**Scheme of Work – Science Stage 7**

Cambridge Lower Secondary

Introduction

This document is a scheme of work created by Cambridge International as a suggested plan of delivery for Cambridge Lower Secondary Science Stage 7. Learning objectives for the stage have been grouped into topic areas or ‘units’. These have then been arranged in a recommended teaching order but you are free to teach objectives in any order within a stage as your local requirements and resources dictate.

The scheme for Science has assumed a term length of 10 weeks, with three terms per stage and three units per term. An overview of the sequence, number and title of each unit for Stage 7 can be seen in the table below. The scheme has been based on the minimum length of a school year to allow flexibility. You should be able to add in more teaching time as necessary, to suit the pace of your learners and to fit the work comfortably into your own term times.

Scientific Enquiry learning objectives are recurring, appearing in every unit. Activities and resources are suggested against the objectives to illustrate possible methods of delivery.

There is no obligation to follow the published Cambridge International scheme of work in order to deliver Cambridge Lower Secondary. It has been created solely to provide an illustration of how delivery mightbe planned over the three stages. A step-by-step guide to creating your own scheme of work and implementing Cambridge Lower Secondary in your school can be found in the Cambridge Lower Secondary Teacher Guide available on the Cambridge Lower Secondary support site. Blank templates are also available on the Cambridge Lower Secondary support site for you to use if you wish.

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| **Term 1** | **Term 2** | **Term 3** |
| Unit 7.1 Living things | Unit 7.4 Acids and bases | Unit 7.7 Putting things into groups |
| Unit 7.2 Solids, liquids and gases | Unit 7.5 The Earth and beyond | Unit 7.8 Habitats and environment |
| Unit 7.3 Energy transfers | Unit 7.6 Micro-organisms and disease  | Unit 7.9 Forces and their effects |

Unit 7.1 Living things

It is recommended that this unit takes approximately **40% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of living things and the senses to develop their knowledge of:

* the characteristics common to all living things, and their importance to survival of the organism
* all living things being made of cells, the structure of typical cells, how cells are adapted to their function
* how cells are organised into tissues, organs and organ systems to efficiently carry out the functions of life
* how to classify animals and plants into major groups, using some locally occurring examples
* what is meant by a species.

Scientific Enquiry work focuses on:

* being able to talk about the importance of questions, evidence and explanations
* choosing appropriate apparatus and using it correctly
* making careful observations including measurements
* presenting results in the form of tables, bar charts and line graphs
* using information from secondary sources
* presenting conclusions using different methods.

Recommended vocabulary for this unit:

* organism, nutrition, respiration, movement, excretion, growth, reproduction, sensitivity
* light microscope, microscope slide, coverslip, stain, magnification
* cell, nucleus, cell membrane, cell wall, cellulose, vacuole, chloroplast, chlorophyll
* sperm, ova, neurone, palisade, root hair, pollen grain
* specialised, tissue, organ, organ system, heart, circulation, brain, nervous system, stomach, intestine, digestion, kidneys, lungs, breathing, liver
* root stem, leaf/leaves, flower
* skull, vertebrae, ribs, ribcage, sternum, pelvis, clavicle, scapula, humerus, ulna, radius, femur, tibia, fibula, patella
* biceps, triceps, tendon, ligament, cartilage, synovial membrane, synovial fluid, antagonistic muscles
* taxonomy, classification, kingdom, phylum, class, order, family, genus, species
* prokaryote, eukaryote, animals, plants, fungi, bacteria, protoctista
* vertebrate, mammals, birds, amphibians, reptiles, fish
* invertebrate, annelids, arthropods, cnidarians, echinoderms, molluscs, sponges, insects, arachnids, crustaceans, myriapods
* moss, fern, flowering plant, grass, conifer.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
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| 7Bc1 | Identify the seven characteristics of living things and relate these to a wide range of organisms in the local and wider environment | Arrange a variety of living, non-living and once-living things around the classroom for learners to observe. Learners decide on an approach for classifying these samples into the three groups, recording their results in a table.Discuss findings, identifying characteristics that the learners used for their classification. Use prompt pictures to help identify as many characteristics of living things as possible (movement, reproduction, sensitivity, nutrition, respiration, excretion, growth).Clarify the meaning of the terms used for the seven characteristics. In particular, discuss the difference between: * breathing and respiration
* growth and reproduction.

Matching exercise: learners match each of the seven characteristics to the correct definitions.Learners devise a memory aid for the seven characteristics, perhaps using the first letters of each word to develop a memorable phrase (MRS GREN and MRS NERG are examples). Learners choose a vertebrate and produce illustrated notes to explain how we know that it is a living creature. The notes should contain the seven characteristics and the correct definitions. If secondary sources are available learners can research facts to make their accounts more interesting e.g. ‘Reindeer eat 4–8 kg of plants daily, they take about 5 years to grow to maturity and they can walk up to 1000 miles in search of food.’ | Living things e.g. a plant growing in a pot, a freshly picked or dug up vegetable, large seeds or fruit, lichen or moss, a raw egg, available small animals. Pictures can be used if animals are not available.Non-living things e.g. a rock, sand, a toy car, a plastic object, milk, water, a sealed jar labelled ‘Oxygen’.Once-living things e.g. dried fruit, wood, coal, paper.Pictures of animals showing characteristics of living things e.g. eating, moving, with their young.Note: explain that respiration happens in all cells. Set of match cards for characteristics of living things and the definitions. Alternatively use a worksheet with a matching exercise on it.Pictures of vertebrates to help learners think about what vertebrate they would like to write about.Reference books / internet. | Health and safety:Care should be taken when handling living things to ensure they are not harmed by the activity.Use small group discussion allowing each learner to voice their ideas on observations, followed by whole class work to encourage confidence in expressing science ideas backed by evidence. |
| 7Bh27Bc1 | Recognise the positions and know the functions of the major organ systems of the human body. Secondary sources can be usedIdentify the seven characteristics of living things and relate these to a wide range of organisms in the local and wider environment | Identify what learners already know about the names and positions of organs in the human body by asking them to annotate an outline body shape.Elicit the names and functions of organs including the heart, brain, lungs, stomach, intestines, liver, kidneys.Learners group the organs by their functions. Discuss findings and use these to identify some of the major organ systems of humans (circulatory, respiratory, digestive, excretory, nervous). Ask learners to describe how these systems relate to the seven characteristics of living things. Ask learners to identify the same organs from diagrams of other vertebrates. Elicit the idea that there are similarities in the organs, and organ systems, of all animals. | This activity can be done on large sheets of paper, if desired.Note: other organ systems will be introduced later in Stage 7.Diagrams showing the organs and organ systems in a range of vertebrates (e.g. dog, cat, cow, snake, deer, lion, bird). |  |
| 7Bp17Bc1 | Recognise the positions, and know the functions of the major organs of flowering plants, e.g. root, stem, leafIdentify the seven characteristics of living things and relate these to a wide range of organisms in the local and wider environment | Identify the root, stem and leaf of different flowering plants. Consolidate understanding of characteristics of living things by relating plant structures and their functions to the characteristics:* leaves and nutrition
* flowers and reproduction
* all parts of the plant and respiration.

Discuss what it means for plants to show movement, sensitivity and excretion. | Photos/specimens of young and mature plants. Include a wide range such as grasses and flowering trees as well as more familiar flowers. | Misconception alert:Plants ‘eat’ through their roots. Emphasise that plants make their own food in their leaves. |
| 7Bc37Bc47Ep77Eo17Eo2 | Identify the structures present in plant and animal cells as seen with a simple light microscope and/or a computer microscopeCompare the structure of plant and animal cellsChoose appropriate apparatus and use it correctlyMake careful observations including measurementsPresent results in the form of tables, bar charts and line graphs | **Scientific Enquiry activity**Show learners how to use a microscope. Initially they can practise by looking at graph paper and newsprint.Demonstrate how to prepare a microscope slide.Learners prepare and focus a good specimen of plant cells without being misled by air bubbles or dust on the cover slip.Learners observe and identify the nucleus, cytoplasm, the cell vacuole and cell wall. They record sketch diagrams of the cells.Learners prepare slides of their own cheek cells and observe them under a microscope.Discuss what learners see and name and describe the functions of the nucleus, cell membrane and cytoplasm.Learners draw a diagram of a typical animal cell and their own labelled diagram of what cheek cells look like on a slide. They should label one of the diagrams with the names of parts and their functions.Compare observed cells with labelled diagrams from secondary sources and explain why the cell membrane is not visible in the prepared slides.Learners compare the structure of typical plant and animal cells and present their results in a table. | Microscopes, graph paper, newsprint (to show inversion)Microscope slides, coverslipsLight microscope, microscope slides, coverslips, mounted needles, iodine stain, onion or other bulbs (the thin skin from between the fleshy areas of an onion is ideal). If red onions are used, then the vacuole can be seen as a purple colour.Light microscope, microscope slides, coverslips, mounted needles, clean cotton buds, methylene blue, disinfectant.Labelled diagrams of cells. | Health and safety:Iodine stain will mark clothes.Health and safety: Make sure that human tissue is safely disposed of in disinfectant and the methylene blue stain is used correctly. |
| 7Bc57Bc37Ep77Eo1 | Relate the structure of some common cells to their functions. Secondary sources can be usedIdentify the structures present in plant and animal cells as seen with a simple light microscope and/or a computer microscopeChoose appropriate apparatus and use it correctlyMake careful observations including measurements | Ask learners: *Do you think that all the cells in an animal or a plant will be the same as each other? Do you know the names of any cells?* Discuss their ideas.Learners look at pictures of a variety of unnamed animal cells, including sperm, ova and neurones that have been labelled with letters. They should first try to match each cell to a function.Discuss the names and functions of the cells. Learners should then describe how the structure of each cell is related to its function.Learners look at pictures of a variety of named plant cells including a palisade cell, a root hair cell and a pollen grain. Using match cards or an equivalent, learners match cells to their functions.**Scientific Enquiry activity**Provide groups of learners with newly germinated seedlings with root hairs. Learners examine them with a hand lens to observe the root hairs.Alternatively, learners dissect a plant and observe its specialised cells under a microscope. | Some images can be found at:[www.bbc.co.uk/bitesize/ks3/science/organisms\_behaviour\_health/cells\_systems/revision/4/](http://www.bbc.co.uk/bitesize/ks3/science/organisms_behaviour_health/cells_systems/revision/4/)Some images can be found in this presentation:[www.saps.org.uk/attachments/article/784/SAPS%20-%20African%20violets%20under%20the%20microscope%20powerpoint.ppt](http://www.saps.org.uk/attachments/article/784/SAPS%20-%20African%20violets%20under%20the%20microscope%20powerpoint.ppt)Small seedlings that have been grown on coloured blotting paper (or equivalent), hand lenses.A possible method for dissection of African Violets (*Saintpaulia*):[www.saps.org.uk/secondary/teaching-resources/784-microscopy-specialised-cells-in-african-violets](http://www.saps.org.uk/secondary/teaching-resources/784-microscopy-specialised-cells-in-african-violets) |  |
| 7Bc67Ec4 | Understand that cells can be grouped together to form tissues, organs and organismsPresent conclusions using different methods | Explain and define the organisation of:* cells (the smallest unit of life)
* tissues (a collection of similar cells that work together to perform a function)
* organs (a structure made up of several tissues that work together to perform a function).

Extend previous work on organ systems by asking learners, or groups of learners, to produce an illustration that shows the difference between a cell, a tissue and an organ.  | Assign different organ systems to different groups (both plant and animal organ systems). | Relate this work on cells to the previous work on major organ systems in animals. |
| 7Bh1 | Explore the role of the skeleton and joints and the principle of antagonistic muscles | Ask learners: *How many bones are there in a human body? Why do humans and other vertebrates need a skeleton and skeletal muscles?* Identify the three main functions of the skeleton (protection, support and movement).Show a picture or model of a human skeleton. Ask learners to name as many bones in the body as they can. Learners start this task by working on their own. They then compare their list with a partner. Then the partners compare their combined list with other learners.Learners use a worksheet to create a skeleton to go on display. They cut out and paste the skeleton in the correct arrangement and then add the labels. Learners explore an online animation of the skeleton.Ask learners: *How do you smile? How do you pick up something from the floor?*Learners investigate what happens to their muscles when they flex and extend their elbow. Elicit the idea that movement happens because muscles, attached to bones, get shorter and fatter – they contract. Explain that muscles work in pairs. As one muscle relaxes another contracts. Identify the pairs of antagonistic muscles that move hinge joints (e.g. the elbow, knee and finger joints).Learners make a model elbow joint and gain an understanding of antagonistic muscles using cardboard, scissors, paper fasteners and rubber bands.Learners use their model to answer questions such as: *Which muscle raises the arm? How does it do this? Which muscle lowers the arm? How does it do this? Can a single muscle raise and lower the arm?*Learners draw and label the muscles, tendons, ligaments, cartilage, bones, synovial membrane and fluid of the elbow joint. Show learners an animated sequence of movement at the elbow joint. Learners find out and write about how the different parts of a joint are suited to their different functions. | Picture or model of a human skeleton.Worksheet of jumbled up skeleton parts and labels, scissors, glue/paste.An interactive outline of the skeleton can be found at:[www.aboutkidshealth.ca/En/HowTheBodyWorks/IntroductiontotheSkeleton/SkeletonAnatomy/Pages/default.aspx](http://www.aboutkidshealth.ca/En/HowTheBodyWorks/IntroductiontotheSkeleton/SkeletonAnatomy/Pages/default.aspx)Stiff card is needed or the model will flex too much. Provide a diagram of a joint and the following:* cardboard
* scissors
* paper fasteners
* rubber bands.

[www.bbc.co.uk/education/guides/zpkq7ty/revision/3](http://www.bbc.co.uk/education/guides/zpkq7ty/revision/3) | Learners can create the skeleton in any pose they like. |
| 7Bv17Bv3 | Understand what is meant by a speciesClassify animals and plants into major groups, using somelocally occurring examples | Classifying speciesExplain to learners that the features they have been studying (cells, plant structures and skeletons) can be used to classify species. Show pictures of some example species from the animal and plant kingdoms. Ask learners, in groups of three or four, to write a definition for the word ‘species’.Discuss the definitions and identify prior knowledge or misconceptions. Explain the term ‘species’ as a group of living things that are able to breed and produce offspring who can also breed.Ask the question: *Why can't a cat and dog produce offspring together*?Be prepared for a range of interesting answers that will open up discussion. Elicit the idea that usually animals have a natural instinct to only breed with other animals of their species.Show learners pictures of common hybrids (e.g. mule, zedonks, ligers, and tigons). Ask learners to suggest what species their parents were. Ask learners to suggest what would happen if two mules mated. Use the definition of a species to elicit the explanation that mules are not fertile and therefore cannot produce offspring.Ask learners to discuss and then write down the answer to this question:*Why are a Sarplaninac and Chihuahua the same species, but a horse and a donkey are not?*Introduce the idea of classifying species. Question learners on types of cells and identify the differences between animal and plant cells. Show learners a bacterial cell and ask them to spot the differences between it and plant/animal cells. Introduce the grouping of cells into prokaryotes and eukaryotes.Give learners pictures of organisms that include examples from the five kingdoms. In pairs, learners sort these into the five kingdoms. Local examples of endangered animals and plants can be included as examples.Demonstrate the complete taxonomic hierarchy using one organism. Discuss the need to group organisms into smaller and smaller groups. Demonstrate the idea of the groups having similar features by asking learners to identify similarities between different birds and different mammals.Ask learners to create a mnemonic to remember the order of:Kingdom-> Phylum-> Class ->Order-> Family-> Genus->Species.Share these as a whole class and decide which ones are the best.Provide learners with information sources (printed or online material). Learners need to find the Kingdom, Phylum, Class, Order, Family, Genus and Species of a range of plants and animals.**Extension activity**At this stage, algae are placed in the plant kingdom. Learners who require more challenge could research algae and write a report to answer this question: *Are algae plants?*Note: they should be prepared to realise they may not find a definite yes or no answer. | Pictures of animal and plant species. Include examples that are likely to be familiar to learners.Pictures of common hybrids and their parents.Pictures of Saraplaninac and Chihuahua.Pictures of plant, animal and bacterial cells.Pictures of different organisms from the five kingdoms:* animals (including several birds, several mammals, other vertebrates and invertebrates)
* plants (including algae, mosses, ferns, gymnosperms and angiosperms)
* fungi
* monera/bacteria
* protoctista.

