaction will increase with an increase in temperature.

Conclusion

This experiment successfully demonstrates the relationship between temperature and reaction rate. Temperature is a measure of kinetic energy. An increase in kinetic energy increases the rate of collision between particles resulting in an increased rate of reaction.

Students may have difficulty with consistency in determining when the reaction has reached completion adding error and affecting accuracy of the experiment.

Activity 3.2.2 support

In their dry forms, the baking soda and citric acid cannot react. Once dissolved in a liquid (saliva), a chemical reaction can occur, forming water, a metal salt (sodium citrate) and carbon dioxide. The carbon dioxide forming bubbles on the tongue is the cause of the fizzing sensation. A slight salty flavour may be noticed.

Carbonates and bicarbonates are both bases. They react with water to form hydroxide ions. Acids are neutralised by carbonates to form salt, water and carbon dioxide. Indicators can be used to show that this is a neutralisation reaction.

Activity 3.2.3 support

These metals will react to different extents. This can be predicted by observing their positions in the periodic table. From most reactive to least reactive: magnesium, aluminium, zinc, iron, tin, lead, copper, silver.

Safety

1 M hydrochloric acid is corrosive. Wear safety goggles and lab coats. Gloves may be worn but if not, and spillage occurs on the skin, wash the affected area immediately with running water.

Practical hints

Make observations for half an hour, then leave overnight before observing again.

Lab tech notes

Have prepared samples cut to 1 cm. Small iron nails are fine to use for the iron source.

Clean-up

Tip the acid solution and metal through a plastic sieve and collect the metal. Rinse the metal and reuse or discard. Suitability for reuse will depend on the time the metal is left in the acid solution.

Expected results

- Magnesium metal is the most reactive and completely dissolves in about five minutes. There is a lot of bubbling and the outside of the test tube is warm to touch. The reaction stops as soon as the metal has dissolved.
- Zinc is the next most reactive. There are slow bubbles initially and bubbling becomes more rapid with time. There is a slight temperature rise. Bubbling will still be happening after half an hour. The iron nail will show a few bubbles forming and the tin will begin to become black.
- After an hour, aluminium will start to get a coating of bubbles. This can be left overnight or for up to a week before making further observations.

Answers

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Questions 3.2.1 answers

1

	pH	Taste	Feel	Ions	Protons	Litmus
Acids	Less than 7	Sour	Prickly/burning	Produce H+	Donate	Turns red
Bases	Greater than 7	Bitter	Slippery/soapy	Produce OH-	Accept	Turns blue

2 Any substance with a pH more than 7 is a base. A strong base has pH 12–14. Any substance with a pH less than 7 is an acid. A strong acid has pH 1–3.

3 A neutral substance has pH 7 (neither an acid nor a base).

4 a Red

b blue

5 A 'salt' and water are produced in a neutralisation reaction.

6 Carbon dioxide is produced when an acid reacts with a metal carbonate.

7 Leo could add a base such as baking soda to neutralise the acid (a chemical reaction that converts the acids to water and salt). Otherwise he could simply dilute the acid with lots of water.

8 Any two of the following pairs of word and chemical equations is acceptable:

Sodium hydroxide + hydrochloric acid → sodium chloride + water: $NaOH + HCl \rightarrow NaCl + H_2O$

Magnesium + hydrochloric acid → magnesium chloride + hydrogen: $Mg + 2HCl \rightarrow MgCl_2 + H_2$

Citric acid + sodium bicarbonate → sherbet + carbon dioxide + water: $C_6H_8O_7 + 3NaHCO_3 \rightarrow C_6H_5O_7Na_3 + 3CO_2 + 3H_2O$

9 Regardless of the equation chosen by the students, the number of atoms of each element will be the same on both sides of the chemical equation. This demonstrates the law of conservation of mass where atoms can only be rearranged in a chemical reaction, not created and/or destroyed.

Resources

Student obook

Bitesize: Acids, bases and metals

http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/acids_bases_metals/activity/

An interactive overview about acids, bases and the use of indicators. It also demonstrates the different types of reactions between acids and has a six-question multiple choice quiz at the end. There are also links to a multiple-choice quiz and a more detailed text-based review of acids and bases.

Teacher obook

Fun Science Gallery

http://www.funsci.com/fun3_en/acids/acids.htm

A general overview of acids and bases including teacher suggestions, tips, hints and activities.

Chem4Kids

http://www.chem4kids.com/files/react_acidbase.html

A two page detailed explanation of acids and bases.

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Reactions involving oxygen

Teaching support for pages 125–126

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

b identify a range of compounds using their common names and chemical formulae

c classify compounds into groups based on common chemical characteristics

d investigate a range of types of important chemical reactions that occur in non-living systems and involve energy transfer, including:

- combustion (ACSSU179)
- the reaction of acids including metals and carbonates (ACSSU179)
- corrosion
- precipitation
- neutralisation
- decomposition

f construct word equations from observations and written descriptions of a range of chemical reactions

Additional content

- balance a range of common chemical equations

Working scientifically

Activity 3.2.4

SC4-4WS – Questioning and predicting

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Learning across the curriculum

Activity 3.2.4

Numeracy

Critical and creative thinking

Teaching strategies

Teaching tip

The opening image of wood burning can be used to emphasise key elements of many reactions. The speed or rate of a combustion reaction often depends on the fuel that is provided. Some fuels burn hotter than others. Small pieces of wood burn faster than large pieces of wood (because of differences in surface area). Providing more oxygen (a reactant) will increase the rate of the reaction.

