

Scheme of Work

Cambridge Primary

Science 0097

Stage 5

This Cambridge Scheme of Work is for use with the Cambridge Primary Science Curriculum Framework published in September 2020 for first teaching in September 2021.

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# Introduction

This document is a scheme of work created by Cambridge Assessment International Education for Cambridge Primary Science Stage 5.

It contains:

* suggested units showing how the learning objectives in the curriculum framework can be grouped and ordered
* at least one suggested teaching activity for each learning objective
* a list of subject-specific language that will be useful for your learners
* some possible models and representations that are relevant to the learning objectives
* some possible misconceptions learners may have, or develop
* sample lesson plans.

You do not need to use the ideas in this scheme of work to teach Cambridge Primary Science Stage 5. This scheme of work is designed to indicate the types of activities you might use, and the intended depth and breadth of each learning objective. These activities are not designed to fill all of the teaching time for this stage. You should use other activities with a similar level of difficulty, including those from endorsed resources.

The accompanying teacher guide for Cambridge Primary Science will support you to plan and deliver lessons using effective teaching and learning approaches. You can use this scheme of work as a starting point for your planning, adapting it to suit the requirements of your school and needs of your learners.

## Long-term plan

This long-term plan shows the units in this scheme of work and a suggestion of how long to spend teaching each one. The suggested teaching time is based on 75 total hours of teaching for Science Stage 5 at 2.5 hours a week. The actual number of teaching hours may vary according to your context.

| Unit and suggested order | Suggested teaching time |
| --- | --- |
| **Unit 5.1** Plants | 17.25% (13 hours) |
| **Unit 5.2** Materials | 17.25% (13 hours) |
| **Unit 5.3** Forces | 17.25% (13 hours) |
| **Unit 5.4** Animals | 16% (12 hours) |
| **Unit 5.5** Waves | 15% (11 hours) |
| **Unit 5.6** Planet Earth | 17.25% (13 hours) |
| **Total** | **75 hours** |

## Sample lesson plans

You will find two sample lesson plans at the end of this scheme of work. They are designed to illustrate how the suggested activities in this document can be turned into lessons. They are written in more detail than you would use for your own lesson plans. The Cambridge Primary Science Teacher Guide has information on creating lesson plans.

## Other support for teaching Cambridge Primary Science Stage 5

Cambridge Primary centres receive access to a range of resources when they register. The Cambridge Primary support site at [**https://primary.cambridgeinternational.org**](https://primary.cambridgeinternational.org) is a password-protected website that is the source of the majority of Cambridge-produced resources for the programme. Ask the Cambridge coordinator or exams officer in your school if you do not already have a log-in for this support site.

Included on this support site are:

* the Cambridge Primary Science Curriculum Framework, which contains the learning objectives that provide a structure for your teaching and learning
* grids showing the progression of learning objectives across stages
* the Cambridge Primary Science Teacher Guide, which will help you to implement Cambridge Primary Science in your school
* templates for planning
* worksheets for short teacher training activities that link to the teacher guide
* assessments provided by Cambridge
* a list of endorsed resources, which have been through a detailed quality assurance process to make sure they are suitable for schools teaching Cambridge Primary Science worldwide
* links to online communities of Cambridge Primary teachers.

## Resources for the activities in this scheme of work

We have assumed that you will have access to these resources:

* paper, graph paper, pens, pencils, rulers and calculators for learners to use
* clean water
* the internet.

Other suggested resources for individual units and/or activities are described in the rest of this document. You can swap these for other resources that are available in your school.

The Cambridge Primary Science Equipment List provides a list of recommended scientific equipment that your school should have access to in order to teach all stages of Cambridge Primary Science. It is available on the support site.

## Websites

There are many excellent online resources suitable for teaching Cambridge Primary Science. Since these are updated frequently, and many are only available in some countries, we recommend that you and your colleagues identify and share resources that you have found to be effective for your learners.

## Approaches to teaching Cambridge Primary Science Stage 5

There are three components to the Cambridge Primary Science Curriculum:

* four content strands (Biology, Chemistry, Physics, and Earth and Space)
* one skills strand (Thinking and Working Scientifically)
* one context strand (Science in Context).

When planning lessons, the three components should work together to enable you to provide deep, and rich, learning experiences for your learners.

We recommend you start your planning with a learning objective from one of the four content strands. This determine the focus of the lesson. Once there is a content learning objective lesson focus you can consider what Thinking and Working Scientifically learning objectives can be integrated into your teaching so learners are developing their scientific skills alongside their knowledge and understanding of science.