Note: the pictures of plants can be used again in another activity.Examples of raps and songs made by learners are available online.Information on the classification of a range of plants and animals. | This is an opportunity to make sure learners are aware of local rare and endangered animals and plants. |
| 7Bv37Eo3 | Classify animals and plants into major groups, using somelocally occurring examplesUse information from secondary sources | Classifying vertebratesAsk learners to suggest as many names of animals (that have skeletons) as possible. As they suggest the names, write them on the board in five columns: mammals, birds, amphibians, reptiles and fish. (Do not put titles on the columns.) Ask learners to suggest the titles for each column.*What features do mammals have in common? What about amphibians? Reptiles? Birds? Fish?*Peer teaching activity on vertebrate classes.* Give groups of learners a group of vertebrates to research.
* Provide each group with information about their vertebrate group (e.g. worksheets, websites or textbooks). Learners use the information to make a poster. The poster should include drawings and a maximum of 10 key words.
* Collect in the original information sources.
* One learner in each group remains with the poster while the others (‘researchers’) visit the other posters and gather information. The person who stays with the poster must peer-teach other learners using only the poster.
* The ‘researchers’ return to their group and share their information with the learner who stayed with their poster.

All learners should make notes on all of the five classes of vertebrates.An alternative activity could be to set up exhibition stations for each class (using specimens (live or dead)/photos/information cards).Use the information to produce a concept map about vertebrates.Ask learners to create a mnemonic to remember the five classes of vertebrates. Share these as a whole class and decide which ones are the best. | Information sources for learners on vertebrate groups.Learners who require more support can be given a template for their concept map: | The taxonomy suitable for learners of this age considers fish as a single class. |
| 7Bv37Eo3 | Classify animals and plants into major groups, using somelocally occurring examplesUse information from secondary sources | Classifying invertebratesAsk learners to suggest names of animals that do not have a skeleton. Display the suggestions on the board (not grouped).Explain that by the end of the lesson you would like the learners to be able to group these examples.Provide groups of learners with information about some invertebrate phyla (e.g. worksheets, websites or textbooks). Learners use the information to classify the invertebrates suggested at the beginning of the lesson.The taxonomy expected at this stage is based on the following phyla: annelids (segmented worms), arthropods, cnidarians, echinoderms, molluscs and sponges. Learners should also be aware of the major classes within the arthropods (e.g. insects, arachnids, crustaceans and myriapods).Learners write a short description, or create a concept map, of the features of each of the phyla and classes of invertebrate they have studied. | Note: you may need to add more examples to make sure there are examples from the following groups of invertebrates:annelids, arthropods (including insects, arachnids, crustaceans and myriapods), cnidarians, echinoderms, molluscs and sponges.Information sources for learners on invertebrate phyla. |  |
| 7Bv37Bp17Eo1 | Classify animals and plants into major groups, using somelocally occurring examplesRecognise the positions, and know the functions of the majororgans of flowering plants, e.g. root, stem, leafMake careful observations including measurements | Classifying plantsUse a starter activity to identify what learners can recall about plants and photosynthesis.Provide learners with a variety of plant specimens to observe: a moss, a fern, a brightly coloured flowering plant, a grass and a conifer.Explain that learners will observe the samples carefully to identify the features that are used to classify plants. Explain that these features are linked to the evolutionary relationships between different species of plants (and not features such as colour).Learners carefully observe each of the specimens with a hand lens. They should draw diagrams of their results. Learners require worksheets to guide their observation of each type of plant.MossLearners draw what they see and then label the leaves and a spore capsule.*Describe the leaves on the moss plant.**Why does the moss plant produce spores?**Where would you expect to find the moss plant growing?*FernLearners draw what they see on the underside of the fern leaf and label the leaflets and the scale that covers the spores.*What features do the moss and fern have in common?**How can you tell the difference between a moss plant and a fern?*Flowering plantLearners draw and label the flower where the seeds are made and the veins in the leaf.*Why are some flowers brightly coloured?**Why are flowering plants found in almost every habitat?*GrassLearners draw the grass and label the part where the seeds are made. This is another type of flowering plant.*How is a grass plant pollinated?*ConiferLearners draw what they see and label the leaves and the cone where seeds are made.*How are conifers different from flowering plants?**How are conifer leaves adapted to save water?* | Each group will require hand lenses, paper and pencils and samples of:* moss with spore capsules clearly visible (Moss should be collected within a few days of the activity. It can be kept fresh by storing in a damp plastic bag.)
* a fern frond (This can be dried and reused for several years.)
* a flowering plant, for example a pelargonium in a pot
* grass with seeds (This can be a fresh sample or dried.)
* a conifer branch with attached cones.
 | This is an opportunity to revise the anatomy of flowering plants.Health and safety:Warn learners not to taste any of the plant material as it may be harmful. Do not choose plants known to be poisonous or skin irritants for this activity. |

Unit 7.2 Solids, liquids and gases

It is recommended that this unit takes approximately **25% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of materials and their properties to develop their knowledge of the particle theory of matter and how this can explain the properties of solids, liquids and gases, including changes of state.

Scientific Enquiry work focuses on:

* choosing appropriate apparatus and using it correctly
* making careful observations including measurements
* presenting results in the form of tables, bar charts and line graphs
* recognising results and observations that do not fit into a pattern, including those presented on a graph, chart or spreadsheet
* considering explanations for predictions using scientific knowledge and understanding and communicating these.

Recommended vocabulary for this unit:

* particle, particle model, particle theory
* state, solid, liquid, gas, flow, compress
* changes of state, melting, boiling, freezing, condensing, evaporating, heating curve, cooling curve.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 7Cs17Eo2 | Show in outline how the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of statePresent results in the form of tables, bar charts and line graphs | Ask learners to complete a mind map showing what they understand by the terms ‘solids’, ‘liquids’ and ‘gases’.Revise solids, liquids and gases. Provide learners with a selection of solids, liquids and gases and ask them to construct a table to classify them. Discuss how they decided which category to place the items in. Introduce the term ‘particle theory’*. What do you think of when I say particle?* *Are solids, liquids and gases all made of particles? Are particles everywhere?* Ask learners to present their understanding of particles in relation to solids, liquids and gases. They can do a poster, a drama activity, or a stand up talk – key focus is their understanding. When looking at explanations unpick any misconceptions learners may hold. Properties of solidsAsk learners to create a table summarising the properties of gases and liquids in terms of whether they:* contain particles
* contain moving particles
* can flow
* take the shape of their container
* can be compressed.

Learners discuss how to complete this table for solids (using their desk or chair as an example). Take feedback. Properties of liquidsDemonstrate pouring a liquid between containers of different shapes. Elicit that the liquid: * can flow
* takes the shape of the container
* does not change volume
* cannot be compressed.

Demonstrate how to represent particles in the liquid state. Draw boxes containing particles that are close together but not in a regular arrangement.Properties of gasesTeacher demonstration or video to show that gases have mass (so they are made of particles) by comparing the mass of an inflated and non-inflated balloon.Elicit the idea of particles being too small to see and always moving.Learners can try to compress air in syringes or balloons. Give explanation in terms of trying to force things together.Demonstrate how to represent particles in the gaseous state. Draw boxes containing well-separated particles.Demonstrate how to represent particles in the solid state. Draw boxes containing particles that are close together and in a regular arrangement.Comparing solids, liquids and gasesDemonstrate the movement and spacing of particles in solids, liquids and gases using a simulationAlternatively, a tray containing small balls or dried peas to represent particles can be used.Give learners syringes filled with sand, water and air and ask them to depress the plunger. *How easy is it to depress the plunger? How can we explain these observations?*Explain why liquids and gases flow easily. Discuss, using the particle theory of matter, why liquids and gases can flow easily but solids cannot.Show learners a jar of sand. *What state is the sand in? Now pour the sand from one jar into another. Does this mean it is a liquid?*Explain why gases and liquids take the shape of their containers but solids do not, in terms of the particle theory of matter.Return to the example of a jar of sand. Discuss the size of the particles and why it would seem that the sand can ‘flow’. If possible show a zoomed-in image of a grain of sand, discuss how each grain is a solid (made of particles) but the grains are so small that they flow. Compare to a bag of marbles and how the marbles move: sand/salt/powders are the same, they are just smaller.  | Selection of solids, liquids (include water) and gases, with a coloured gas included (or a picture of a coloured gas).Two transparent containers of different shapes, water.A possible approach for a demonstration:[www.youtube.com/watch?v=Bv\_tS6-qCJ4](https://www.youtube.com/watch?v=Bv_tS6-qCJ4) Two equal-sized balloons and a top-pan balance (that can measure to 0.1g).Small sealed plastic syringes without needles should be used.<https://phet.colorado.edu/en/simulation/states-of-matter-basics> (translations available in many languages)Tray, or shallow box with edges.Small balls or dried peas.Sets of three syringes filled with sand, water and air. The syringes should be sealed so the contents cannot come out. This can be done by melting the end of the syringe or sealing it with a hot glue gun. Syringes should be tested in advance and learners warned not to press too hard.A jar of sand and an empty jar. | It is likely that learners will already have met ideas about the different states of matter and revisiting this provides the opportunity to assess prior learning and build on it.Misconception alert: Learners may think that when in solid form, particles have no movement when in fact they still have energy and vibrate. It is important this is explored and discussed.  |
| 7Cs17Eo1 | Show in outline how the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of stateMake careful observations including measurements | Changes of stateAsk learners to draw a particle diagram for water in the different states: solid (ice), liquid (water), gas (water vapour). *What happens to particles of a solid as it is heated? What is needed for a change in state to happen?*Review the changes of state to describe how the motion and particle arrangement change during melting, freezing, boiling, condensing and evaporating. A simulation can be used. Emphasise that the energy stored by a substance increases when it is melting or evaporating, and is reduced during condensation and freezing. Learners can spray air freshener onto a watch glass. They support the watch glass on their hand and feel it go cold. Elicit the idea that this shows that energy is needed for evaporation. In groups learners model particle arrangement and motion as a solid is heated and as a gas is cooled.Show learners images of water boiling and evaporating, e.g. a boiling kettle and water evaporating from a puddle of water*.* *What is the difference?* *What is in the bubbles in boiling water/liquid?* Learners discuss and share ideas about the differences between boiling and evaporation. Explain that when any liquid reaches a set temperature (under standard conditions) it will change from liquid to gas in the body of the liquid, creating bubbles of gas and boiling. In contrast, evaporation takes place at a liquid’s surface and occurs over a wider temperature range as the surface particles get more energy from the surroundings. The energy from the surroundings doesn’t reach the body of the liquid so it doesn’t boil. A useful check of misconceptions is to ask learners to discuss whether clouds are solids, liquids or gases. Learners’ contributions will indicate whether they mistakenly think that water vapour is visible. | <https://phet.colorado.edu/en/simulation/states-of-matter-basics> (translations available in many languages)[www.youtube.com/watch?v=dHJmOH38agY](https://www.youtube.com/watch?v=dHJmOH38agY) Air freshener, watch glass.Pictures/videos of water boiling and water evaporating.More information can be found at: [www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-are-clouds-58.html](https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-are-clouds-58.html) The water cycle could be introduced here. | Misconception alert: learners often think that changes of state only happen at exactly the ‘boiling point’ or ‘freezing point’ for each substance.Health and safety: check for allergies or asthma before doing this activity. |
| 7Cs17Ep77Eo17Eo27Ec27Ec3 | Show in outline how the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of stateChoose appropriate apparatus and use it correctlyMake careful observations including measurementsPresent results in the form of tables, bar charts and line graphsRecognise results and observations that do not fit into a pattern, including those presented in a graph, chart or spreadsheetConsider explanations for predictions using scientific knowledge and understanding and communicate these | **Scientific Enquiry activity**Cooling curveMeasure the temperature during the heating or cooling of a substance. Learners create a cooling curve for a low melting-point solid (e.g. stearic acid). The solid is first warmed so that it is liquid and then allowed to cool. The temperature is taken at regular intervals to note its temperature change with time.(Alternatively, provide learners with data to use to draw a line graph.)Learners plot temperature against time.Learners discuss the shape of the graph. Elicit that the flat portion of the curve corresponds to freezing. *Why does the temperature not decrease during freezing?* **Scientific Enquiry activity**Investigating the temperature change when ice is heatedFollowing on from creating a cooling curve, learners plan an investigation into the temperature change when ice is heated. Before conducting their investigation, they should make a prediction (including a sketch of the shape of the graph they think they will obtain).Make sure that no learners heat the water above 50oC.Learners conduct the investigation and plot a graph of temperature against time.Discuss the shapes of the graphs. Do any of the results not fit the expected pattern? Ask learners to predict what would happen if they continued to measure temperatures when the water boiled.**Scientific Enquiry activity**Learners analyse and evaluate heating or cooling curves. Learners plot graphs and draw conclusions about the melting and boiling points of substances. They decide whether any of the results do not fit a pattern. | Thermometers, heating apparatus (e.g. Bunsen), heatproof test-tubes.Stearic acid can be used.A possible method can be found at: [www.rsc.org/learn-chemistry/resource/res00001747/melting-and-freezing-stearic-acid?cmpid=CMP00005262](http://www.rsc.org/learn-chemistry/resource/res00001747/melting-and-freezing-stearic-acid?cmpid=CMP00005262) Example data.Graph paper, rulers.Ice, beakers, thermometers, heating apparatus (e.g. Bunsen).Heating or cooling curve data both in table and graph form.  | Safety goggles should be worn.Health and safety:Learners should stop heating the water at about 50oC. Some data needs to be presented that is not ideal – having results that do not fit the pattern. |

Unit 7.3 Energy transfers

It is recommended that this unit takes approximately **35% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of energy as something that makes things happen, to develop their knowledge of:

* different types of energy
* energy as something that cannot be created or destroyed
* energy transfers.

It provides the opportunity for learners to develop their thinking skills in suggesting explanations for their observations. This unit provides a good opportunity to investigate the appliance of scientific knowledge and how this affects our daily life.

Scientific enquiry work focuses on:

* making careful observations including measurements
* presenting results in the form of tables, bar charts and line graphs
* using information from secondary sources
* considering explanations for predictions using scientific knowledge and understanding and communicating these.

Recommended vocabulary for this unit:

* energy, energy type, energy transfer, conservation of energy, energy flow diagram, Sankey diagram, efficiency
* chemical energy, kinetic energy, thermal energy, sound energy, light energy, gravitational potential energy, elastic potential energy, electrical energy and nuclear energy
* turbine, energy source, fuel, fossil fuel, renewable, non-renewable.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 7Pe2 | Recognise different energy types and energy transfers | Ask learners what they already know about energy, types of energy, energy transfers and the conservation of energy. Learners make a mind map or poster to record their current understanding. This could be developed further during the unit.The following activity can be used to check for misconceptions. Tell learners that: ‘Adam is a boy who has lots of energy and Anna is a girl who seems to have no energy at all.’* In pairs, one learner describes what they imagine Adam to be like. Then the other imagines what Anna is like.
* Share the characteristics with the whole class.
* Then ask learners to use their previous learning about energy*: Is this what energy means to scientists?*

Ask learners to list the types of energy they have previously learned about in science. Introduce or elicit the names of ‘types’ of energy: * chemical
* kinetic
* thermal
* gravitational potential
* elastic potential
* nuclear
* sound
* light
* electrical.