Additional information: Oxidation

Oxidation is an important term in later studies of chemistry. It used in this chapter to mean the addition of oxygen to a compound. However, oxidation is more accurately the loss of electrons from the compound. Oxidation is usually one part of a two-part reaction where the second is the reduction of the reactant. These two part reactions are called redox reactions. A weblink to an introduction to redox reactions is provided in the Resources tab. In this section, oxidation is examined in the form of combustion and corrosion.

Differentiation

For those with lower abilities:

- Some students may have difficulty remembering the different types of reactions involving oxygen. Create flashcards that can be used every lesson to help consolidate these general reactions.

For those with higher abilities:

- Students can be directed to investigate redox reactions. See the Resources tab for a possible weblink.

Extra activities

Starter activity: Brainstorm reactions involving oxygen

As a class, brainstorm as many examples of reactions that involve oxygen as possible. Most students will be able to list respiration, rusting and burning as reactions involving oxygen. Try to group the examples into the types of reactions listed in the section – corrosion, combustion and non-metal oxidation.

Activity: Kinaesthetic modelling of the combustion of hydrocarbons

Write and draw copies of methane (CH_4), ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), pentane (C_5H_{12}), hexane (C_6H_{14}), heptane (C_7H_{16}) and octane (C_8H_{18}) on cardboard. Include several copies of oxygen (O_2) and the product molecules (CO_2 and H_2O). Start with methane and encourage the students to model each combustion equation in turn, adding extra oxygen, carbon dioxide and water molecules, as they are needed.

Extension activity: Hindenburg disaster

Students can research the Hindenberg disaster and create scientific commentary to accompany the newsreel footage on the Internet. This reaction can be used as an example to demonstrate what a chemical reaction is, conservation of mass and combustion reactions.

Practical support

Activity 3.2.4 support

Note: It may prove very difficult to observe an increase in mass over eight days as the mass gain will be very small and some mass will be lost in the rust that remains in the water.

Practical hint

The mass increase will be minimal and may be difficult to measure. Use balances that are very accurate. Increasing the surface area by using steel wool instead of a nail may also help.

Discussion

The change in mass of the nail will be minimal. Iron corrodes to produce iron oxide so the mass of the rusty nail will include the mass of the added oxygen and should be greater than the mass of the clean nail. Students may find, however, that the mass has decreased if large amounts of rust are left in the test tube and not weighed.

Students should recognise that rusting is a corrosion reaction between iron and oxygen. In this activity the initial mass of only one reactant (the iron) is recorded, whereas the mass of the product includes both the iron and the oxygen. Therefore the activity in this form cannot be used to test the law of conservation of mass.

Rust forming on the surface of iron or iron alloys is friable and will flake away and be lost to the surrounding environment. The iron can appear to have rusted away and disappeared.

Resources

Teacher obook

About Chemistry: Redox reactions

http://chemistry.about.com/od/chemicalreactions/a/oxidation-reduction-reactions.htm

This introduction to redox reactions may help teachers understand the processes of combustion and corrosion more clearly, and may be suitable for extending students with higher abilities.

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Student design task

Teaching support for pages 126–129

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

b identify a range of compounds using their common names and chemical formulae

c classify compounds into groups based on common chemical characteristics

d investigate a range of types of important chemical reactions that occur in non-living systems and involve energy transfer, including:

- combustion (ACSSU179)
- the reaction of acids including metals and carbonates (ACSSU179)
- corrosion
- precipitation
- neutralisation
- decomposition

f construct word equations from observations and written descriptions of a range of chemical reactions

Working scientifically

Student design task: Investigating corrosion prevention

SC4-4WS – Questioning and predicting

SC4-5WS – Planning investigations

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Deeper understanding

SC4-7WS – Processing and analysing data and information

Questions 3.2.2

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Student design task: Investigating corrosion prevention

Literacy

Numeracy

Critical and creative thinking

Information and communication technology capability

Deeper understanding

Literacy

Critical and creative thinking

Teaching strategies

Common misconceptions

Students are usually familiar with the idea of iron rusting, but have difficulty understanding that iron rusting is a specific example of the corrosion of metals. Insist that students use the term corrosion rather than rusting to apply to all metals.

Practical support

Student Design Task support

Practical hint

Iron nails are a convenient test material. Nail varnish or liquid paper can be used to coat nails.

Lab Tech notes

If students wish to coat nails with oils, wax, paints etc., cotton buds make ideal paint brushes. Oil provided in dropper bottles minimise mess and quantities used.

Expected results

Conditions with moisture, salt solutions or acidic solutions will increase the rate of rusting. Any conditions which minimise contact of iron to environmental conditions such as those listed above, will slow rusting rates.

Processing data and problem solving

Students should identify rusting as a type of corrosion requiring the presence of both oxygen and water. Rusting is an example of an oxidation/reduction reaction where electrons get transferred from one substance to another. Water is necessary for this process to facilitate the transport of electrons. Any other substance that facilitates the transport of electrons (such as acids, or salt solutions) will increase the rate or rusting.

Preventing iron coming into contact with oxygen and/or water using a protective coating will slow the rate of rusting. Rusting can also be slowed by the presence of more reactive metals such as magnesium or zinc, which will donate their electrons to the iron. This is called sacrificial protection and is used commercially for rust prevention.

Answers

Questions 3.2.2 answers

1 Oxygen is the gas reactant required for combustion.

2 Hydrogen and carbon are always present in hydrocarbons.

3 Oxygen and water are required for corrosion of a metal.

4 The ‘di’ means two; there are two atoms of the element in the molecule.

5 a carbon dioxide + water → carbonic acid

b $CO_2 + H_2O \rightarrow H_2CO_3$

c As an acid, the pH must be less than 7. As a weak acid, the pH is closer to 7 than 0, so carbonic acid is likely to be around 4–6.

d zinc carbonate

6 The presence of acid increases the rate of corrosion. Acids donate protons creating charged ions in the solution. Corrosion is an oxidation reaction, which also involves the transfer of charges particles. More charges allow the reaction to proceed faster.