This approach is exemplified in this scheme of work by providing activities that cover the content learning objectives while also developing selected Thinking and Working Scientifically learning objectives. Some Thinking and Working Scientifically learning objectives are covered multiple times over the scheme of work which reflects the need for learners to have several opportunities to develop skills.

The selection, and frequency, of Thinking and Working Scientifically learning objectives in this scheme of work may match the needs of your learners. However, the selection of Thinking and Working Scientifically learning objectives needs suit the requirements of your school and needs of your learners. Any changes to what Thinking and Working Scientifically learning objectives are selected to be developed when teaching the content learning objectives will require activities to be reviewed and edited.

Once you are confident with the combination of content and Thinking and Working Scientifically learning objectives, you then have the option to integrate context into your lessons to show how the learning objectives and/or skills relate to the world the learners know and experience. The Science in Context learning objectives provide guidance on doing this. As including context is dependent on your learners and your context, the scheme of work does not give contextual links to an activity. Possible ways to contextualise units are provided in the unit introductions, aligned to the relevant Science in Context objectives.

Further support about integrating Thinking and Working Scientifically and Science in Context into lessons can be found in the Cambridge Primary Science Teacher Guide.

Models and representations

Scientists use models and representations to represent objects, systems and processes. They help scientists explain and think about scientific ideas that are not visible or are abstract. Scientists can then use their models and representations to make predictions or to explain observations. Cambridge Primary Science includes learning objectives about models and representations because they are central to learners’ understanding of science. They also prepare learners for the science they will encounter later in their education.

To support the integration of models and representations into your teaching, for each learning objective we have suggested possible models you may wish to use.

Misconceptions

Scientific misconceptions are commonly held beliefs, or preconceived ideas, which are not supported by available scientific evidence. Scientific misconceptions usually arise from a learner’s current understanding of the world. These ideas will informed by their own experiences rather than evidence. To support you in addressing misconceptions, for each learning objective in each unit we have suggested, where relevant, possible misconceptions to be aware of.

Due to the range of misconceptions that learners can hold not all misconceptions have been provided and you may encounter learners with misconceptions not presented in this scheme of work.

Misconceptions may be brought to the lesson by the learners, reinforced in the lesson, or created during a lesson. It is important that you are aware of misconceptions that learners may exhibit so that you can address them appropriately.

It is important to note that not all misconceptions are inappropriate based on the conceptual understanding learners are expected to have at different stages of their education. Therefore, some misconceptions may be validly held by learners at certain stages of their learning. A misconception of this type is known as an age-appropriate concept. Trying to move learners away from age-appropriate concepts too soon may give rise to other, more significant, misconceptions or barriers to their understanding of science. Over time age-appropriate concepts can become misconceptions when they start to interfere with the expected level of understanding learners need to have.

The misconceptions flagged in this scheme of work are considered to be either inappropriate concepts for a learner at this stage of understanding science or important age-appropriate concepts to be aware of so they are not challenged too early.

Health and safety

An essential part of this curriculum is that learners develop skills in scientific enquiry. This includes collecting primary data by experiment. Scientific experiments are engaging and provide opportunities for first-hand exploration of phenomena. However, they must, at all times, be conducted with the utmost respect for safety, specifically:

* It is the responsibility of the teacher in charge to adhere and conform to any national, regional and school regulation in place with respect to safety of scientific experimentation.
* It is the responsibility of the teacher in charge to make a risk assessment of the hazards involved with any particular class or individual when undertaking a scientific experiment that conforms to these regulations.

Cambridge International takes no responsibility for the management of safety for individual published experiments or for the management of safety for the undertaking of practical experiments in any given location. Cambridge International only endorses support material in relation to curriculum content and is not responsible for the safety of activities contained within it. The responsibility for the safety of all activities and experiments remains with the school.

The welfare of living things

Throughout biology, learners study a variety of living things, including animals. As part of the University of Cambridge, Cambridge International shares the approach that good animal welfare and good science work together.

Learners should have opportunities to observe animals in their natural environment. This should be done responsibly and not in a way that could cause distress or harm to the animals or damage to the environment.

If living animals are brought into schools then the teacher must ensure that any national, regional and school regulations are followed regarding animal welfare. In all circumstances, the teacher responsible must ensure all animals have:

* a suitable environment, including being housed with, or apart from, other animals (as required for the species)
* a suitable diet
* the opportunity to exhibit normal behaviour patterns
* protection from pain, injury, suffering and disease.