Explain the meaning of the word ‘potential’ as having the capacity/ability to do something in the future. Identify the types of energy that can be stored. Discuss learners’ previous experience of gravitational potential energy, elastic potential energy and electrical energy.Learners do an activity (energy circus) where they try to identify the types of energy illustrated. This first activity should focus on identifying the types of energy rather than energy transfers. Kinetic, gravitational potential energy, elastic potential energy, sound and thermal energy, for example, could all be identified in a bouncing ball.Discuss the learners’ findings as a class activity. | Change the names to be appropriate for your school.Objects for an energy circus e.g. clockwork toys, lamps (battery or mains operated), matches (teacher demo if appropriate), photographic negative, tin containing some dried beans (or something else that makes a sound when shaken), solar-powered calculator, mass on a spring. | This is an opportunity to identify the areas of energy which learners have previously studied.There are likely to be several misconceptions about energy. The mind maps can be used to identify these in order to plan.In Stages 5 and 6 learners will have been introduced to light as energy, plants and energy for growth, food chains and energy flow, energy use (renewables etc.) and energy in movement. |
| 7Pe27Eo1 | Recognise different energy types and energy transfersMake careful observations including measurements | Demonstrate an energy transfer such as a bouncing ball. Elicit the idea that often we notice energy when something happens.* Learners suggest the energy types that are involved (perhaps kinetic, gravitational potential energy, elastic potential energy, sound and thermal energy).
* Given these types, ask the learners to put them in a time order.
* Formalise their ideas into an energy transfer diagram:

e.g. gravitational potential energy → kinetic → elastic potential energy + thermal + sound → kinetic → gravitational potential energy etc.Learners use the activities and equipment from the energy circus in the previous lesson to identify the energy transfers and create energy transfer diagrams.Show learners a simple food chain e.g.:Lettuce → rabbit → foxAsk learners to write down the energy transfers in the food chain. | Ball.Objects for an energy circus e.g. clockwork toys, lamps (battery or mains operated), matches (teacher demonstration if appropriate), photographic negative, tin containing some dried beans (or something else that makes a sound when shaken), solar-powered calculator, mass on a spring. |  |
| 7Pe27Pe1 | Recognise different energy types and energy transfersUnderstand that energy cannot be created or destroyed and that energy is always conserved | Ask: *Where do our bodies get their energy from? How do we use energy?*Show the video clip of a struggling long-distance runner: *Did they have enough energy?*Tell learners that energy is measured in units called joules (J). Learners look at some food packaging labels to see how many kJ of energy are absorbed during a typical meal. They may need to be told that 1 kJ = 1000 J.Demonstrate lifting a mass of 2 kg (or weight of 20 N) 0.5 m with your arm. This uses 10 J of energy. *What energy transfers take place when the mass is lifted?** Learners do the same activity and count how many lifts they can do before they get too tired. (Agree safety measures before starting this activity.)
* They use this information to calculate how many joules of energy have been used in raising the 20N repeatedly before they get tired. They can compare the results with their other arms.
* Learners use the results from the class to calculate a mean and range. Discuss how many joules each person used in the activity.
* Compare learners’ measured energy to that in a typical meal (from earlier in the lesson). Discuss this energy gap: *Do you have any suggestions on why the gap is so large? How many times would we have to do this exercise to transfer all the energy from the meal?*
* Ask learners to suggest why the energy input (eating) seems to be much larger than our output (lifting). *Have we missed anything? Has energy been destroyed? Is there any energy ‘escaping’?*
* Explain that learners need to consider that energy is used to: lift our (empty) hand, pump more blood more quickly, raise our temperature, make our lungs work faster, etc. These parts of the activity are difficult to measure.
* Distinguish between useful energy and wasted energy in the lifting example. Introduce the term ‘efficiency’.

**Extension activity**Learners who require more challenge calculate the percentage efficiency of the activity.Learners identify the useful energy and wasted energy in a range of appliances (e.g. kettle, computer, light bulb). They discuss how to reduce the wasted energy associated with these appliances.**Extension activity**Learners who require more challenge find out about the efficiency information given to consumers (for example European Union efficiency labels). | e.g.[www.bbc.co.uk/news/world-us-canada-31513159](http://www.bbc.co.uk/news/world-us-canada-31513159)[www.theguardian.com/sport/video/2016/sep/19/alistair-brownlee-gives-chance-win-helps-brother-jonny-video](https://www.theguardian.com/sport/video/2016/sep/19/alistair-brownlee-gives-chance-win-helps-brother-jonny-video) Used food packaging for typical meals, calculators.Meter ruler, object that weighs 20 N or has a mass of 2 kg (e.g. bag of sand or plastic bottle of water).Enough for one per group for small groups of learners:meter rulers, objects that weigh 20 N or have a mass of 2 kg (e.g. bag of sand or plastic bottle of water).This is a good opportunity to make the connection between the energy used to keep the body at 37 oC and the energy required for chemical reactions in the body.Extension: Learners can discuss why some people need to take in more energy (in the form of chemical energy stored in food) than others. |  |
| 7Pe27Pe17Ec3 | Recognise different energy types and energy transfersUnderstand that energy cannot be created or destroyed and that energy is always conservedConsider explanations for predictions using scientific knowledge and understanding and communicate these | Show learners examples of ‘perpetual motion’ machines. Explain that they claim to run forever without any energy being added to the system. In pairs, ask learners to discuss if they think the claim is true.Learners identify the energy transfers in each machine. They should identify any wasted energy. Discuss the energy transfers involved in each machine. Learners use this analysis to explain why the perpetual motion machines cannot be made.Show learners an example of one perpetual motion machine.Learners analyse its energy source. They create a leaflet explaining why it is not a perpetual motion machine.**Extension activity**Learners who require more challenge design their own ‘perpetual motion machine’. They should draw what it would look like and write an explanation of how it appears to work and how it would really work.Conclude that perpetual motion is not possible because there will always be some energy transfers that are not useful. Perpetual motion would break the law of conservation of energy. | Videos of ‘perpetual motion’ machines e.g. <https://youtu.be/2D9FcjTNaEk> ‘Perpetual motion machine’ or video e.g.:<https://youtu.be/Q6vd5kyKIpA>Explanation:[www.instructables.com/id/Overbalanced-Wheel-Fake-Perpetual-Motion-Machine-/step5/The-Real-Deal-Non-Perpetual-Motion/](http://www.instructables.com/id/Overbalanced-Wheel-Fake-Perpetual-Motion-Machine-/step5/The-Real-Deal-Non-Perpetual-Motion/)(The machine is powered by a small electronic motor.) |  |
| 7Pe27Pe1 | Recognise different energy types and energy transfersUnderstand that energy cannot be created or destroyed and that energy is always conserved | Consolidate learning by asking learners to explain the action of a pendulum.Demonstrate swinging a pendulum starting at the teacher’s nose. This shows that the bob does not lose a noticeable amount of energy but simply transfers it from ‘moving’ (i.e. kinetic) to ‘stored’ (i.e. gravitational potential) and back again. Learners draw energy transfer diagrams and explain them using the idea of conservation of energy.Discuss with learners the wasted energy in this example.Introduce the idea of Sankey diagrams to represent the proportion of each of the energy transfers.Learners compare different Sankey diagrams and identify the useful, and wasted, energy transfers. | Pendulum bob, string, means of suspending string and bob.Video clip at:[www.youtube.com/watch?v=EZNpnCd4ZBo](https://www.youtube.com/watch?v=EZNpnCd4ZBo) Sankey diagrams represent quantities of energy by the width of an arrow.Accurate scale representation using Sankey diagrams not required at this stage. | Health and safety: This must be a teacher demonstration only, in case a learner moves their head and gets hit by the bob. |
| 7Pe27Pe17Be47Eo17Eo27Eo3 | Recognise different energy types and energy transfersUnderstand that energy cannot be created or destroyed and that energy is always conserved.Discuss a range of energy sources and distinguish between renewable and non-renewable resources. Secondary sources can be usedMake careful observations including measurementsPresent results in the form of tables, bar charts and line graphsUse information from secondary sources | Generating electricityTeacher demonstration: * Move a coil of wire near to a strong magnet. Use a voltmeter to show that a voltage has been produced.
* Learners suggest ways of making more voltage.
* Explore faster movement, stronger magnets and more coils.

Alternatively use the ‘pick up coil’ tab on this simulation (see link). Learners explore how to make the bulb light up.Summarise that to generate electricity three things are needed:* coil of wire
* magnetic field
* movement.

Use the ‘generator’ tab of this simulation (see link) to show a simple model of how a turbine can be used to generate electricity.Learners identify the energy transfers involved in this process and draw an energy transfer diagram.Wind turbineShow learners a picture of a wind turbine. In pairs they explain where they would find a coil of wire and magnet (to create the magnetic field) and what causes the movement.Learners identify the energy transfers involved in this process and draw an energy transfer diagram.**Scientific Enquiry activity**If small electric motors are available these can be used as generators (since they contain a coil of wire and a magnet).* Learners make their own wind turbine by making blades using cardboard.
* Learners attach their sails to a small motor and use a voltmeter to detect whether a voltage is generated when the blades turn.
* Learners can test different shapes, numbers and sizes of blades.
* Learners collect data and present it in a suitable table.

Steam turbines (and fossil fuels)Demonstrate a steam generator using a source of steam (e.g. water boiled in a kettle). * Use the steam to turn a wind turbine (from a previous lesson) or a toy windmill. The steam may need to be directed through rubber tubing.
* In pairs learners discuss the energy transfers involved. Take feedback.
* Create an annotated energy flow diagram using these basic stages: chemical energy → thermal energy → kinetic energy → electrical energy.
* Identify examples of how some of the energy in these transfers may be wasted.

Ask learners to suggest examples of fuels that can be burned to create steam.Introduce the key parts of the power station: furnace, boiler, turbine and generator. Learners discuss the energy transfers that may be involved. Show a video of an example coal-fired power station. Learners create an annotated diagram to summarise the function of the key parts in a coal-fired power station (furnace, boiler, turbine, generator).Provide learners with information sources (printed or online material). Learners find the answer to the questions:* What fuels can be burned to create steam (include examples of fossil fuels and renewable fuels)?
* What are the advantages and disadvantages of each type of fuel?
* What types of fuel are burnt in this country’s power stations?

Learners compare Sankey diagrams for different types of electricity generation.Learners classify different ways of generating electricity as ‘renewable’ or ‘non-renewable’. Include solar power, explaining that photovoltaic cells do not use turbines. | Wires, voltmeters, strong magnets.<https://phet.colorado.edu/mk/simulation/legacy/generator>(Simulation is available in several languages.)Note: at this stage it is acceptable to say that the magnetic field is due to a magnet. Learners do not need to understand electromagnets at this stage.<https://phet.colorado.edu/mk/simulation/legacy/generator>Picture of a wind turbine.Electric motors (can be purchased or taken from broken electrical equipment), card, scissors, sticky tape, electric fans or hairdryers, rulers.Source of steam (e.g. means for boiling water, such as a kettle or spirit burner and conical flask), model wind turbine or toy windmill, rubber tubing.Video of a coal-fired power station e.g.: <https://www.tva.com/Energy/Our-Power-System/Coal/How-a-Coal-Plant-Works> Information sources for learners (including information about local power stations). | An understanding of the energy transfers involved in generating electricity will support learning in biology on human impacts on the environment.Many leaners wrongly think that renewable energy can be re-used. Suggest that it will run out or is not being replaced as fast as it is being used up.Details of magnets and magnetism not covered or required until Stage 8.Healthy and safety:Care must be taken to avoid scalds and burns. |

Unit 7.4 Acids and bases

It is recommended that this unit takes approximately **30% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of acids to develop their knowledge of:

* how to tell if a solution is an acid or an alkali
* using a pH scale
* neutralisation and some of its applications.

Scientific Enquiry work focuses on:

* suggesting ideas that may be tested
* outlining plans to carry out investigations, considering the variables to control, change or observe
* making predictions referring to previous scientific knowledge and understanding
* identifying appropriate evidence to collect and suitable methods of collection
* choosing appropriate apparatus and using it correctly
* making careful observations including measurements
* using information from secondary sources
* making conclusions from collected data, including those presented in a graph, chart or spreadsheet
* recognising results and observations that do not fit into a pattern, including those presented in a graph, chart or spreadsheet.

Recommended vocabulary for this unit:

* acid, acidic, alkali, alkaline, base, neutral, neutralisation
* indicator, universal indicator, litmus, pH scale, concentrated, dilute.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 7Cc3 | Use indicators to distinguish acid and alkaline solutions | Acids and hazardsStart by reviewing previous knowledge of acids. *What is an acid? Can you name any acids?*Provide a display of acids to compare different acids (vinegar, lemon juice, canned drink, laboratory acids) with hazard labels.Explain that dilute acids have a sour taste (a concentrated acid would be too dangerous to taste).Bring learners’ attention to the hazard labels. Discuss the meaning of the hazard labels. *Why do you think we need to use them? What do they mean? How can we be safe when using acids? Which are more dangerous – naturally occurring or laboratory acids? Which hazard symbol would you expect to find on a bottle of a laboratory acid?*Learners examine labels of household items (or their pictures), containers of laboratory chemicals or a chemical transporter. They identify, discuss and draw hazard labels seen.*How can you make acids less dangerous?* Discuss dilution of acids. *What should you do if an acid is spilt?* Ensure that learners make the connection between washing a spillage and diluting the acid. Discuss how if you dilute the acid, it is still acidic. The best way to make an acid less dangerous is to neutralise the acid with a base/alkali, which reacts with the acid to produce safe products. This will be talked about later.  | Different acids or pictures of laboratory acids and sources of naturally occurring acids e.g. vinegar, lemon juice (lemon), canned drink, grapes, milk, laboratory acids etc.A list of hazard labels and their meaning.Note: show learners the globally harmonised system for hazards together with any older hazard symbols they might see:[www.sigmaaldrich.com/safety-center/globally-harmonized.html](http://www.sigmaaldrich.com/safety-center/globally-harmonized.html)<https://www.tes.com/teaching-resource/new-hazard-symbols-6361473> (free registration required)Labels (or their pictures) of household items, containers of laboratory chemicals, chemical transporter. | Misconception alert: Ensure learners understand that alkalis can be as dangerous as acids and can be corrosive and cause serious damage to living organisms. Health and safety: Teacher and learners must wear safety glasses whenever using acids. |
| 7Cc17Cc37Ep7 | Use a pH scaleUse indicators to distinguish acid and alkaline solutionsChoose appropriate apparatus and use it correctly | Using indicators*How do you know if a liquid is an acid?* Explain that chemists use indicators. *How does an indicator work?*Explain that alkali can be thought of as an opposite to an acid. Dilute alkalis have a soapy feel. Concentrated alkalis are also very dangerous, similar to concentrated acids. Test indicator solutions with an acidic solution, alkaline solution and distilled water (neutral). Learners record results in a table. They can then use their results to test an unknown solution.Learners design a set of instructions to explain how to distinguish acidic, alkaline and neutral solutions. (This will normally need the use of two indicators.)Making indicators*What is an indicator?* Elicit the idea that an indicator is a dye that changes colour depending on whether a solution is acidic or alkaline.Explain that many plants contain dyes that can be used as indicators. Show a picture of a pH- dependent plant, e.g. hydrangea grown in two different types of soil.Different groups of learners make indicators from different plants.* Before starting the practical activity, learners should discuss what variables they will control to make sure that the results are fair.
* Learners prepare indicator dyes from colourful vegetables, fruits and flowers by putting them into hot water. Crushing the plants will help extract the dye. Good examples are turmeric, red cabbage, beetroot, cranberry tea, cranberry juice, grape juice, cherry tea.
* Learners test their indicator on solutions of an acid, alkali and distilled water. They make a colour chart for their indicator.
* Learners use the indicators to test a variety of acids and alkalis, including some household substances. They record their results in a table.
* Learners compare the results from different indicators. Did they all give the same results? Which was the best indicator? Why?