7 a $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$

b $C_5H_{12} + 5O_2 \rightarrow 5CO_2 + 6H_2$

8 ethene + excess oxygen → carbon dioxide + water (word equation)

$C_2H_4 + O_2 \rightarrow CO_2 + H_2O$ (unbalanced chemical equation)

$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$ (balanced chemical equation)

9 While the mass of iron decreases as it corrodes, the atoms are not destroyed but rearranged to form the new substance – rust. The rust itself is brittle and flakes off the surface of the iron so that it appears that the iron has disappeared.

10 a All hydrocarbons burn to produce carbon dioxide, carbon monoxide and water.

b The enhanced greenhouse effect is a result of a build-up of carbon dioxide in the atmosphere surrounding the Earth. Light and UV rays from the Sun are able to penetrate the atmosphere and warm the Earth. The reflected heat is absorbed by the gases in the atmosphere (including the extra carbon dioxide), preventing it from escaping.

Resources

Teacher obook

About Chemistry: Redox reactions

http://chemistry.about.com/od/chemicalreactions/a/oxidation-reduction-reactions.htm

This introduction to redox reactions may help teachers understand the processes of combustion and corrosion more clearly, and may be suitable for extending students with higher abilities.

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Displacement and decomposition reactions

Teaching support for pages 130–132

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

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Students:

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- the reaction of acids including metals and carbonates (ACSSU179)
- corrosion
- precipitation
- neutralisation
- decomposition

f construct word equations from observations and written descriptions of a range of chemical reactions

Working scientifically

Experiment 3.2.4

SC4-4WS – Questioning and predicting

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Experiment 3.2.5

SC4-4WS – Questioning and predicting

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Questions 3.2.3

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Experiment 3.2.4

Numeracy

Critical and creative thinking

Experiment 3.2.5

Numeracy

Critical and creative thinking

Teaching strategies

Teaching tip

Both displacement and displacement reactions can be demonstrated with molecule cards that have the two components of the compounds joined together with Velcro or blue-tack that can easily be separated and recombined. If Velcro is used, ensure that all the metal ions have the same side of the tape so that students can't accidentally join two metals or two non-metals together.

Common misconceptions

Many students find it difficult to distinguish between each of the types of reaction. In small groups, or as a class, come up with identifiers for each type of reaction and mnemonics to help student remember them.

Differentiation

For those with lower abilities:

- Repetition will help students recall the differences between reaction types and help them classify. There are numerous free worksheets available online. See the Resources tab for some weblinks.

For those with higher abilities:

- Challenge students with classifying reactions as more than one type.
- There are usually six identified types of reactions. Students can investigate what these six types are and determine the general equation that represents each of them.

Extra activities

Starter activity: Catalytic decomposition of hydrogen peroxide

Find a video clip of (or demonstrate in your own laboratory) the catalytic decomposition of hydrogen peroxide. It is a very fast and dramatic reaction and produces a lot of heat. You may like to show *The Big Bang Theory* episode 'The Vengeance Formulation' where the reaction is carried out. Students can discuss what is happening during the reaction and why it is not one of the types of reaction already discussed so far.

Extension activity: Real life uses of chemical reactions

Students can investigate industrial or other real life uses of decomposition, displacement and precipitation reactions. Encourage them to find the chemical equations for the reactions.

Practical support

Experiment 3.2.4 support

Safety

Lead salts are toxic, a cumulative poison and can be absorbed through the skin, therefore should be handled with great care. Wear gloves, eye protection and lab coats.

Practical hints

Students should perform this experiment in groups to reduce the use heavy metal salts.

Use the same balance for each measurement to reduce inaccuracy due to differences in balance calibrations.

Lab tech notes

Provide dropper bottles of 0.1 M solutions of lead nitrate and sodium iodide.

Lead waste should be collected and solutions should be treated with sodium hydroxide or sodium carbonate to precipitate any lead salts. When settled, the clear solution can be washed down the sink and any solid should be stored in a separate lead waste bottle for collection by a licensed waste contractor.

Class clean up

All lead waste should be collected in a waste container. Benches should be washed down with a dilute detergent solution.

Discussion

1 A gas is produced (in the form of foam) and there is a significant rise in temperature.

2 The products were significantly hotter than the reactants.

Experiment 3.2.5 support

Safety

- Wear lab coat and goggles.
- Ensure correct technique when heating test tubes. Hold the mouth pointing away from you while gently moving the tube in and out of the Bunsen flame.
- Allow test tube to cool in a test tube rack before handling and reweighing.

Practical hint

Students may find it easier to weigh the test tube standing up in a small beaker. Ensure the balance is tared with the beaker.

Expected results

Although the mass should remain unchanged students may find a small decrease in mass. This will be due to the buoyancy of the balloon displacing its equal volume of air.

The copper carbonate will be in a hydrated form, heating will release this water and students may observe water forming on the neck of the test tube.

Discussion

1 Copper carbonate is the only reactant in this reaction.

2 The copper carbonate decomposes to form copper oxide and carbon dioxide. Evidence gas is evolved is seen when the balloon inflates. The evolved gas is identified as carbon dioxide using the limewater test.

3 Copper carbonate → copper oxide + carbon dioxide

4 The initial mass of the system and the final mass should be the same. This supports the theory of the conservation of mas. Any loss in mass can be explained either by gas escaping from an incomplete seal of the balloon and test tube and/or buoyancy from the inflated balloon.

Conclusion

The results of this experiment show insignificant change of mass of reactant and products and thus supports the hypothesis that the thermal decomposition of copper carbonate obeys the law of conservation of mass. Repeat experiments with consistent results and additional experimentation that allows for the calculation of buoyancy of the inflated balloon will improve the reliability and validity.