Universal indicator and the pH scaleReturn to the question: *What makes a good indicator? What is the problem with an indicator that only has two colours?* Learners discuss in groups the advantages of the best indicator(s) from the previous lesson and its possible limitations.Introduce ‘pH’ as a measure of how acidic or alkaline a solution is.Define acids, alkalis and a neutral solution in terms of pH.Explain that the universal indicator consists of a mixture of plant dyes and therefore has a wide range of colours.Demonstrate how the colour of universal indicator changes in solutions of different pH. A pH chart can be used to find out the pH number for each colour.Learners draw and annotate a suitable colour chart. Make sure they know the number(s) that correspond to acids, alkali and neutral solutions.Ask learners to discuss why universal indicator is more useful than other indicators with one colour change. Combine ideas to make an agreed explanation.Use universal indicator to test different substances. * Before testing each substance learners should predict its position on the pH scale.
* Then learners use universal indicator to determine the pH of each substance.
* They use their results to put each substance in its correct position on the pH scale.
* If universal indicator paper is used, learners can dry the strips. Once dry they can glue them into their books and annotate them.
* Learners compare their results with their predictions and discuss any surprises.
* Were there samples for all of the pH values? Why not?
 | Spotting tiles/well plates and teat pipettes will reduce the quantities of chemicals needed.Use dilute hydrochloric acid as the acidic solution and dilute sodium hydroxide as the alkaline solution.Suitable indicators are litmus and methyl orange. Suitable indicator paper can be used if needed. Do not use universal indicator at this stage.Picture of a pH-dependent plant.Selection from: turmeric, red cabbage, beetroot, colourful flowers, cranberry tea, cranberry juice, grape juice, cherry tea.Heating apparatus, heatproof beakers, water. (The water can be heated in a kettle.)Dropping tile or test tubes, dropping pipettes or glass rods.Items to test including:* two named acid solutions (e.g. dilute hydrochloric acid and dilute sulfuric acid)
* two named alkali solutions (e.g. dilute sodium hydroxide and dilute potassium hydroxide)
* distilled water
* a range of household items to test (e.g. toothpaste, fruit drinks, tea, coffee, cleaning products, liquid soap, washing up liquid, milk, deodorant, indigestion tablets, soil shaken in water).

pH chart.Coloured pencils are more realistic than pens for charts.Universal indicator solution or universal indicator paper cut into strips.Substances to test. These should be the same substances used to test the plant indicator. For example:* two named acid solutions (e.g. dilute hydrochloric acid and dilute sulfuric acid)
* two named alkali solutions (e.g. dilute sodium hydroxide and dilute potassium hydroxide)
* a range of household items to test (e.g. toothpaste, fruit drinks, tea, coffee, cleaning products, liquid soap, washing up liquid, milk, deodorant, indigestion tablets, soil shaken in water).

Dropping tiles/well plates, dropping pipettes. | Learners may have already used pH paper. This is an opportunity to build on this experience.Reinforce the use of the terms ‘concentrated’ and ‘dilute’ rather than strong and weak acids. Health and safety**:** Eye protection must be worn.Health and safety:* Eye protection must be worn.
* Care should be taken when heating water and using hot water.

Prepared indicators should be stored in a dark place if they are to be used in several lessons.Health and safety:Eye protection must be worn. |
| 7Cc27Cc37Eo1 | Understand neutralisation and some of its applicationsUse indicators to distinguish acid and alkaline solutionsMake careful observations including measurements | Neutralisation reactionsAsk learners to discuss*: If acids and alkalis are chemical opposites, what will happen when an acid is added to an alkali?*Learners investigate the reaction by adding alkali a drop at a time to an acid containing indicator. They count the number of drops before the indicator turns green (for pH 7) and the number of drops before the indicator turns blue (for pH 8). They record their results in a table.Similarly, learners add acid a drop at a time to an alkali containing indicator. They count the number of drops before the indicator turns green (for pH 7) and the number of drops before the indicator turns yellow (for pH 6). Learners record their results in a table.Introduce the term ‘neutralisation’. Compare the number of drops of acid/alkali that learners needed to use to create a neutral solution. Were there any anomalous results? | Dilute alkali solution, dilute acid solution, universal indicator solution, beakers or cups, measuring cylinders, dropping pipettes. | Health and safety:* Eye protection must be worn.
* Use only small quantities (e.g. 5 cm3 of an acid or an alkali solution).
 |
| 7Cc27Ep37Ep47Ep57Ep67Ep77Ec17Ec2 | Understand neutralisation and some of its applicationsSuggest ideas that may be testedOutline plans to carry out investigations, considering the variables to control, change or observeMake predictions referring to previous scientific knowledge and understandingIdentify appropriate evidence to collect and suitable methods of collectionChoose appropriate apparatus and use it correctlyMake conclusions from collected data, including those presented in a graph, chart or spreadsheetRecognise results and observations that do not fit into a pattern, including those presented in a graph, chart or spreadsheet | Investigating indigestion remedies*What is the function of the stomach? What is indigestion? What causes it? How could you remedy it?*Discuss that indigestion is caused by the excess of stomach acid. A neutralisation reaction can be used to remedy it. *What do you think makes a good indigestion remedy?*Learners choose a question they would like to investigate about indigestion tablets. They should peer assess their questions to make sure that they can be tested.Learners, in pairs, plan an investigation to answer their question about indigestion tablets. They should decide on their independent, dependent and control variables and write a method for the investigation.As part of their plans, learners should conduct a simple risk assessment and decide the precautionary measures that they will take.Learners peer assess their methods with a different group. There are several ways that this investigation could be completed. Learners should give each other feedback on whether the method is clear:* What is the independent variable?
* How will the independent variable be changed?
* What is the dependent variable?
* How will the dependent variable be measured?
* What are the control variables?
* How will these variables be controlled?
* What are the precautionary measures?

Identify the resources available to learners for their investigation and allow them five minutes to read through their plans and familiarise themselves with resources needed and how to set up the investigation.Alternatively, provide learners with a method that they will all use for their investigation.Groups of learners carry out the investigation to answer a question about indigestion tablets (e.g. Which brand of indigestion tablet neutralises the most acid? What mass of indigestion tablet is needed to neutralise 5 cm3 of acid? How many drops of hydrochloric acid can an indigestion tablet neutralise?). Circulate and provide support for groups.Learners collect and interpret their results. They compare their results with their predictions and with the results from others in the class. Ask if any learners have anomalous results (one that do not fit the pattern).**Extension activity**Give learners who require more challenge a titration curve showing the change in pH when milk of magnesia is added to stomach acid. Learners explain in their own words what it means. | The resources required will depend on the chosen method(s) of investigation. It is likely that the following will be needed:* at least two different brands of indigestion tablets

(It is better to use tablets that contain simple active ingredients, such as carbonates and hydrogen carbonates.)* dilute hydrochloric acid (distilled vinegar can be used instead) to mimic stomach acid.

Universal indicator (solution or paper), mass balance, measuring cylinders, dropping pipettes, goggles. | This lesson is an opportunity to revise and expand upon knowledge of the digestive system from biology. It is also an opportunity to apply their learning from chemistry to an everyday situation and develop their scientific enquiry skills. Learners have previously been taught that the stomach contains acid and that food leaves the stomach and enters the small intestine. They are unlikely to know that there is a substance called bile that neutralises stomach acid as it enters the small intestine. For this lesson, indigestion is taken to be caused by acid from the stomach not being fully neutralised by bile and so damaging the small intestine.Health and safety:If learners follow their own method, then it must be checked by the teacher in advance.If learners count the number of drops of acid needed to neutralise an antacid, then advise learners to use only a very small portion of a tablet. The whole tablet will require a lot of acid (especially if vinegar is being used).Health and safety:* Eye protection must be worn.
* Use only small quantities (e.g. 5 cm3 of an acid or an alkali solution).
 |
| 7Cc27Cc37Eo17Eo3 | Understand neutralisation and some of its applicationsUse indicators to distinguish acid and alkaline solutionsMake careful observations including measurementsUse information from secondary sources | Problems with the properties of acidsProvide learners with information sources (printed or online material). Learners answer one or more of these questions:*What is acid rain? How does it affect buildings?**What is the effect of acidic foods and drinks on teeth? What is the pH of common drinks?**How does the pH of soils affect what plants can be grown? How can farmers or gardeners change the pH of soil?**What happens to the pH of milk when it goes off? Why does this happen?*Learners make a plan for an investigation linked to acid rain, the pH of soil or the pH of milk. Learners can be given strips of universal indicator paper and asked to do experimental work as homework. Alternatively, they can prepare an indicator out of plant material as described in previous lessons.Ask learners to discuss what they can conclude from these statements:* Stings from ants and bees can be eased by adding baking powder.
* Stings from wasps can be eased by adding vinegar.

Explain that these are examples of useful neutralisation reaction. *Can you suggest an example of* ***not******useful*** *neutralisation?* Learners refer to the previous work on acid rain and limestone. Explain that it is possible to reduce the effect of acid rain by fitting chimneys with gas scrubbers. *What do you think is the pH of a substance used in a gas scrubber?*Learners consolidate by matching a problem with a solution from a list. | Information sources for learners.For example, learners can measure the pH of rain, a range of drinks (including fizzy drinks), soil, fresh milk and sour milk.List (or cards) with problems associated with acids or alkalis and corresponding solutions. |  |

Unit 7.5 The Earth and beyond

It is recommended that this unit takes approximately **35% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of the Earth and Space and develop their ideas on:

* the different types of rocks and soils
* simple models of the internal structure of the Earth
* fossils and the fossil record as a guide to estimating the age of the Earth
* how the movement of the Earth causes the *apparent* daily and annual movement of the sun and the stars
* the relative positions and movement of the planets and the Sun in the solar system
* the impact of the ideas and discoveries of Copernicus, Galileo and more recent scientists
* the Sun and other stars as sources of light, and that planets and other bodies are seen by reflected light.

Note: the activities in this unit fall into two halves – astronomy and Earth science. These can be approached in either order.

Scientific enquiry work focuses on:

* being able to talk about the importance of questions, evidence and explanations
* outlining plans to carry out investigations, considering the variables to control, change or observe
* making careful observations including measurements
* using information from secondary sources
* presenting conclusions using different methods.

Recommended vocabulary for this unit:

* astronomy, orbit, spin, tilt, star, planet, moon, solar system, eclipse, lunar eclipse, solar eclipse
* Copernicus, Galileo
* core, mantle, crust
* sedimentary, igneous, metamorphic, grain, crystal, fossil
* pedosphere, soil, sandy, clay, loam.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 7Pb1 | Describe how the movement of the Earth causes the *apparent* daily and annual movement of the sun and the stars | Astronomy: day, night and seasonsBegin by determining what learners can remember from previous study about the movement of the Earth, moon and sun.Show learners a simulation showing the orbits of the sun, Earth and moon (see link for an example). Ask them to predict the length of time needed for:* the Earth to make half a rotation
* the moon to orbit once round the Earth
* the Earth to orbit three-quarters of the way round the sun.

Show a time-lapse video clip showing night and day. Ask learners to observe it closely and identify what appears to be moving. In pairs learners discuss their observation.Give groups of learners three balls of different sizes. In groups learners need to create role plays that explain:* day and night
* the apparent movement of the Sun each day from the east to the west
* the apparent movement of the moon each night
* the changing length of shadows during a day.

Circulate during this activity and deal with any misconceptions as they arise.Learners demonstrate their role plays to each other.Ask learners to critique each other’s models:*What does this model show well? What does this model not show well? Is it ‘good enough’ to explain the points above?* Show how the shadow that causes night affects the Earth by looking at a day and night world map. This is interactive so learners can see the effect of time and latitude. *Why are there always some places in the dark and some in the light?*Ask: *What causes summer and winter?* Take feedback from learners.Show learners the tilt of the Earth and how it is retained when the Earth orbits the sun. If a torch is used to represent the sun, then it is possible to model the light intensity of the sun in summer and winter.A simulation of the seasons can be used. This can be set to different latitudes (e.g. to match the latitude of the school). Show a video of the most northern city in the world (Tromsø in Norway) in its winter months. In pairs learners discuss and develop an explanation for 24- hour darkness in the winter and 24-hour daylight in the summer.**Extension activity**Learners can be challenged to explain timezones (cross-curricular link with mathematics).**Extension activity**Display this statement to learners:‘*You are stationary on your chairs yet you are really moving at at least 1100 km per hour*’.In pairs, learners discuss this statement and try to explain what it means. Take feedback from different pairs.Summarise that while you are stationary on your chair, the surface of the Earth is spinning at 1100 km per hour. | [www.bbc.co.uk/schools/scienceclips/ages/9\_10/earth\_sun\_moon\_fs.shtml](http://www.bbc.co.uk/schools/scienceclips/ages/9_10/earth_sun_moon_fs.shtml)<https://youtu.be/pAdSSIVF6Xo>Three balls of different sizes, e.g. football, tennis ball, table tennis ball, golf ball, dried pea.Possible demonstrations using a globe, small figure and ball to represent the sun:[www.bbc.co.uk/education/clips/zkynvcw](http://www.bbc.co.uk/education/clips/zkynvcw)Suggested link:[www.timeanddate.com/worldclock/sunearth.html](http://www.timeanddate.com/worldclock/sunearth.html)Globe, torch.This demonstration can also be viewed here: [www.bbc.co.uk/education/clips/zkynvcw](http://www.bbc.co.uk/education/clips/zkynvcw)<http://astro.unl.edu/classaction/animations/coordsmotion/eclipticsimulator.html>[www.bbc.co.uk/education/clips/z9qd7ty](http://www.bbc.co.uk/education/clips/z9qd7ty) | Learners have previously studied the relative movements of the Earth, sun and moon in Stage 5. It is important to identify whether any misconceptions persist and to respond to these.Make sure that learners’ models can explain why the sun rises in the east and sets in the west.Misconceptions alert:Common misconceptions include:* the Earth moves closer to the sun in summer and further away in winter
* the axis of the Earth changes as it orbits the sun.

If these misconceptions are expressed, then it is important that they are addressed. |
| 7Pb27Pb47Eo37Ec4 | Describe the relative position and movement of the planets and the sun in the solar systemUnderstand that the sun and other stars are sources of light and that planets and other bodies are seen by reflected lightUse information from secondary sourcesPresent conclusions using different methods | Astronomy: planets and starsShow a long-exposure photograph of the night sky and discuss learners’ ideas. *What does it show? How long was the exposure? What are the light sources in this picture? Are the stars moving? What is really happening?* Explain the photograph.Various internet sites show a view of the sky from different locations on Earth. Learners can be shown one of these using their own location and find the name of the star that other stars seem to rotate about.Show learners a photograph of the moon and Venus. Ask learners: *What are the light sources in this picture?* If necessary, explain that the sun and stars are light sources. Other objects including the planets and the moon are seen by reflected light.Ask learners (without any help) to draw a diagram of our solar system. They should include: the planets, the sun and any other bodies (moons, asteroid belts etc.).Learners compare their answers. Show learners the correct answer. If necessary, explain why Pluto is no longer considered a planet.Learners can create a mnemonic to help them remember the order of the planets in the solar system.Learners use labelled diagrams to explain solar and lunar eclipses (making reference to the sources of light).Give learners pictures of the planets and information about the planets. * They should use the information to sort or group the planets in as many ways as possible (e.g. size, number of moons, length of a day, gravitational field strength, composition).
* Learners compare their approach to sorting or grouping the planets.
 | [www.universetoday.com/85730/do-stars-move/](http://www.universetoday.com/85730/do-stars-move/)<https://in-the-sky.org/whatsup.php> <https://thenightskyinfocus.files.wordpress.com/2013/08/venus-moon_aug102013.jpg><http://solarsystem.nasa.gov/planets/>Cards with information about each planet. |  |
| 7Pb27Pb37Ep17Eo37Ec4 | Describe the relative position and movement of the planets and the sun in the solar systemDiscuss the impact of the ideas and discoveries of Copernicus,Galileo and more recent scientistsBe able to talk about the importance of questions, evidence and explanationsUse information from secondary sourcesPresent conclusions using different methods | History of astronomyDiscuss: *How did people explain the movement of the sun, stars and planets in ancient times? When and how did ideas change?*Explain that, in groups, the learners will be given one of the scientists who influenced our understanding of the solar system.* The groups studying Ptolemy and Copernicus need to:
	+ state when and where the scientist lived
	+ describe their model of the solar system (including what was at the centre of their universe)
	+ describe the evidence that their model explained
	+ describe the evidence that their model could not explain.
* The groups studying Galileo, Leavitt or Hubble, need to:
	+ state when and where the scientist lived
	+ describe how they collected evidence about the solar system and universe
	+ describe the conclusions they reached from their evidence.

Learners can be given a choice of methods to present their research, e.g. spoken talk, computer presentation, video, poster, drawing, drama, short role play, 3D models, demonstration, poem, song.* Organise the class for the presentations. Groups of learners make a short presentation and answer questions relating to it.
* The learners who are listening to the presentations should make notes on the contributions of different scientists.
* At the end of each presentation, the audience can ask questions which relate to the presentation.

Ask learners: *Which was more important – creative thinking or evidence – in developing the model of the solar system?* Take feedback. Discuss that both creative thinking and evidence are vital to be a successful scientist.Show learners pictures of the scientists from the presentations. Learners put these in order according to the time when the scientists lived and worked.Learners make a timeline that shows the major developments in the model of the solar system. As a minimum this timeline should include both Copernicus and Galileo. It may also include many other scientists.Learners can make an individual timeline or a timeline for the classroom. | Possible sources of information include:* [www.bighistoryproject.com/chapters/2#the-rock-we-call-home](https://www.bighistoryproject.com/chapters/2#the-rock-we-call-home)
* [www.polaris.iastate.edu/EveningStar/Unit2/unit2\_sub1.htm](http://www.polaris.iastate.edu/EveningStar/Unit2/unit2_sub1.htm)
* <http://abyss.uoregon.edu/~js/ast121/lectures/lec02.html>
* [www.kidsastronomy.com/leavitt.htm](http://www.kidsastronomy.com/leavitt.htm)

Other scientists, astronauts and space research organisations can be included.Pictures of scientists from presentations. | This activity consolidates and extends learning on the Stage 5 learning objective ‘Research the life and discoveries of scientists that explored the solar system and stars’. |
| 7Ce27Eo3 | Research simple models of the internal structure of the EarthUse information from secondary sources | The structure of the EarthUse secondary sources to investigate the structure of the Earth.Discuss the difficulty of studying the internal structure of the Earth. One approach is by studying earthquakes – detailed analysis can give information about the materials the energy waves travelled through (seismology). The same approach can be used to find out about the composition of stars by studying ‘starquakes’ (asteroseismology).Learners build models of the internal structure of the Earth, showing the relative sizes of the layers.**Extension activity**Learners who require more challenge research the different ways of describing the structure of the Earth based on composition (e.g. crust and mantle) and flow properties (e.g. lithosphere and asthenosphere). |  | There may be opportunities for cross- curricular links with geography.Misconception alert:A common misconception is that the Earth has a hard crust floating above a runny mantle. Although parts of the mantle flow (at a rate measured in centimetres per year) it is under very high pressure and so is extremely viscous. When it is seen at the surface (e.g. when a volcano erupts) it is more runny because it is no longer being compressed. |
| 7Ce17Ep47Eo1 | Observe and classify different types of rocks and soilsOutline plans to carry out investigations, considering the variables to control, change or observeMake careful observations including measurements | Classifying rocksElicit the idea that the rocks we can see are found in the Earth’s crust.Give learners different samples of rocks and ask them to sort them into groups.Discuss the approaches taken. Emphasise features about appearance (e.g. containing crystals or round grains) and hardness (e.g. whether they crumble).Learners use secondary sources to find the properties of igneous, sedimentary and metamorphic rocks and how each different type of rock is formed. They use these sources to:* relate properties of each type of rock to its formation
* classify the rock samples they have found.

Take learners on a geology walk around the school. Look at the rocks and stones present in buildings and in soil. Classify the rocks as igneous, sedimentary or metamorphic. If desired, samples of rocks and soils can be taken back to the classroom for further study.Learners plan and carry out an investigation into one property of the rock samples in more detail e.g. porosity, hardness, susceptibility to weathering. Following their investigation, they present their findings to the rest of the class.**Extension activity**The rock cycle can be introduced and related to the structure of the Earth. | Several different samples of rocks e.g. granite, sandstone, lava, chalk, limestone, marble.Reference books / internet about the formation and properties of igneous, sedimentary and metamorphic rocks. | If a drop of dilute hydrochloric acid (e.g. 0.4 mol dm-3) is dropped on carbonate minerals then it will fizz. This can be used to test for building materials such as limestones and sandstones. This can be used as a teacher demonstration. Vinegar can be used, but the surface of the stone may need to be scratched first. |
| 7Ce1 | Observe and classify different types of rocks and soils | Investigating soilsIntroductory the discussion asking learners: *What is soil and why is it important?* Introduce the term ‘pedosphere’.Learners work in groups. They look at a sample of soil in detail to identify its main constituents.Each learner should make a table and use it to record their observations and compare the types of soil (sandy, clay and loam).* Learners observe the three soil samples and discuss the differences in appearance.
* Learners add water to some of each soil sample and try to mould it into a ball. They discuss the differences between the samples *Do they feel sticky? Can you make a ball? Does the ball break easily?*
* Learners put a small amount of each soil sample into a small labelled jam jar with a lid; add water and shake, leaving the contents to settle until the following lesson.
* Distinct layers will form with pebbles and sand at the bottom, silt, clay, water discoloured by soluble organic material and floating organic material on the top.
* Learners measure the heights of the layers and calculate the percentage of each constituent. Results can be displayed as a pie chart.

Learners can investigate the characteristics of soil that is best for agriculture and how to improve the quality of soil (e.g. by adding organic matter). | Learners can be asked to bring in samples of soil before the lesson.Soil samples, paper to put samples on, hand lenses. If available, a microscope can be used to look at small soil organisms.Samples of sandy, clay and loam soils in small waterproof dishes, water.A simple key for classifying soils can be found at <http://www.soil-net.com/sm3objects/activities/Activity_TestingSoil.pdf> Jam jars with lids (three of the same size per group), water.[www.youtube.com/watch?v=VeuQeAxJIjs](https://www.youtube.com/watch?v=VeuQeAxJIjs) | This topic has cross-curricular links to agriculture. It can be helpful to liaise with teachers of this subject. Aim to make these links explicit to learners and encourage them to apply their learning in different subjects.Health and safety: Learners should wash their hands after handling soil samples. |
| 7Ce37Eo3 | Examine fossils and research the fossil recordUse information from secondary sources | FossilsAsk learners what they know about fossils. Find out whether any learners were very interested in dinosaurs (perhaps when they were younger). Explain that fossils are the 'remains' of organisms from thousands or millions of years ago, which are found in rocks.Show real-life examples / photographs of fossils.Show learners an animation on how fossils form.Provide learners with sources of information (printed or online material) and with a cartoon strip outline. Learners research and complete a cartoon strip to show the stages involved in forming a fossil. The storyboard should cover the different ways fossils can be formed.Show pictures of fossils that have been formed in different ways. Learners should write down how they think each fossil has been formed.Highlight that a specimen is deemed a fossil if it is older than 10,000 years.  | It can be helpful to liaise with teachers of these subjects. Aim to make these links explicit to learners and encourage them to apply their learning in different subjects.Presentation with photographs of fossils:[www.fossilsforkids.com/](http://www.fossilsforkids.com/)[www.sedgwickmuseum.org/index.php?page=wenlock](http://www.sedgwickmuseum.org/index.php?page=wenlock) Animated video of fossils and their formation can be found at:[www.youtube.com/watch?v=3rkGu0BItKM](http://www.youtube.com/watch?v=3rkGu0BItKM)An example of a storyboard task (with differentiation) can be found at:[www.tes.com/teaching-resource/differentiated-task-sedimentary-rock-fossils-6087801](https://www.tes.com/teaching-resource/differentiated-task-sedimentary-rock-fossils-6087801)[www.sedgwickmuseum.org/index.php?page=reconstructing-wenlock](http://www.sedgwickmuseum.org/index.php?page=reconstructing-wenlock)  | This topic has many cross-curricular links:* geography – sedimentary rocks
* within science – fossil fuels.
 |
| 7Ce37Ce47Eo3 | Examine fossils and research the fossil recordDiscuss the fossil record as a guide to estimating the age of the EarthUse information from secondary sources | The fossil recordAsk learners: *Why do we not have fossils of all species that have ever lived?* Use the answers to revise that most organisms die without the necessary conditions for fossilisation. In addition, many fossils that exist are inaccessible (under the sea, deep underground) and so have not been found. Provide learners with information about the ‘Hobbit people’ (*Homo floresiensis*). This information should include:* Remains of small humans were discovered in 2003 on the island of Flores in Indonesia.
* Scientists think *Homo floresiensis* is a possible human species, now extinct.
* Partial skeletons of nine individuals have been recovered, including one complete skull.
* At a depth that corresponds to about 38,000 years ago, a ‘hobbit’ tooth along with a mammoth tooth were also found as were stone tools and snake bones.
* Arm bones were found at a depth that corresponds to 76,000 years ago that suggested the ‘hobbit people’ were the height of a three-year-old child, weighed around 25 kg and had a brain smaller than most chimpanzees.
* At the same depth, palaeontologists found mammoth bones with cuts in them, burnt rodent skulls, fish bones and stone tools.

Learners should study this information and answer the following questions:* What sort of food might ‘hobbits’ have eaten? Why?
* How long did ‘hobbits’ live on the island of Flores?
* What tools did ‘hobbits’ use?
* What might have caused the extinction of ‘hobbits’?
* What did ‘hobbits’ use for shelter?
* What evidence is missing? Why?
* How certain are you of your explanations? Why?

Learners write a report about the fossil record and extinction using the ‘hobbit people’ as an example.The ages of fossilsShow learners a picture of a sedimentary cliff face. Ask: *Would you expect to find the oldest fossils at the top or at the bottom?* Use the answers to identify any misconceptions.Explain that layers of rock provide a timeline. The oldest fossils are found in the oldest layers. The youngest fossils are found in the newer layers. A simple explanation is that the oldest layers form first and then are covered by newer layers. This means that the deepest layers would be the oldest. However, rocks can move over time so that newer rock is found further down and older rock is found nearer the surface.For some types of fossils, it is known when the plants or animals were alive. If these fossils are found in a layer of rock, then it is possible to use this information to date this layer. This process is called ‘cross-dating’ or ‘biostratigraphy’.Provide learners with an outline of a cliff face with areas labelled ‘Triassic’, ‘Jurassic’, ‘Cretaceous’ periods. Learners research the type of fossil that might be found in each part of the cliff and draw example fossils on the cliff. **Extension activity**Learners who require more challenge could investigate the fossils that might be found in other eras, periods and epochs. | Information, pictures and a video can be found at:<http://humanorigins.si.edu/research/asian-research/hobbits>This worksheet could be adapted for use. It requires the word ‘dinosaur’ to be replaced with ‘mammoth’.[www.tes.com/teaching-resource/hobbit-dig-site-6108993](https://www.tes.com/teaching-resource/hobbit-dig-site-6108993)(free registration required).Picture of a sedimentary cliff face.A useful interactive guide can be found at: ‘Geologic Time’:[www.ucmp.berkeley.edu/education/explorations/tours/stories/middle/intro.html](http://www.ucmp.berkeley.edu/education/explorations/tours/stories/middle/intro.html)Outline of a cliff face on a worksheet to include Triassic, Jurassic, and Cretaceous periods.These are periods of the Mesozoic Era. |  |
| 7Ce57Eo3 | Learn about most recent estimates of the age of the EarthUse information from secondary sources | Recent estimates of the age of the EarthDiscuss that humans have only been around for a tiny fraction of the Earth's 4.6-billion-year history. *How do we know what the Earth was like in the past? How do we know how old it is?*Explain that, in groups, the learners will be given one of the ways that scientists can estimate the age of the Earth. They need to:* describe that type of dating
* describe the range of dates that it can be used to obtain
* describe how this method has helped scientists to estimate the age of the Earth.

Learners can be given a choice of methods to present their research, e.g. spoken talk, computer presentation, video, poster, drawing, drama, short role-play, 3D models, demonstration, poem, song.* Organise the class for the presentations. Groups of learners make a short presentation and answer questions relating to it.
* The learners who are listening to the presentations should make notes on the different methods of estimating the age of the Earth.
* At the end of each presentation, the audience can ask questions which relate to the presentation.
 | Earth’s timeline highlights can be found at:[www.bbc.co.uk/science/earth/earth\_timeline](http://www.bbc.co.uk/science/earth/earth_timeline)Possible sources of information include:* [www.ck12.org/earth-science/Radiometric-Dating/lesson/Radiometric-Dating/?referrer=concept\_details](http://www.ck12.org/earth-science/Radiometric-Dating/lesson/Radiometric-Dating/?referrer=concept_details)
* [www.bbc.co.uk/schools/gcsebitesize/science/add\_gateway\_pre\_2011/radiation/radioisotopesrev3.shtml](http://www.bbc.co.uk/schools/gcsebitesize/science/add_gateway_pre_2011/radiation/radioisotopesrev3.shtml)
* <http://science.howstuffworks.com/environmental/earth/geology/dinosaur-bone-age1.htm>
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Unit 7.6 Micro-organisms and disease

It is recommended that this unit takes approximately **35% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of health, the characteristics of living things and cells to develop their knowledge of:

* how some micro-organisms can be useful to humans but others are harmful
* the use of micro-organisms in food production
* how micro-organism activity can cause decay
* the work of Louis Pasteur and other scientists studying the human body.

Scientific Enquiry work focuses on:

* using information from secondary sources
* outlining plans to carry out investigations, considering the variables to control, change or observe
* identifying appropriate evidence to collect and suitable methods of collection
* making careful observations including measurements
* presenting conclusions using different methods.