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Answers

Questions 3.2.3 answers

1 A precipitate will form if one of the products is insoluble.

2 The ions of two soluble compounds swap positions. This is most clearly observable if one of the new products is insoluble and forms a precipitate.

3 A decomposition reaction has a single reactant, but multiple products.

4 Decomposition of zinc carbonate could result in the extraction of zinc metal.

Resources

Student obook

Bitesize

http://www.bbc.co.uk/education/topics/zypsgk7

Tutorials, interactive videos and a quiz related to chemical reactions can be used as revision or support for students.

Teacher obook

Worksheets involving chemical reactions

http://misterguch.brinkster.net/equationworksheets.html

A page that has multiple links to different chemical reactions worksheets including classifying the different types of reactions. Answers are included.

Weblink

http://sciencespot.net/Media/ChemReactionsWkst.pdf

A printable worksheet that uses colours to help classify reaction types. Answers are provided.

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Checkpoint 3.2

Teaching support for page 133

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

c classify compounds into groups based on common chemical characteristics

d investigate a range of types of important chemical reactions that occur in non-living systems and involve energy transfer, including:

- combustion (ACSSU179)
- the reaction of acids including metals and carbonates (ACSSU179)
- corrosion
- precipitation
- neutralisation
- decomposition

Additional content

- balance a range of common chemical equations

Working scientifically

SC4-5WS – Planning investigations

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

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Learning across the curriculum

Literacy

Numeracy

Critical and creative thinking

Information and communication technology capability

Answers

Checkpoint 3.2 answers

1

a Products are made in chemical reactions.

b Hydrocarbons are fuels that combust in the presence of oxygen.

c Hydrocarbons require oxygen to burn.

d Sulfur dioxide will dissolve in water to form an acid.

2 Carbon dioxide and water

3

a CO_2

b CO

c SO_3

4 All three chemicals in question 3 will form acids when dissolved in water. Non-metal oxides tend to form acids in water.

5

a Reactants: potassium hydroxide and sufuric acid. Products: potassium sulphate and water.

b Neutralisation (base + acid → sat + water)

c An indicator would show if all the acid had been used. Universal indicator should show that the pH is neutral and blue litmus paper should not turn red.

6 Orange juice does contain acid, but it is very weak and is perfectly safe to drink.

7

a i The combustion reaction will likely release energy in the form of heat and light. Carbon will be released as a gas that may form smoke with other particles in the air.

ii carbon + oxygen → carbon dioxide

iii $C + O_2 \rightarrow CO_2$

b i The universal indicator should change from green to red-orange.

ii carbon dioxide + water → carbonic acid

iii $CO_2 + H_2O \rightarrow H_2CO_3$

8 Student responses will vary, however, they should consider that a treatment that has both acid and basic components to treat both types of sting would neutralise itself. They may come up with a two-part treatment that first tests the sting with an indicator.

9 Student responses will vary, but insist they provide references for all their sources of information.

10 The activity series of metals lists different metals in order of reactivity. The higher the period number of a metal, the more reactive it is. The lower the group number, the more reactive the metal is. Reactive metals include potassium, sodium and calcium; unreactive metals include lead, silver and gold. The galvanic series lists the metals in the reverse order.

Resources

Teacher obook

Checkpoint 3.2 Worksheet A

Students who score less than 15 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet A, which is designed for extra support.

Checkpoint 3.2 Worksheet A answers

Answers for Checkpoint Worksheet A

Checkpoint 3.2 Worksheet B

Students who score between 15 and 30 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet B, which is designed for consolidation.

Checkpoint 3.2 Worksheet B answers

Answers for Checkpoint Worksheet B

Checkpoint 3.2 Worksheet C

Students who score more than 30 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet C, which is designed for extension.

Checkpoint 3.2 Worksheet C answers

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Answers for Checkpoint Worksheet C

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Using acids and bases

Teaching support for pages 134–136

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

b identify a range of compounds using their common names and chemical formulae

e identify some examples of important chemical reactions that occur in living systems and involve energy transfer, including respiration and reactions involving acids such as occur during digestion (ACSSU179)

Working scientifically

Activity 3.3.1

SC4-5WS – Planning investigations

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Deeper understanding

SC4-7WS – Processing and analysing data and information

Questions 3.3.1

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Activity 3.3.1

Literacy

Numeracy

Critical and creative thinking

Information and communication technology capability

Deeper understanding

Literacy

Critical and creative thinking

Teaching strategies

Introducing section 3.3

Having examined a range of different types of reactions, students can put these concepts into a real life context. Photosynthesis, respiration and digestion are all explored as naturally occurring reactions and examines them as combustion, synthesis and decomposition reactions.

Teaching tip

The purpose of this section is to demonstrate the practical uses of chemical reactions in everyday life, so be sure to use multiple examples where possible. Encourage students to identify their own examples. A quick survey of common household chemicals will show students how many chemicals are used every day in their lives.

Additional information: pH of the digestive system

The pH varies throughout the whole digestive system depending on the purpose of that particular section. The mouth and oesophagus is around 6.8, the stomach drops to about 1.3; the duodenum rises again to roughly 6.5 and in the lower intestine the pH rises to about 7 or 8.

Common misconceptions

Most students are aware that there are acids involved in digestion in the stomach, but may be unaware that the pH varies so dramatically. Discuss with students that the acid in the stomach does not dissolve the stomach lining because of the thick layer of basic mucus that protects the surface.

Differentiation

For those with lower abilities:

- Students can add the items examined in this section to a pH poster similar to that in Figure 3.16 of the Student Book.