Recommended vocabulary for this unit:

* micro-organism, bacteria, virus, fungi, yeast
* decay, decomposer
* pasteurisation, fermentation
* acid, base, neutral, pH
* disease, pathogen, symptom, treatment.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 7Bc27Bc1 | Know about the role of micro-organisms in the breakdown of organic matter, food production and disease, including the work of Louis PasteurIdentify the seven characteristics of living things and relate these to a wide range of organisms in the local and wider environment | Introducing micro-organismsDiscuss the idea that some living organisms are so small that we cannot usually see them unless we use a microscope. These ‘micro-organisms’ include bacteria, viruses and some single-celled fungi (multicellular fungi will be looked at later). *Where do they live and how might we identify they are present without a microscope?*Set up at least one demonstration that shows the presence of micro-organisms in the air and on skin:* Leave small items of food in the open air for 20 minutes and then place under a transparent cover and observe over several weeks to see what happens. This can be done as a learner activity or a teacher demonstration.
* Lightly press unwashed and washed fingers on sterile nutrient agar plates. Observe the colonies that grow after the plates have been kept in a warm place for a few days. This can be done as a learner activity or a teacher demonstration.
* Put flour and water in a clean jar to set up a sourdough starter. This can be done as a learner activity or a teacher demonstration.

Learners look at the results of these demonstration(s) in the next lesson activities and discuss their observations.Learners draw labelled pictures of a typical bacterium, a virus and a single-celled yeast (as an example of a fungi) making sure that the dimensions of each are included on the diagram. Discuss relative sizes.Learners create a comparison table for the three types of micro-organism.Provide learners with information sources (printed or online material). Learners identify which of the seven characteristics of life take place in bacteria, fungi and viruses.**Extension activity**Learners justify whether viruses should be considered as living or non-living. | Small items of food, transparent cover.Sterile nutrient agar plates.Flour, water, clean jar.[www.thekitchn.com/how-to-make-your-own-sourdough-starter-cooking-lessons-from-the-kitchn-47337](http://www.thekitchn.com/how-to-make-your-own-sourdough-starter-cooking-lessons-from-the-kitchn-47337) Information about different types of micro-organisms such as <http://www.childrensuniversity.manchester.ac.uk/learning-activities/science/microorganisms/what-and-where-are-micro-organisms/> Information sources for learners. | This unit is an opportunity to review the classification of living things.Health and safety: The food must be disposed of properly at the end of this demonstration.Health and safety: This activity should only be done if there are facilities available for the production of sterile media and the safe disposal of cultures by autoclaving.The sourdough starter can be observed in a later lesson. |
| 7Bc27Eo37Ec4 | Know about the role of micro-organisms in the breakdown of organic matter, food production and disease, including the work of Louis PasteurUse information from secondary sourcesPresent conclusions using different methods | Louis Pasteur and spontaneous generationDiscuss the idea that what we know about reproduction today has not always been known. *What happens to a piece of fruit if it is left uneaten or meat is left outside a refrigerator? What causes these changes? Where did the living things feeding on the food come from?* Introduce the idea of spontaneous generation. *What evidence could be collected to disprove this theory?*Set up a version of Louis Pasteur’s experiment (the one with broth and a swan-necked flask that allowed him to disprove spontaneous generation and win the Alhumbert Prize in 1862). This could be done as a learner activity or teacher demonstration, or a video could be shown.Learners write about how Louis Pasteur’s experiment was important in developing scientific ideas about reproduction of small organisms. This could be a formal essay or a creative writing exercise (for example writing a documentary script or Pasteur’s diary). | A video showing the formation of a swan-necked flask and the experiment: [www.bbc.co.uk/timelines/z9kj2hv](http://www.bbc.co.uk/timelines/z9kj2hv)[www.pasteurbrewing.com/the-life-and-work-of-louis-pasteur/experiments/louis-pasteurs-experiment-to-refute-spontaneous-generation/204.html](http://www.pasteurbrewing.com/the-life-and-work-of-louis-pasteur/experiments/louis-pasteurs-experiment-to-refute-spontaneous-generation/204.html) |  |
| 7Bc27Ep47Ep6 | Know about the role of micro-organisms in the breakdown of organic matter, food production and disease, including the work of Louis PasteurOutline plans to carry out investigations, considering the variables to control, change or observeIdentify appropriate evidence to collect and suitable methods of collection | Yeast and breadIf the sourdough starter was previously established, learners can observe it now. Ask learners to suggest why there are bubbles in the sourdough starter. Elicit the idea that these are carbon dioxide formed when the yeast respires. Ensure that learners are aware that yeast is a type of fungi.As part of the observation, learners compare its smell to the smell of fresh yeast or dried yeast that has been mixed with water. Explain that the sourdough starter also contains bacteria from the air.Learners look at yeast cells under the microscope. They draw diagrams of what they see.Groups of learners investigate the activity of yeast at different temperatures using different measurement methods. For example:* measuring the height of dough rising (e.g. in a measuring cylinder)
* measuring the height of froth
* measuring the volume of gas produced by collecting it in a balloon or measuring syringe.

Different groups of learners could try a different technique. They could then present their technique to the rest of the class.Alternatively, ask learners, working in groups, to imagine they were alive many centuries ago and they have been asked to design an experiment (using simple apparatus) to show that it is yeast that causes bread to rise and that this works best in warm conditions.Provide learners with information sources (printed or online material). Learners should investigate the ways in which yeast is useful (e.g. for the production of bread and in brewing). | Microscope, prepared slide of yeast cells.Resources for chosen activity, e.g. measuring cylinder, water, yeast, balloon.Information sources for learners. |  |
| 7Bc27Ep47Ep67Eo1 | Know about the role of micro-organisms in the breakdown of organic matter, food production and disease, including the work of Louis PasteurOutline plans to carry out investigations, considering the variables to control, change or observeIdentify appropriate evidence to collect and suitable methods of collectionMake careful observations including measurements | Yoghurt and cheeseAsk learners to describe the appearance of yoghurt and milk. They should also describe the difference in their tastes. (They should do this from prior experience; the foods do not need to be eaten in the classroom.) Learners should recognise the acidic taste of yoghurt.Learner activity, teacher demonstration or video. Milk and yoghurt are tested with pH paper to show the difference in acidity.Explain how bacteria are used to make yoghurt and that the bacteria work best in the right temperature.Learners set up an experiment to show that ‘live’ bacteria are used to make yoghurt and that the process needs to happen in a warm temperature. * The need for a starter culture of live yoghurt can be used to revise how Pasteur disproved the theory of spontaneous generation.
* Learners test and record the pH of their milk before adding the yoghurt starter.
* They test and record the pH after at least 24 hours.

Explain that cheese-making also involves the production of lactic acid which alters the milk but that the curds are separated from the whey. *What causes the differences in texture and taste of different cheeses?* Discuss the idea of different bacterial cultures used at the start of the process and the idea that fungi and bacteria are important for the ripening of some cheeses. | Milk, yoghurt, pH paper.[www.thekitchn.com/how-to-make-yogurt-at-home-cooking-lessons-from-the-kitchn-125070](http://www.thekitchn.com/how-to-make-yogurt-at-home-cooking-lessons-from-the-kitchn-125070)Milk, yoghurt starter, pan/pot, heat source, pH paper. | This is a good opportunity to revise learning on acids, bases and pH.Many other foods are also made using micro-organisms and can be used as the basis of investigations (e.g. fermented foods such as soy sauce, sauerkraut and kimchi). Health and safety:The yoghurt produced should not be eaten if there is any risk that it has been contaminated (e.g. by pH paper or by being produced in a laboratory). |
| 7Bc27Ep47Ep67Eo1 | Know about the role of micro-organisms in the breakdown of organic matter, food production and disease, including the work of Louis PasteurOutline plans to carry out investigations, considering the variables to control, change or observeIdentify appropriate evidence to collect and suitable methods of collectionMake careful observations including measurements | Food spoilage, micro-organisms and pasteurisationMicro-organisms can be helpful: recall how yeast and bacteria can be useful when making foods.*Why does fresh food not last forever?* Discuss the idea that many kinds of bacteria and fungi can live on food. Some of these produce chemicals which ruin the taste and texture and sometimes cause food poisoning. Discuss hygienic handling of food.*How can food be kept for longer?* Recall the seven characteristics of living things and that bacteria and fungi are living. Brainstorm ideas about what foods in the kitchen keep for longest (e.g. dried foods, canned foods, pickles, jams). Ask learners to explain why these foods last a long time.Learners produce illustrated notes to show the different types of preservation and why they work.Learner activity or teacher activity. Set up an experiment to compare what happens to powdered milk, pasteurised milk and UHT milk when left at room temperature for several days.* The colour, texture, smell and acidity of each should be recorded at the start. Explain that these are all forms of treated milk because raw milk contains bacteria.
* Learners observe the results of the milk experiment.
* Learners write about the experiment and record any changes in colour, texture, smell and acidity in a suitable table of results.
* Discuss the results, noticing that UHT and powdered milk keep better. Ask learners to suggest: *Why is most milk sold as pasteurised milk? Why is it called pasteurised milk? Who do they think the technique is named after?*

Discuss Louis Pasteur’s work on pasteurisation and why it is important to heat milk to an exact temperature. *How do you think Pasteur managed to find this temperature?*Learners plan how they would find the best temperature for pasteurising milk. They should decide on their independent, dependent and control variables and write a method for the investigation.Watch a video on Pasteur’s work on pasteurisation. | Powdered milk, pasteurised milk, UHT milk, pH paper.This is a planning exercise. It is not expected that learners will perform the investigation.Possible video:[www.youtube.com/watch?v=0OmWbRKW4K8](https://www.youtube.com/watch?v=0OmWbRKW4K8) | Health and safety: Learners must not taste the milk. |
| 7Bc2 | Know about the role of micro-organisms in the breakdown of organic matter, food production and disease, including the work of Louis Pasteur | Decay*What would happen if you left a plate of food on the table for months?* Discuss the idea that because bacteria and fungi are feeding on the food they will eventually break it down. They are decomposers and cause decay. It may be inconvenient for humans that bacteria and fungi cause food to decay but imagine what would happen in the world outside if there was no decay.Learners observe time-lapse videos showing food breaking down and bacteria and fungi decomposing leaf litter or animal waste.Provide learners with information sources on leaf mould and compost (printed or online material). Learners need to find the answer to the questions:* How are leaf mould and compost used?
* How are leaf mould and compost made by gardeners?
* How is compost made on a large scale?
 | A time-lapse video of food rotting:<https://youtu.be/c0En-_BVbGc> Information sources for learners on leaf mould and compost.Learners could find out about local composting facilities. |  |
| 7Bc27Bh3 | Know about the role of micro-organisms in the breakdown of organic matter, food production and disease, including the work of Louis PasteurResearch the work of scientists studying the human body | Disease-causing micro-organismsAsk learners to brainstorm diseases that are caused by micro-organisms. It is likely that most will contribute human diseases. Ask if any learners know of plant or animal diseases.Discuss the different ways in which micro-organisms can get into our bodies to cause disease and the ways of preventing their entry. Learners summarise the information by drawing a diagram of a human and labelling it to show entry routes and preventative strategies.Discuss the meaning of the words: disease, pathogen, symptom and treatment.Present a short introduction to an infectious disease (e.g. the common cold, smallpox, rabies). Ideally the talk should be illustrated and contain an interesting mix of facts, some scientific, some historical and some general, that will model what can be included in a presentation.* Learners work in small groups to produce a poster or presentation about a particular disease. Provide learners with information sources (printed or online material).
* They should design the poster or presentation to provide useful and interesting information about the disease. Each member of the group should take on a different responsibility for the work so that all members are included when the work is presented to the rest of the class.
* Learners make their presentations.
* Learners listening to the presentation can make notes on each disease (for example: the name, type of micro-organism, transmission, symptoms etc.).
* At the end of each presentation, the learners who have been listening ask questions. They can also provide constructive feedback on what they found interesting and helpful and where they would like more information.
* Use a quick quiz to test the recall of the learners who have been listening to the presentations. This could be a short quiz answered individually on pieces of paper or mini-whiteboards.

Learners research the range of jobs available for scientists working in health care. | Assign diseases so there are a range caused by viruses (e.g. measles, Ebola, HIV), bacteria (e.g. cholera, anthrax, food poisoning such as from *Bacillus cereus*) and fungi (e.g. ringworm, athlete’s foot).During the presentations, produce a quick quiz for learners. There should be about two questions from each presentation.This could be combined with a visit from a speaker who works in medical science, a visit to a research lab or other input on possible scientific careers. | You may want to choose diseases that are particular public health concerns in your area. |

Unit 7.7 Putting things into groups

It is recommended that this unit takes approximately **25% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of grouping together materials and living things with similar properties and characteristics to develop their knowledge of:

* metals and non-metals
* everyday materials and their physical properties.

Scientific enquiry work focuses on:

* making predictions and reviewing them against evidence
* suggesting ideas that may be tested
* outlining plans to carry out investigations, considering the variables to control, change or observe
* identifying appropriate evidence to collect and suitable methods of collection
* choosing appropriate apparatus and using it correctly
* making careful observations including measurements
* presenting results in the form of tables, bar charts and line graphs
* using information from secondary sources
* recognising results and observations that do not fit into a pattern, including those presented in a graph, chart or spreadsheet.

Recommended vocabulary for this unit:

* material, property, object
* natural, man-made, hard, malleable, flexible, rigid, rough, smooth, absorbent, waterproof, transparent, opaque, conductor, insulator, magnetic, non-magnetic, brittle, high/low density, ductile, sonorous, strength
* metal, non-metal, Periodic Table
* melting point, boiling point.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 7Cp27Ep37Ep47Ep67Ep77Eo17Eo27Ec2 | Describe everyday materials and their physical propertiesSuggest ideas that may be testedOutline plans to carry out investigations, considering the variables to control, change or observeIdentify appropriate evidence to collect and suitable methods of collectionChoose appropriate apparatus and use it correctlyMake careful observations including measurements.Present results in the form of tables, bar charts and line graphs.Recognise results and observations that do not fit into a pattern, including those presented in a graph, chart or spreadsheet. | Everyday materials and their propertiesGive learners a picture of a room in a house with different objects. Learners name as many objects as possible and state the material they are made of, the property this material has and why it is suitable for this use (e.g. a table / made of wood / hard and durable / used to support things).Alternatively, show a video and ask learners to list as many objects as they can see, giving the materials, uses and properties on which these uses are based.Learners sort the objects in the picture or the video into different groups. *What property will you use to sort the* ***objects****?* (e.g. *Material? Use?*)*How could you sort different* ***materials****?* Discuss different approaches and give learners the opportunity to sort materials by different criteria, e.g.: * hard or malleable
* flexible or rigid
* rough or smooth
* absorbent or waterproof
* transparent or opaque
* conductor or insulator (of heat or electricity)
* magnetic or non-magnetic.

**Scientific enquiry activity**For **properties** that can be measured (e.g. strength, absorbency, transparency) learners plan and conduct an investigation. For example, they could discover which thread is stronger – a cotton thread or a polyester thread. * Learners, in pairs, plan an investigation on one of the properties.
* They should decide on their independent, dependent and control variables and write a method for the investigation.
* As part of their plans, learners should conduct a simple risk assessment and decide the precautionary measures that they will take.
* Learners peer assess their methods with a different group. There are several ways that this investigation could be completed. Learners should give each other feedback on whether the method is clear:
	+ What is the independent variable?
	+ How will the independent variable be changed?
	+ What is the dependent variable?
	+ How will the dependent variable be measured?
	+ What are the control variables?
	+ How will these variables be controlled?
	+ What are the precautionary measures?
* Learners collect and interpret their results. They compare their results with their predictions and with the results from others in the class. Ask if any learners have anomalous results (results that do not fit the pattern).

Ask learners if they would build a house made of straw. Discuss the suggestions, focusing on ideas connected with the properties of straw. Show an example of modern houses being built with straw. Discuss how the quantity and application of a material can allow a material to be used in innovative ways. **Extension activity:** If suitable apparatus is available then learners can investigate the properties of glass including transparency, melting and solidifying, forming into narrow tubes etc. Look at sources describing glass blowing. Discuss how glass is generally unreactive – doesn’t change when in contact with other substances – so is used a lot in chemistry.  | Picture of a room, e.g. kitchen (either projected on a screen or printed out for each learner/ small group of learners).[www.bbc.co.uk/education/clips/ztjc87h](http://www.bbc.co.uk/education/clips/ztjc87h)[www.bbc.co.uk/education/clips/zqcfb9q](http://www.bbc.co.uk/education/clips/zqcfb9q)Pictures or examples of a range of materials (e.g. stick, dried pasta, plastic ruler, pebble, packing foam).Ways to test the properties of materials (e.g. magnets, simple electrical circuit, beaker of hot water).Video showing straw house [www.bbc.co.uk/news/science-environment-31156579](http://www.bbc.co.uk/news/science-environment-31156579)Information on glass blowing.Heat source (e.g. Bunsen burner), glass capillary tubes, safety goggles. | It is important that learners can distinguish between objects, materials and properties.Aim to achieve a common understanding of the words used to describe properties e.g. transparent, opaque brittle, malleable etc.Misconception alert: Some learners may suggest grouping materials by state e.g. solid, liquid and gas. This would only work when the temperature is fixed, as most materials will change state as temperature changes. E.g. water can exist in all three states at temperatures available in the classroom. Health and safety:Safety goggles must be worn if forces are applied to brittle materials.If learners follow their own method then it must be checked by the teacher in advance.Health and safety:Safety goggles must be worn. |
| 7Cp17Cp27Ep27Eo17Eo27Eo37Ec2 | Distinguish between metals and non-metalsDescribe everyday materials and their physical propertiesMake predictions and review them against evidenceMake careful observations including measurementsPresent results in the form of tables, bar charts and line graphsUse information from secondary sourcesRecognise results and observations that do not fit into a pattern, including those presented in a graph, chart or spreadsheet | Metals and non-metals in the Periodic TableShow learners spoons made out of different materials (e.g. wood, metal and plastic). *When might you use each spoon? What property makes it suitable for this use?*Learners investigate properties of a metal spoon and a plastic spoon (bendiness, flexibility, strength etc.) and present their findings in a table.*What are the differences between metals and non-metals? What are the properties of metals?* Compare properties of metals and non-metals.*Can you name some metals? Non-metals?* *Can you find them in the Periodic Table?**What do you notice about the position of metals and non-metals in the Periodic Table?* Discuss the relative position of metals and non-metals in the Periodic Table.**Extension activity**Show learners names and symbols of less-known metals (e.g. tungsten, molybdenum) and non-metals (e.g. selenium, arsenic). Ask them to predict whether each is a metal or a non-metal based on its position in the Periodic Table.*How else could you tell if a material is a metal or non-metal?* Revise that metals and non-metals will have different properties.* Learners test a variety of properties of metals and non-metals. For each test they should make a prediction.
	+ Hardness can be determined by taking two materials and identifying which one can scratch the other.
	+ A density scale can be made by finding the masses of samples of the same size.
	+ Flexibility can be investigated by trying to bend strips of metals and non-metals.
	+ Melting points from a database can be plotted as a bar chart to compare metals and non-metals.
* Learners compare their results with their predictions. They write a short summary of the different properties of metals and non-metals.

Show pictures of bromine and mercury. *Is bromine/mercury a metal or non-metal? How can you tell?* Learners may use position in the Periodic Table or shininess of mercury to classify it as a metal. Discuss that mercury is the only metal that is liquid at room temperature.*Can you name any other metals that do not share the general properties of metals?*Provide learners with information sources (printed or online material). Learners research metals with unusual properties. They need to make a table that includes the following points:* Describe the colour of most metals. In what way are gold and copper unusual?
* Describe the hardness of most metals. In what way are lithium, sodium and potassium unusual?
* Do most metals sink or float when put on water? In what way are lithium, sodium and potassium unusual?
* Describe the magnetic properties of most metals. In what way are iron, nickel and cobalt unusual?
 | Spoons made of different materials, e.g. wood, plastic, metal.Periodic Table of elements.The Periodic Table app from the Royal Society of Chemistry might be useful and is available free for both Android and iOS: ([www.rsc.org/periodic-table](http://www.rsc.org/periodic-table))Samples of metals (e.g. drawing pins, paperclips) and non-metals (e.g. wood, graphite).Similarly-sized cubes or balls made of different materials.Note: learners will study density in more detail in Stage 9.Samples/strips of different metals and non-metals.Secondary sources (melting point data-base: e.g. [www.bbc.co.uk/schools/gcsebitesize/science/add\_ocr\_pre\_2011/chemicals/metalpropertiesrev1.shtml](http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/chemicals/metalpropertiesrev1.shtml)Pictures of bromine and mercury,Periodic Table.Access to the internet or data books/printouts.  | Learners are expected to identify the properties of metals and non-metals. Although the Periodic Table is used, learners do not need to understand the concept of elements at this stage. Health and safety:Mercury is highly toxic and shouldn’t be handled by learners.  |

Unit 7.8 Habitats and environment

It is recommended that this unit takes approximately **40% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of sorting living things into groups and the characteristics of living things to develop their knowledge of:

* where organisms live
* how organisms interact with each other and the environment
* the influences humans have on the natural environment
* variation within a species.

Scientific enquiry work focuses on:

* presenting conclusions using different methods
* using information from secondary sources
* presenting results in the form of tables, bar charts and line graphs
* identifying appropriate evidence to collect and suitable methods of collection
* making careful observations including measurements.

Recommended vocabulary for this unit:

* ecosystem, environment, habitat, biotic factor, abiotic factor
* food chain, draw a food chain, energy flow, producer, consumer, decomposer, predator, prey, herbivore, omnivore, carnivore, detritivore
* adaptation, variation, continuous variation, discontinuous variation
* ozone depletion, greenhouse effect, climate change, combustion, pollution, smog, renewable, non-renewable
* fertilisers, eutrophication, pesticides.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 7Be1 | Describe how organisms are adapted to their habitat, drawing on locally occurring examples. Secondary sources can be used | An introduction to our environmentAsk learners to make a mind map on the topic of the environment. Identify whether learners have included examples of biotic and abiotic factors.Introduce the idea that an ecosystem is made up of biotic and abiotic components. Learners start to create a glossary of the scientific terms used in this unit. More words can be added to the glossary in later lessons.Ask learners, working in groups, to list as many abiotic factors as they can.Take feedback and use it to make a class list of abiotic factors. Discuss why each abiotic factor is important to living things.Show learners an introductory video to abiotic factors.Learners write about the abiotic factors including water availability, light intensity, temperature, acidity, humidity, soil structure, altitude and pollution. | A simple introductory video:[www.youtube.com/watch?v=E1pp\_7-yTN4](https://www.youtube.com/watch?v=E1pp_7-yTN4) | This is a good opportunity to identify what learners can remember from their study of caring for the environment in Stage 6.This is an opportunity to revise soils. |
| 7Be1 | Describe how organisms are adapted to their habitat, drawing on locally occurring examples. Secondary sources can be used | Adaptations to the abiotic and biotic environment Ask learners: *Why don’t you find fish in a desert? Why don’t you find oak trees in a desert? What does live in a desert? Why do these organisms survive?* Discuss learners’ ideas.Choose a desert animal, e.g. a camel. Ask learners to recall the abiotic factors of the ecosystem. Then have them describe all the features of the organism that make it well adapted to its habitat.Choose a desert plant e.g. a cactus and show learners a picture, asking them to comment on ways in which it is different from an oak tree. Ask them how these features help it to survive in the desert ecosystem.Learners pick a name of a plant or animal at random from a selection provided by the teacher. Learners form groups by finding the other learners who have a plant/animal that would live in the same ecosystem.Provide sources of information for the groups and explain that each group needs to describe:* the abiotic factors in the ecosystem
* the biotic factors in the environment including examples of plants, animals, predators and prey
* any positive or negative influences that humans are having on the ecosystem.

Learners present their work in any format, e.g. a wall display, electronic presentation, a talk with pictures or an amusing poem/song. Learners should use their creativity. | Camel adaption song. This is an amusing song:[www.youtube.com/watch?v=YpGg-m8wyY4](https://www.youtube.com/watch?v=YpGg-m8wyY4)Picture of a cactus.Names of plants and animals from different ecosystems. The number of ecosystems should match the number of groups of learners and can include for example: ocean, soil, woodland, rainforest, polar regions, mountains. For each ecosystem include at least:* one predator organism
* its prey
* a plant that is a food source for the prey (in preparation for the lesson on food chains).

Information sources for learners. |  |
| 7Bv27Ec4 | Investigate variation within a species. Secondary sources can be usedPresent conclusions using different methods | Types of variationExplain that adaptations are ways that we describe differences between species. However, there are also differences within species.Learners write down some variations that they can find in dogs (fur colour etc.). They list as many different breeds of dog that they can think of.Alternatively use a think, pair, share activity. Show learners pictures of a famous family (perhaps local celebrities). In pairs, give them one minute to discuss why they look alike, but not exactly the same.Explain to learners that physical features are inherited from both parents in species that use sexual reproduction to reproduce, and that leads to variation within a species. Think, pair, share: Give learners one minute to discuss with the person next to them what physical differences they have that they can measure. Compile a list on the board. Include arm span, hand span, eye colour, head circumference, foot length.Explain the difference between continuous and discontinuous variation. Identify some examples in the class (e.g. foot length and shoe size).Learners move round the class looking at images showing different types of variation. For each image learners have to decide:* Does it show continuous or discontinuous variation?
* Is the variation inherited, caused by someone’s environment or a combination of both?

**Scientific Enquiry activity**Learners, working in groups of three, investigate variation in the class. * Make sure that at least two groups investigate an example of discontinuous variation (e.g. eye colour or shoe size).
* Give learners 15 minutes to measure features of fellow learners.
* Learners present their results as a graph. Before learners draw the graphs explain that line graphs are used for continuous variation and bar charts are used for discontinuous variation.
* Learners who require more support can be given a graph with the axes pre-drawn. Good examples of learners’ work can be shown to the class as a model.
* Learners can peer review each other’s graphs and comment on:
	+ Has the correct type of graph been chosen?
	+ Are axes correctly labelled?
	+ Is there an even scale?
	+ Have the data been correctly plotted?
	+ Does the graph use most of the graph paper?

Give learners a set of cards showing different characteristics. * Learners, working in pairs, decide how much of the variation in each characteristic is due to inherited variation and how much is due to the environment.
* Learners put their cards on a continuum line. Allow six to eight minutes to sort all the cards. Learners should be ready to explain their reasons for sorting the cards.
* Learners produce a Venn diagram showing examples of variation that are inherited, environmental or a combination of both.
 | Pictures of a famous family.Images showing variation in, for example: eye colour, natural hair colour, blood type, hand span, height, weight, foot length, resting pulse, tongue rolling.Worksheets to help learners organise their data collection may be useful.Per group: tape measure or meter rule as required.Graph paper.Cards with characteristics that are inherited (e.g. blood group), due to the environment (e.g. scars) or a combination of both (e.g. weight, height). |  |
| 7Be27Eo37Eo27Pe17Pe2 | Draw and model simple food chainsUse information from secondary sourcesPresent results in the form of tables, bar charts and line graphsUnderstand that energy cannot be created or destroyed and that energy is always conservedRecognise different energy types and energy transfers. | Food chainsIntroductory whole class discussion. Feeding relationships are one form of biotic interaction that can be represented as a food chain. Recall knowledge from Stage 6 about the terms ‘herbivore’, ‘carnivore’, ‘omnivore’, ‘consumer’ and ‘producer’ and the term ‘decomposer’.**Extension activity:** Introduce the term ‘detritivore’. Provide learners with examples of detritivores and decomposers. Recall how a food chain is drawn. Identify the arrows as showing the direction of energy flow through the food chain.Learners work in the same groups as in the previous ecosystem activity. They should produce a set of cards for their ecosystem. Each card should have written on it one of the following things: * name of a living organism and what it eats
* consumer, producer or decomposer
* herbivore, carnivore, omnivore (or detritivore)
* an arrow.

These cards should be designed so that they can make several complete food chains.Learners shuffle the cards and pass to another group. This group sorts them to create food chains for the ecosystem. These cards should be retained for the next lesson.**Extension activity**Learners who require more challenge can create food webs. They can predict what would happen if abiotic or biotic factors changed so that the numbers of one organism declined dramatically. It is useful to emphasise that food chains model energy flow. Discuss the idea that in a food chain/web matter (particles) is passing from one living thing to another. *What is happening to energy? What is the unit of energy?*Ask learners to draw the longest food chain they know. *Why aren’t food chains very long?*Show learners a simple food chain with the sun drawn at the beginning and figures showing the percentage of energy that is transferred from one part of the chain to the next. *Energy cannot be created or destroyed, so what happens to the stored chemical energy?* Recall information about energy transfers related to the processes of living. *What happens if you try to extend the food chain?*Humans are omnivores. Learners think about and answer the question: *If we want to feed an increasing world population with limited land, how might our diet need to change? Why would this change be necessary?* | White or coloured card (cut up into roughly playing card-sized pieces) and coloured pens.Simple food chain. | It can be helpful to make it explicit to learners that this is another way of classifying organisms – by their functions in an ecosystem rather than how similar their anatomy is to each other.The idea of energy flow in a food chain was introduced in Stage 6.The phrase ‘drawing a food chain’ confuses many learners. Make it clear that they do not need to draw pictures of the plants and animals in the food chain. |
| 7Be17Ep67Eo1 | Describe how organisms are adapted to their habitat, drawing on locally occurring examples. Secondary sources can be usedIdentify appropriate evidence to collect and suitable methods of collectionMake careful observations including measurements | Investigating the school environmentGroups of learners study and describe/draw a local small habitat such as a hedge, a tree, a pond. They:* describe the abiotic factors
* identify as many living things as possible
* classify them as plants, fungi, vertebrates, invertebrates
* classify them as producers, consumers, predators, prey.