For those with higher abilities:

- Students can investigate and map the progressive changes of pH throughout the human digestive system. They can present their information as a poster explaining why the pH changes at the various organs within the system.

Extra activities

Starter activity: Chemical brainstorm

Students can brainstorm the chemicals they have around the house. Try to group the products into acids, bases and unknown. The list of unknowns can be investigated.

Activity: pH of common household chemicals

Students can test the pH of common household products using the predict, observe explain method.

Extension activity: Acidic oceans

After reading the Deeper Understanding box, students can investigate further.

1 Before the Industrial Revolution the amount of carbon dioxide released by the ocean was the same as the amount absorbed. During the Industrial Revolution fossil fuels were burned to provide energy for machines to produce goods. This produced large quantities of carbon dioxide.

2 In this situation, equilibrium is a balance where the amount of carbon dioxide being absorbed by the ocean is equal to the amount being released.

3 When carbon dioxide is absorbed in water it forms carbonic acid.

4 As acidity increases, pH decreases.

5 The acidity levels will only stabilise if the amount of carbon dioxide absorbed by the ocean is the same as that released. To decrease the acidity we would need to decrease the amount of carbon dioxide absorbed by the ocean.

Students can research a marine organism to determine how it might be affected by acidity. For example, the size of oyster larval shells was found to have decreased by 16% (and a 42% decrease in calcium content) when carbon dioxide levels were increased in the water.

Other organisms that can be researched include:

- *globigerina bulloides*: These creatures' shells have been shown to shrink in size with increased acidification of the oceans along the South Tasman Rise.
- *gorgonians*: Sea fans are animals that look like plants. Their skeletons are made of calcium and are therefore vulnerable to ocean acidification.
- phytoplankton: An important part of the ocean food chain, phytoplankton require iron in order to survive. Acidification of the ocean can reduce the amount of iron that is available for the

phytoplankton. This will in turn affect their survival and the survival of all the organisms further along the ocean food chain.

- pteropods: These creatures have shells made of calcium carbonate, which is vulnerable in acidic oceans.

Practical support

Activity 3.3.1 support

Strong acids include hydrochloric acid, sulfuric acid and nitric acid. Weak acids include vinegar (acetic acid), tartaric acid (in baking powder) and citric acid (in fruit). Citric acid can be used for preserving food as most bacteria cannot live in acidic conditions. All three are also used to make sour lollies. Few precautions are needed for weak acids, although they can irritate eyes or the mucosal passages of noses and airways.

This is a good opportunity for students to learn the chemical formulas of common acids, which they will use in chemical equations later.

Answers

Questions 3.3.1 answers

1 Acids and bases are both corrosive. Acids are bitter, contain at least one hydrogen atom and have a low pH. Bases taste bitter, feel slippery or soapy and have a pH higher than 7.

2

a Ammonia is commonly in cleaning products.

b Phosphoric acid may be in some drinks, and ethanol is very slightly basic.

c Most insect stings contain acids like methanoic acid.

3 Increased carbon dioxide in the atmosphere means more carbon dioxide is dissolving into the seawater, reacting with the water to form carbonic acid.

4 Acids have a pH lower than 7. So, as the acidity of the oceans increases, the pH decreases.

5 Acids are corrosive, so acids used in foods must be weak, otherwise they would cause injury to people eating them. This is why it stings to spill some foods and drinks into cuts and abrasions.

6 Acids are required to break down some nutrients but can also break down the cells of our own body. The stomach is protected from its own acid by a layer of mucus. The pH must be raised before the chyme moves further down the digestive system. Other nutrients require bases to be digested, and so each section of the digestive system has the appropriate enzymes and secretions to help produce the optimum pH to function properly.

7 Lime is calcium hydroxide, $Ca(OH)_2$. When it dissolves it is able to release a hydroxide ion (OH-) making it into a base. This will help neutralise the acid in the soil.

Resources

Teacher obook

Live Strong

http://www.livestrong.com/article/459954-the-acid-base-balance-in-the-digestive-system/

Information about the changes in pH throughout the human digestive system.

Michelle Wang

http://www.wangmichelle.com/images/experience/related_teaching_experience/science_engineering_explorations/curriculum/science_camp/digestive_system.pdf

A suggested lesson plan for integrating the function of the human digestive system with acids and bases.

Sciencenter

http://www.sciencenter.org/chemistry/d/activity_guide_acids_bases.pdf

A suggested lesson plan for testing pH of household products.

Lower Cape May Regional School District

https://www.lcmrschooldistrict.com/demers/cbphysicalscience/Chp%209-3%20Interactive%20Guide.pdf

A suggested lesson plan for examining the uses of acids, bases and salts around the home.

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Cellular reactions

Teaching support for pages 137–139

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

b identify a range of compounds using their common names and chemical formulae

e identify some examples of important chemical reactions that occur in living systems and involve energy transfer, including respiration and reactions involving acids such as occur during digestion (ACSSU179)

f construct word equations from observations and written descriptions of a range of chemical reactions

Working scientifically

Activity 3.3.2

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Experiment 3.3.1

SC4-4WS – Questioning and predicting

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Questions 3.3.2

SC4-4WS – Questioning and predicting

SC4-5WS – Planning investigations

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Learning across the curriculum

Activity 3.3.2

Critical and creative thinking

Experiment 3.3.1

Numeracy

Critical and creative thinking

Teaching strategies

Teaching tips

Students should already be fairly familiar and comfortable with the basic processes of respiration and photosynthesis. This section focuses on the chemistry of the reactions and the energy transfers involved. Some students will know the chemical equations for both respiration and photosynthesis, so encourage them to explain why the equations look the way they do, i.e. that they are balanced due to the law of conservation of mass. Discuss how the law of conservation of mass could be tested with a biological reaction.

Respiration and photosynthesis will be discussed again in Chapter 5 in terms of the energy conversion, but it may be helpful to introduce these concepts now to better prepare students for making the links between matter and energy conservation.

Common misconceptions

Many students believe that the chemical equations presented for respiration and photosynthesis are the literal processes. However, both respiration and photosynthesis are processes involving a number of separate chemical reactions. The equations are a summary of the whole process. This explains why photosynthesis is not simply a reversal of the respiration reaction. The individual steps are very different.

Differentiation

For those with lower abilities:

- Create flashcards for the compounds involved in respiration and photosynthesis, with the name of the compound on one side and the formula on the other.

Extra activities

Starter activity: Observing respiration and photosynthesis

There are a range of video clips showing experiments involving respiration and photosynthesis on YouTube. Choose appropriate clips for your class, ideally showing the production of carbon dioxide in respiration, and oxygen bubbles from a photosynthetic water plant. Potentially watch both clips with the sound off and encourage students to explain what is going on. Have the students identify the gas being produced in each case and suggest different methods of testing exactly what the gases are. Some students may already know about the limewater test for CO_2, or the pop test for oxygen and hydrogen.

Extension activity: Multiple reactions of respiration and photosynthesis

Students can investigate the specific reactions of either respiration or photosynthesis, including reactions like the Krebs cycle and the Calvin-Benson cycle. Students can either discover the different reactions involved in the overall processes, or can be assigned one of the specific reactions to investigate and present to the class.

Practical support

Activity 3.3.2 support

Safety

- Limewater is corrosive, so conduct a risk assessment. Wear safety goggles and protective clothing.
- Warn students to blow gently and not to suck the limewater.

Lab tech notes

- Limewater is made from a saturated solution of calcium hydroxide in water. To a 1 L bottle add 25 g of calcium hydroxide to 1 L of distilled water. Shake until no more calcium hydroxide dissolves. Allow to settle. There should be a clear solution on top of the undissolved calcium hydroxide powder. Decant the clear saturated calcium hydroxide solution to a new bottle. Filter if you need to. This is your working solution. Refill the bulk bottle with water and shake again to saturate – there should always be powder undissolved in the bottom. Label and put away to settle out for another time. This solution may be used many times over by adding more calcium hydroxide and water where required.
- To remove limewater scale on bottles, rinse with 2 M hydrochloric acid.

Expected results

- The limewater will become cloudy as carbon dioxide, a product of respiration, is blown into the limewater.

Discussion

- limewater (calcium hydroxide) + carbon dioxide → calcium carbonate + water

  $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

- Calcium hydroxide is slightly soluble in water (limewater) and forms a clear liquid. When carbon dioxide reacts with the calcium hydroxide, the new substance formed (calcium carbonate) is insoluble and produces very fine white particles (precipitate) suspended in the liquid giving it a milky appearance.

Experiment 3.3.1 support

Safety

Wear safety goggles and lab coats.

Practical hints

- Fresh yeast is recommended.
- Unless it is a very warm night (over 37°C), put the apparatus in an incubator. Yeast will respond poorly to cold temperatures and very hot temperatures.
- Too much yeast and sugar will cause the mix to overreact and create a mess by leaking. Make sure the students use the required amounts and no more.

Lab tech notes

Bromothymol blue for detecting CO_2 should be a blue colour. It has a tendency to fade to a green or yellow colour over time. If this has happened, pour it into a beaker on a magnetic stirrer and add 0.1M sodium hydroxide drop by drop, until the colour returns to blue.

Clean-up

Wash everything with hot soapy water, rinse with fresh water and allow to dry.

Expected results

- The test tube with the yeast in it should have frothed, which shows that the yeast is active and gas is being produced. The attached test tube with the water and bromothymol blue (base) in it should have changed from blue to either green or yellow, depending on how much carbon dioxide gas was produced. The carbon dioxide gas reacts with water to form a weak acid.
- The bromothymol blue tube that was not connected should remain unchanged.

Discussion

- The third test tube of water and bromothymol blue (unconnected to the yeast mixture) acts as a control demonstrating the bromothymol blue does not change over time. This reinforces that it is the gas produced by the yeast that causes the change in colour.

- The bromothymol blue in the tube connected to the yeast should have changed from a light blue to a yellow colour.
- Bromothymol blue is an indicator, which changes colour from blue to yellow in the presence of a weak acid. It will have a blue colour at a pH above 7.6 and yellow below pH 6. Therefore it will change colour in the presence or carbonic acid formed by the dissolution of carbon dioxide gas in water.
- Condensation can often be found in the tubing between the two test tubes. This is an indication that water was formed as part of the respiration reaction and condenses on the inside of the cooler tubing.
- Cellular respiration is a metabolic reaction that takes place within the cells of organisms. It is the process of oxidising food sources such as glucose to provide energy and form carbon dioxide and water; $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
- Students should recognise that respiration is a process shared by all living organisms. Green plants respire at all times but they can also make their own food during photosynthesis. This experiment can be modified to test for cellular respiration in a water plant. Instead of the test-tube with yeast, a water plant like *Spirogyra* and water can be added. When grown in the dark (no photosynthesis) the plant will respire, producing carbon dioxide and changing the bromothymol blue to yellow. This can be contrasted to *Spirogyra* grown in light (which will use the carbon dioxide to produce glucose). As a result the bromothymol blue will not change colour.

Answers

Questions 3.3.2 answers

1 Photosynthesis occurs in chloroplasts of plants, which are usually found in the leaves or other parts of the plant exposed to sunlight.

2 Sunlight provides the energy source to trigger the start of photosynthesis and is the energy that is converted into stored chemical energy within the bonds of glucose.