For one of the local species found, learners identify its adaptations (structural and behavioural).  | Quadrats, pooters, pit-fall traps, trowel, magnifying lens (as available).Examples of adaptations will depend on the species chosen, but for any given adaptation learners should be able to suggest how it helps an organism to survive and reproduce.For plants this may include adaptations of roots, leaves, flowers. For animals this could include adaptations in skin colour, eye position, hearing etc.Behavioural adaptations include being active in day or night, migration, hibernation and communication with others in the species (e.g. bird song, bee waggle dance). | This is an opportunity to revise soils, classification, adaptations and food chains. |
| 7Be37Be4 | Discuss positive and negative influence of humans on the environment, e.g. the effect on food chains, pollution and ozone depletionDiscuss a range of energy sources and distinguish between renewable and non-renewable resources. Secondary sources can be used | Identify what learners can remember from previous study of human influences on the environment (e.g. in Stage 6) and renewable and non-renewable sources of electricity. For example, learners could create a mind map of their existing knowledge which they update throughout this topic.How humans pollute airIntroductory discussion about air pollution. *How do humans pollute the atmosphere?* Show learners some pictures e.g. eroded statues, smog in cities, dead tree tops etc. to stimulate discussion.Schools in cities can test for airborn particles by leaving a white tissue on the outside of a building for a few days and comparing with a clean one.A waxy or oily fuel can be burned and the fumes collected on cotton wool or similar.Give learners, working in groups, sets of ‘match’ cards where they have to match sources of air pollutants, names of the pollutants and effects of the pollutants. Pollutants should include: sulfur dioxide, oxides of nitrogen, particulates and chlorofluorocarbons (CFCs). Each group of learners then produces a short presentation to describe and explain their type of pollution.Learners complete a table showing names of pollutants, sources and effects.Teacher demonstration or video. Burn some fossil fuel and demonstrate that stored chemical energy is transferred to other forms of energy and that carbon dioxide and water particles are produced. *How does combustion compare with respiration?*Provide data on global carbon dioxide levels over time. Learners draw graphs from data to show that carbon dioxide levels have been rising.Show learners a graph of average global temperatures over the same period. Discuss the correlation. Discuss the theory that increasing carbon dioxide in the atmosphere is causing global temperatures to rise and the climate to change. Show learners a video about the possible ways our climate can change.In groups, learners think about and predict the possible environmental, economic and social impacts of changes to the climate.Learners can research the commitments made by different countries at the United Nations conference on climate change in Paris 2015.Revise the difference between renewable and non-renewable sources of electricity. | Pictures showing air pollution.White tissue paper.Waxy/oily fuel /candle, cotton wool /white paper. This should be a demonstration as the fumes can be unpleasant. Match cards showing names of pollutants, sources and effects of pollutants. Include human sources of pollution and natural activities (including volcanoes).Coal, oil or gas.An example of how to do this demonstration and the resources required is shown here:[www.youtube.com/watch?v=FfFs4q6PSaU](https://www.youtube.com/watch?v=FfFs4q6PSaU)Data of carbon dioxide levels:<https://www.esrl.noaa.gov/gmd/ccgg/trends/data.html> Graph paper.The first half of the video (in English) shows the climate changes. The second half can be shown after learners have discussed potential impacts.<http://video.nationalgeographic.com/video/way-forward-climate><http://unfccc.int/paris_agreement/items/9485.php>  | This topic has cross-curricular links to geography and Global Perspectives.It can be helpful to liaise with teachers of these subjects. Aim to make these links explicit to the learners and encourage them to apply their learning in different subjects.Health and safety: Precautions should be taken as appropriate and a fume hood used if necessary.The effects of CFCs should include ozone depletion. |
| 7Be3 | Discuss positive and negative influence of humans on the environment, e.g. the effect on food chains, pollution and ozone depletion | Farming and pollutionStarter activity. Hold up two identical fruits (e.g. apples) and ask learners *Which of these is produced by organic farming?* Discuss the meaning of organic and non-organic farming. Discuss the advantages and disadvantages of both conventional and organic farming.Discuss how farming changes food chains.Explain how fertilisers can pollute water. Learners produce an illustrated description to help them remember the stages in the process.Learners watch a video of the process of eutrophication.Explain that pesticides do not break down; they accumulate in living tissues. Ask learners to predict which organisms will be the worst affected in a food chain and why. | Two identical fruits.<https://youtu.be/L2ImgVwv5qM> | Learners frequently have misconceptions about organic farming including: no fertilisers or pesticides are used, the food is always more nutritious, the food does not need to be washed. |

Unit 7.9 Forces and their effects

It is recommended that this unit takes approximately **35% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of pushes and pulls to develop their knowledge of:

* the effects of forces on movement, including friction and air resistance
* the effects of gravity on objects.

Scientific enquiry work focuses on:

* making predictions and reviewing them against evidence
* being able to talk about the importance of questions, evidence and explanations
* suggesting ideas that may be tested
* outlining plans to carry out investigations, considering the variables to control, change or observe
* making predictions referring to previous scientific knowledge and understanding
* identifying appropriate evidence to collect and suitable methods of collection
* choosing appropriate apparatus and using it correctly
* making careful observations including measurements
* making conclusions from collected data, including those presented in a graph, chart or spreadsheet
* considering explanations for predictions using scientific knowledge and understanding and communicating these
* presenting conclusions using different methods.

Recommended vocabulary for this unit:

* force, balanced, unbalanced, resultant force, motion, acceleration, deceleration, constant speed, terminal velocity
* friction, oppose, air resistance, lubrication
* gravity, mass, weight.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 7Pf17Ep2 | Describe the effects of forces on motion, including friction and air resistanceMake predictions and review them against evidence | What do forces do?Use an activity to find out the learners’ existing knowledge and understanding of forces and motion. For example, each learner could make a mind map. These can be kept and developed further during the unit.Show a video clip of table tennis (for example). Learners watch the video and write down examples of forces.Discuss their ideas. *Can we see forces?* Suggest a better question may be ‘*Can we see the effects of forces?*’Explain that we cannot see forces – but we can see their effects.Demonstrate forces using a ball (such as a football):* ask individual learners to demonstrate actions such as: dropping a ball, kicking a ball, squeezing a ball, catching a ball, heading a ball, bouncing a ball
* for each demonstration discuss the effects of the force.

Identify that forces can **change the motion** of something: * start things moving
* stop things moving
* change the speed or direction

or they can **change the shape** of something.Groups of learners select five sports. For each sport they should identify examples of the four effects of forces. Discuss the responses from different groups.Discuss the meaning of ‘start moving’, ‘stop moving’, ‘change speed’ or ‘change direction’. Elicit the link between ‘start moving’, ‘stop moving’ and ‘changing speed’ and acceleration/deceleration.Show these situations to the class and ask them to use scientific thinking to predict what will happen.*How would these* ***identical*** *masses accelerate?* 2 N 4 N 8 N1kg1kg1kg*How would these* ***different*** *masses accelerate?*9 kg3 kg 2 N 2 N 2 N1 kg**Scientific Enquiry activity**Learners try to test their predictions by using a forcemeter to pull a small and large object with the same force. They should identify that the small object starts moving easier and gets faster quicker. | Example of table tennis: <https://youtu.be/NodCOX6NwO0>Ball (e.g. tennis ball, football, sponge ball, softball).Learners can select their own sports or provide a wide range: netball, wrestling, swimming, bungee jumping, parachuting, cycling, basketball, volleyball, tennis, bobsleighing, wind surfing, skiing, football, fencing, etc.Large and small objects, forcemeters. | Learners were introduced to the terms ‘balanced forces’ and ‘unbalanced forces’ in Stage 6. |
| 7Pf1 | Describe the effects of forces on motion, including friction and air resistance | Friction opposes motionExplain the term ‘resultant’ force. (An object may have several different forces acting on it, which can have different strengths and directions, but they can be added together to give the resultant force. This is a single force that has the same effect on the object as all the individual forces acting together.)Discuss that an object travelling at steady speed has no resultant force acting on it. Many learners will be surprised by this result.Ask learners to think about the movement of a bicycle or skateboard on a flat road. *What makes it stop? Why does a bicycle stop if the rider doesn’t use the brakes?* Elicit the idea that it is friction and air resistance that is causing the bicycle/skateboard to slow down. This causes an unbalanced force.Ask learners to draw a picture of what they think a smooth surface looks like close up. Discuss that even smooth surfaces have rough surfaces if you look at them through a microscope.Learners discuss situations where friction is useful (such as on wheel treads or sports shoes). They compare this to situations where friction is not useful. *Why do cars need oil? Why do skiers polish their skis?* Ensure learners know the term ‘lubrication’.Pairs of learners discuss what it feels like when they move quickly (e.g. run, on a bicycle, on a roller-coaster). Elicit the idea that they can feel ‘wind on their face’ even if it is not a windy day. Discuss that this is due to them hitting air particles and this causes air resistance.Learners draw a cartoon showing situations where friction forces, including air resistance, occur. These should include examples where friction is useful and where friction is not useful. |  | Note: this lesson is a further opportunity to revise the concepts of balanced and unbalanced forces from Stage 6. |
| 7Pf2 | Describe the effect of gravity on objects. Secondary sources can be used | GravityShow a video clip of an astronaut on the moon. Learners in pairs compare this movement on the moon to that on Earth. *Can you explain these differences?* Take feedback and discuss the explanations. Some learners may have the misconception that there is no gravity on the moon. Be prepared to challenge these misconceptions with questioning. *What do you think that gravity is?*Explain that all masses have a gravitational field around them. Any other masses in the field will experience the force of gravity (measured in newtons, N). This force is called weight and pulls the objects together. Bigger masses have a bigger gravitational field. The Earth is a big mass so its gravitational field strength is large. The moon is smaller than the Earth so it has a smaller gravitational field strength.Introduce the equation: Weight (N) = mass (kg) x gravitational field strength (N/kg)Provide problems so that learners can calculate the weight of objects and people on the Earth, moon and different planets.Learners use their answers to explain the astronaut’s movement on the moon. They can predict what a bunny-hop would look like on other planets.Create a set of tins or tennis balls that have their masses manipulated to represent their weight on different planets and the moon. Allow learners to hold the objects to experience their different weights. | <https://youtu.be/HKdwcLytloU>Problems for learners to solve.The gravitational field strength of Earth can be taken as 10 N/kg.Tins or tennis balls.The required masses can be calculated using an online weight calculator:[www.seasky.org/solar-system/planet-weight-calculator.html](http://www.seasky.org/solar-system/planet-weight-calculator.html) | This is a good opportunity to revise the difference between weight and gravity from Stage 6. |
| 7Pf17Pf2 | Describe the effects of forces on motion, including friction and air resistanceDescribe the effect of gravity on objects. Secondary sources can be used | Falling objectsShow this situation to the class and ask them, in pairs, to use scientific thinking to predict what will happen. *Which would hit the ground first? Can you explain your answer?* Take feedback from the class and identify predictions.Demonstrate the scenario with a heavy and light object (e.g. a book and a piece of paper). This can be done out of a high window or down a stairwell. The demonstration can be videoed for analysis.Repeat the demonstration with the paper scrunched into a ball.Alternatively, use two objects with the same dimensions (e.g. two tennis balls, one of which has been filled with coins and resealed).Discuss the results. Identify that if air resistance is a major factor then the objects fall at different rates. However, if air resistance is the same for both objects (i.e. they are the same size), then they fall at the same rate.Ask *Which will fall quicker – a feather or a hammer?* Show the experiment being done on the moon. Discuss why it was important to do this experiment on the moon.**Extension activity**Learners find out about Galileo’s legendary experiment at the Tower of Pisa. | Heavy and light objects that can be dropped, newton meters, video camera (if available), paper.Two tennis balls (one filled with coins and resealed securely with tape).Dropping a hammer and a feather on the Moon.<https://youtu.be/KDp1tiUsZw8>  | Learners may have seen several of these demonstrations in Stage 6. Use a selection of these activities to identify what they can remember and to prepare for investigations into air resistance.Health and safety:Care must be taken when dropping objects from a height. |
| 7Pf17Pf27Ec1 | Describe the effects of forces on motion, including friction and air resistanceDescribe the effect of gravity on objects. Secondary sources can be usedMake conclusions from collected data, including those presented in a graph, chart or spreadsheet | Investigating air resistanceWatch a video clip showing what happens when a bowling ball and a feather are dropped in a vacuum. *Why did this need to be in a vacuum? What would have happened if air particles where present?*Remind learners of force diagrams from Stage 6. Explain the conventions of force diagrams (tail of arrow placed where force acts; length of arrow represents size of force).Help learners to draw force diagrams for the objects falling in a vacuum and in air.Drop a paper cake case from a height of about 2 m. It should fall slowly through the air. Ask the learners to describe and explain its movement. *How could you make it fall slower? Why will a larger surface area make it fall slower? What would happen if you made the paper case heavier?***Scientific Enquiry activity**Learners conduct an investigation to test their predictions.* Learners time how long it takes for paper cake cases to fall from 2 m.
* They should change the mass of the cases by creating stacks of one, two, three cases etc.
* Learners identify their independent, dependent and control variables.
* They calculate average speed as distance / time and plot a graph of average speed against mass of paper cake.
* The expected result is that as mass increases, the effect of air resistance becomes less and all objects will fall the same distance at the same average speed.
* Learners explain their results using the concepts of force and air resistance.
 | <https://youtu.be/E43-CfukEgs> (2:50 - 3:50)Paper cake cases (or filter papers made into cones).Paper cake cases (or filter papers made into cones), metre rulers or tape measure, stopwatches. | Elicit the idea that, for example, doubling the weight doubles the force down but a doubled mass is more difficult to start moving and so without air resistance they should fall at the same rate. |
| 7Pf17Pf2 | Describe the effects of forces on motion, including friction and air resistanceDescribe the effect of gravity on objects. Secondary sources can be used | ParachutesAsk learners: *What happens when a skydiver opens their parachute?* It is very likely that learners will say that they ‘go up’. This is because they have seen videos taken by another skydiver who has not yet opened their parachute.Introduce and explain the term ‘terminal velocity’.Learners draw force diagrams for the four stages of a parachute fall: acceleration without parachute open; terminal velocity without parachute open; deceleration with parachute open; and terminal velocity with parachute open.Learners create a presentation (electronic or on paper) to explain the stages of a parachute jump (and why a skydiver does not go up when they open the parachute). | An animation of a parachute jump showing the forces involved:[www.physicsclassroom.com/mmedia/newtlaws/sd.cfm](http://www.physicsclassroom.com/mmedia/newtlaws/sd.cfm) | Use conventions of force diagrams correctly in each of the four stages to help represent balanced and unbalanced forces at different stages (tail of arrow placed where force acts; length of arrow represents size of force). |
| 7Ep17Ep37Ep47Ep57Ep67Ep77Eo17Ec17Ec37Ec4 | Be able to talk about the importance of questions, evidence and explanationsSuggest ideas that may be testedOutline plans to carry out investigations, considering the variables to control, change or observeMake predictions referring to previous scientific knowledge and understandingIdentify appropriate evidence to collect and suitable methods of collectionChoose appropriate apparatus and use it correctlyMake careful observations including measurementsMake conclusions from collected data, including those presented in a graph, chart or spreadsheetConsider explanations for predictions using scientific knowledge and understanding and communicate thesePresent conclusions using different methods | Investigating motionAsk learners to expand the mind map they made at the beginning of this unit to show their learning.In groups, learners discuss scientific questions that relate to one of the topics of the unit that they could investigate (e.g. speed, friction, falling objects).Ask learners to suggest why it is important to develop a question that can be answered by doing an investigation and collecting data. Discuss answers. Circulate and support the groups in selecting a question that could be investigated using equipment that is available.Learners, in pairs or groups of three, plan an investigation to answer their question. They should decide on their independent, dependent and control variables and write a method for the investigation. Their method should only use equipment that will be available. Ask learners to remember the feedback they received on their previous plans. They should use that feedback to make this plan better.As part of their plans, learners should identify activity-related risks and hazards. They should decide the precautionary measures that they will take.Learners peer assess their methods with a different group. There are several ways that this investigation could be completed. Learners should give each other feedback on whether the method is clear:* What is the question?
* What is the independent variable?
* How will the independent variable be changed?
* What is the dependent variable?
* How will the dependent variable be measured?
* What are the control variables?
* How will these variables be controlled?
* What are the precautionary measures?

Identify the resources available to learners for their investigation and allow them five minutes to read through their plans and familiarise themselves with resources needed and how to set up the experiment. They should write down their prediction for their investigation. The prediction should include a sketch to show the shape of the graph they expect.Groups of learners carry out the investigation and collect their results in an organised way.Learners interpret their results. They should compare their results with their predictions. Learners evaluate their investigation by answering questions such as:* What went well?
* What could be improved upon?
* Are your confident that your results allow you to answer your question?
* What more information would you need to answer the question?

Ask learners: *What makes a good presentation?* Use their answers to create a set of success criteria agreed by the class.Allow groups time to create a presentation for their investigation. This should include their question, method, results, conclusion and evaluation. All members of the group must be involved in the presentation.Groups take it in turns to present their investigations. At the end of each presentation, the audience can ask questions which relate to the presentation. | Mind maps made at the beginning of the unit.The resources required will depend on the chosen method(s) of investigation. It is likely that the following will be needed:stopwatches, metre sticks, rulers, paper.Materials for making a presentation (e.g. poster paper, pens etc.). | Health and safety: The teacher must confirm that the methods created by the learners are safe before they do their investigations.These presentations will help to identify what each learner has understood. |