3 The energy for respiration is contained within the bonds of the glucose molecules.

4 glucose + oxygen → carbon dioxide + water + energy

5 Energy is required for every activity and function a cell performs, so respiration is constantly occurring within cells to provide that energy.

6 CO_2 enters the plant through the stomata of the leaves. H_2O enters the plant from the soil via the roots.

7 Student responses will vary, but should include inputs of O_2 from the lungs and glucose from the digestive system being carried to individual cells via the blood stream. The outputs CO_2 should

leave cells via the blood stream and lungs, while water is recycled within the body and excreted through the urinary system, exhaled through the lungs and secreted through the skin as sweat.

Resources

Student obook

Bitesize

http://www.bbc.co.uk/education/topics/zb3d7ty

Twin tutorials on photosynthesis and respiration, including multiple-choice quizzes.

Teacher obook

BioTopics

http://www.biotopics.co.uk/plants/psfac2.html

A lesson plan for an experiment testing the role of carbon dioxide and light in photosynthesis.

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Checkpoint 3.3

Teaching support for page 140

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

e identify some examples of important chemical reactions that occur in living systems and involve energy transfer, including respiration and reactions involving acids such as occur during digestion (ACSSU179)

Additional content

- balance a range of common chemical equations

Working scientifically

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Literacy

Numeracy

Critical and creative thinking

Answers

Checkpoint 3.3 answers

1 Carbon dioxide and water.

2 Any two of the following: Carbon dioxide forms carbonic acid (H_2CO_3). Sulfur dioxide forms sulphuric acid (H_2SO_4). Nitrogen dioxide forms nitric acid (HNO_3).

3 When there is enough oxygen available to cells, they respire aerobically. In oxygen-poor conditions, they respire anaerobically. But in both cases, the energy is released from the bond in the glucose molecule.

4 Carbon dioxide has two atoms of oxygen for every carbon atom. Carbon monoxide only has one oxygen atom for every carbon atom. When the amount of oxygen available is reduced, there may not be enough to form carbon dioxide, so carbon monoxide is formed instead.

5 Antacids contain basic substances that react when in contact with the acids in your stomach. A neutralisation reaction occurs with the base chemicals cancelling out the acid chemicals to produce water and a salt.

6

a $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

b Six molecules of carbon dioxide and six molecules of water are required to make one molecule of glucose.

c Photosynthesis converts sunlight energy into stored chemical energy. It is so important because most organisms cannot transform sunlight energy into other forms of energy. However, the chemical energy of glucose can be transformed into almost any other form of energy.

7 Student responses will vary but they need to include a minimum of five points within their table. Some positives may include: acids are vital for digestion, improve the flavour of food and drinks, kill harmful pathogens, etc. Some negative may include: acids are corrosive, and are harmful to many types of cells, etc.

8 If the carbon dioxide concentration levels remained constant at the current level, then the pH of the oceans would also remain constant. Carbon dioxide in the atmosphere dissolves into the water forming carbonic acid, but it also evaporates from the water. This cycle of dissolving and evaporating will reach equilibrium if the concentration in the atmosphere remains constant.

9

	Reactants	Products	Energy	Organisms	Organelle	When
Respiration	O_2 and $C_6H_{12}O_6$	CO_2 and H_2O	Releases energy	All	Mitochondria	Constantly
Photosynthesis	CO_2 and H_2O	O_2 and $C_6H_{12}O_6$	Requires energy	Plants and some bacteria	Chloroplasts	Only during daylight

10 Student responses will vary but should include reference to the following changes: Combustion of LPG to produce heat, denaturing of proteins in the bread dough and respiration of the yeast in the bread to cause it to rise.

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Resources

Teacher obook

Checkpoint 3.3 Worksheet A

Students who score less than 10 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet A, which is designed for extra support.

Checkpoint 3.3 Worksheet A answers

Answers for Checkpoint Worksheet A

Checkpoint 3.3 Worksheet B

Students who score between 10 and 25 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet B, which is designed for consolidation.

Checkpoint 3.3 Worksheet B answers

Answers for Checkpoint Worksheet B

Checkpoint 3.3 Worksheet C

Students who score more than 25 in the Student Book Checkpoint should be directed to complete Checkpoint Worksheet C, which is designed for extension.

Checkpoint 3.3 Worksheet C answers

Answers for Checkpoint Worksheet C

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3 Chapter Review

Teaching support for pages 141–143

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

a recall that all matter is composed of atoms and has mass

b identify a range of compounds using their common names and chemical formulae

c classify compounds into groups based on common chemical characteristics

d investigate a range of types of important chemical reactions that occur in non-living systems and involve energy transfer, including:

- combustion (ACSSU179)
- the reaction of acids including metals and carbonates (ACSSU179)
- corrosion
- precipitation
- neutralisation
- decomposition

e identify some examples of important chemical reactions that occur in living systems and involve energy transfer, including respiration and reactions involving acids such as occur during digestion (ACSSU179)

f construct word equations from observations and written descriptions of a range of chemical reactions

g deduce that new substances are formed during chemical reactions by rearranging atoms rather than creating or destroying them

Additional content

- balance a range of common chemical equations

Working scientifically

SC4-4WS – Questioning and predicting

SC4-7WS – Processing and analysing data and information

SC4-8WS – Problem solving

SC4-9WS – Communicating

Learning across the curriculum

Numeracy

Critical and creative thinking

Information and communication technology capability

Answers

Chapter review answers

1 reactants; products; conservation; destroyed; formulas; equations; reactions; corrosion; metal; carbonate; spontaneously; fuel

2 All matter is made up of atoms. Atoms of the same element are exactly the same, but different atoms form different elements. Atoms can be joined together to form molecules or crystal lattices. When atoms of different elements bond they form compounds.

3 The rust that is produced contains atoms from water and oxygen molecules as well as the iron. The additional atoms increase the mass of the iron.

4 a Potassium iodide – KI

b Calcium nitride – Ca_2N_3

5 a O_3

b NH_3

6 Respiration: oxygen + water → glucose + carbon dioxide

Photosynthesis: glucose + carbon dioxide → oxygen + water

7 methane + excess oxygen → carbon dioxide + water

8 The law of conservation of mass states that the total mass of reactants equals the total mass of products because no atoms can be created or destroyed in a chemical reaction. So the rubbish doesn't really disappear, it is just converted into gas and smaller solids like ash.

9 A new substance is always produced in a chemical reaction.

10 Any two of the following reasons are suitable: Ionic compounds contain a metal and a non-metal while molecular compounds only contain non-metals. Ionic compounds donate and accept electrons between elements while molecular compounds share electrons between atoms. Ionic compounds tend to form crystal lattices while molecular compounds form discrete molecules.

11

	pH	Taste	Feel	Ions	Protons	Litmus
Acids	Less than 7	Sour	Prickly/burning	Produce H+	Donate	Turns red
Bases	Greater than 7	Bitter	Slippery/soapy	Produce OH-	Accept	Turns blue

12 Concentrated bases are much stronger than weak bases, but strong bases are very corrosive. Using a strong base would neutralise the acid faster, but it would also burn the cells of the mouth, throat and stomach.

13 Neutralisation reactions produce a salt and water. The gas in the belch is most likely water vapour.

14 Molecules must be small enough to cross the cell membrane of cells. Digestion breaks larger food particles into small molecules. Molecules like glucose store energy within the chemical bonds between atoms. The cell can use this energy for other reactions.

15 If the rate of photosynthesis significantly reduced, carbon would build up in the atmosphere because less of it would be used in the reaction. Less oxygen would be produced as well, causing the percentage of carbon dioxide in the atmosphere to increase and the percentage of oxygen to decrease.

16 Most acids release a hydrogen ion (H+) when dissolved in water, while bases release a hydroxide ion (OH-). When the hydrogen and hydroxide ions bond together they form water (H_2O).

17 a Oxygen must be a reactant and carbon dioxide and water are likely to be products.

b Two soluble reactants produce at least one solid product.

c One reactant results in two or more products.

d Reactants must include a metal and an acid and produce hydrogen gas.

18 a $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

b $C_{10}H_8 + 12O_2 \rightarrow 10CO_2 + 4H_2O$

Resources

Teacher obook

The Chemical Blog

http://www.thechemicalblog.co.uk/uses-of-phosphoric-acid/

An article about some of the uses of phosphoric acid.

Altered States

http://altered-states.net/barry/update178/

Information about pH in the blood stream and affects of changes to pH levels.

How Stuff Works

http://science.howstuffworks.com/dictionary/chemistry-terms/explosive-info4.htm

A short history of the development of explosives.

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3 Making Connections

Teaching support for pages 144–145

Syllabus links

Outcomes

SC5-17CW A student discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Knowledge and Understanding

CW3 Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed. (ACSSU178)

Students:

b identify a range of compounds using their common names and chemical formulae

c classify compounds into groups based on common chemical characteristics

d investigate a range of types of important chemical reactions that occur in non-living systems and involve energy transfer, including:

- combustion (ACSSU179)
- the reaction of acids including metals and carbonates (ACSSU179)
- corrosion
- precipitation
- neutralisation
- decomposition

g deduce that new substances are formed during chemical reactions by rearranging atoms rather than creating or destroying them

Working Scientifically

SC4-6WS – Conducting investigations

SC4-7WS – Processing and analysing data and information

SC4-9WS – Communicating

Learning across the curriculum

Literacy

Numeracy

Critical and creative thinking

Information and communication technology capability

Teaching strategies

Teaching tips

This activity allows students to apply their knowledge of chemical reactions. Some students may choose to focus on just one of the chemical reactions being described. This is fine, but if so, they should include details of the reactants and products, and describe the importance of their chosen reaction. Diagrams showing the behaviour of atoms as they recombine to form new compounds should be encouraged. It is also important for students to consider how energy is involved in the reaction.

Other students may chose to look at a series of reactions, showing how they are connected to each other, with the product of one reaction being used as a reactant in another.

Another way of addressing the activity is to ask students to focus on the role of one particular element. For example, by looking at the changes to iron, oxygen or carbon through the processes, students will be able to focus on important reactions occurring.

Visual activity

Students can prepare a flow chart of the steps involved in obtaining steel from iron ore. Alternatively, students can draw a cartoon of an iron atom as it is dug up from the ground and goes through the chemical reactions to become part of a steel object.

Kinaesthetic activity

Students can build a model of the iron refinery process. Alternatively students can use playdough/plasticine to model the bonds that break apart and form as part of the process.

Auditory activity

Students can be ‘sports presenters’, calling the race of iron atoms as they chemically react and move from iron ore to being part of a steel object.

Answers

Making connections answers

Student responses will vary, but insist that they provide a full bibliography of their sources. Some potential research starting points are listed in the Resources tab.

Resources

Teacher obook

ChemGuide

http://www.chemguide.co.uk/inorganic/extraction/iron.html

Some basic information about the process of steel production including some environmental considerations.

EPA

http://www.epa.gov/ttnchie1/ap42/ch12/final/c12s05.pdf

Very detailed and technical description of steel production. Only suitable for students will very high literacy skills.

TATA

http://resources.schoolscience.co.uk/Corus/14-16/steel/msch1pg1.html

Some basic information and some explanation of the chemical reactions involved in the production of steel. Navigate with the buttons in the top right corner.

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