There is no requirement for learners to participate in, or observe, animal dissections for Cambridge Primary. Although dissection can provide a valuable learning opportunity, some learners decide not to continue studying biology because they dislike animal dissection. Several alternatives are available to dissection (such as models and diagrams) which you should consider during your planning.

If you decide to include animal dissection then animal material should be obtained from premises licensed to sell them for human or pet consumption, or from a reputable biological supplier. This approach helps to ensure animal welfare standards and also decreases the risk from pathogens being present in the material. Neither you nor your learners should kill animals for dissection.

When used, fresh material should be kept at 5 °C or below until just before use. Frozen material should be defrosted slowly (at 5 °C) without direct heat. All fresh or defrosted material should be used within 2 days. Preserved animal materials should only be handled when wearing gloves and in a well-ventilated room.

The responsibility for ensuring the welfare of all animals studied in science remains with the school.

# Unit 5.1 Plants

| Unit 5.1 Plants |
| --- |
| Outline of unit: |
| This unit covers all aspects of flowering plants: parts and functions, life cycle including pollination and germination, seed and fruit production, and dispersal. Learners then study the features of plants that attract pollinators, how seeds disperse and how plants are adapted to survive in different environments.  Learners benefit from observing the stages of the life cycle of real flowers and plants in the classroom and in their natural environment. However, where this is not possible secondary sources of information can be used, e.g. online video clips.  The unit relies on learners observing plants at different stages of their life cycle. Some background research of your local environment will enable you judge when to schedule teaching the different aspects of the unit. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * understanding plants are living things, need water and sunlight to grow and grow from seeds * how to identify plants and some of the basic features e.g. leaves, flowers, stem and roots. |
| Suggested examples for teaching Science in Context: |
| ***5SIC.02*** *Describe how science is used in their local area.*  Learners can discuss the food that is grown in their local area for them to eat; this could include farms they visit and/or their own gardens.  ***5SIC.03*** *Use science to support points when discussing issues, situations or actions.*  Learners can explore the negative impact of using pesticides on the number of pollinators and the effect that a decline in pollinators could have on food production.  ***5SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science.*  Learners could identify farmers; gardeners (e.g. people who tend their own garden, employed gardeners); foresters (e.g. people who maintain tree health and keep trees safe to humans by cutting branches) and botanists (i.e. people who study plants).  ***5SIC.05*** *Discuss how the use of science and technology can have positive and negative environmental effects on their local area.*  Learners could research how their local environment has changed over time and the effect this has had on native plants. For example, learners could research the impact of buildings (e.g. shade) on plant growth and/or seed dispersal. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
| --- | --- | --- | --- |
| **5Bs.02** Identify the parts of a flower (limited to petals, sepals, anthers, filaments, stamens, stigma, style, carpel, and ovary). | Flower, petal, anther, filament, stamen, stigma, style, carpel, sepal, ovary, male, female | Learners can make and/or use a diagram of a flower. | Some learners may believe that flowers exist to make plants look attractive. Clearly explain the important functional role that flowers have in plant reproduction. |
| **5Bs.03** Describe the functions of the parts of a flower (limited to petals, anthers, stigma and ovary). | Flower, petal, anther, stigma, ovary |
| **5Bs.01** Know that not all plants produce flowers. | Flowering,  non-flowering | Learners can use diagrams of different plants to show understanding that not all plants produce flowers. | Some learners may believe that something is only a plant if it flowers. Explain that not all plants have flowers and that other plants only flower for a short time in their life cycle.  Some learners may believe that trees are all non-flowering. Explain that many trees produce flowers (e.g. blossom) during their life cycle although in many cases it is for a short time. |
| **5Bp.02** Know the stages in the life cycle of a flowering plant. | Seed, germination, root, shoot, leaves, flower, pollination | Learners can make and/or annotate a life cycle diagram of a flowering plant with captions for each stage.  Learners watching and discussing an animation of the life cycle of a flowering plant may also support understanding. | Learners may believe that a plant flowering is not a separate part of the life cycle. Clarify to learners that plants only flower when they are ready to reproduce and is a distinct part of the life cycle. |
| **5Bp.04** Describe seed germination and know that seeds, in general, require water and an appropriate temperature to germinate. | Germination, seed, temperature | Learners can make and/or annotate a diagram of the stages of the process of seed germination.  Learners could use drama to represent the stages of seed germination. | Some learners may believe that seeds always require soil to germinate. Demonstrate that seeds can germinate without soil by germinating fast growing seeds (e.g. cress) on cotton wool. . |
| **5Bp.03** Describe how flowering plants reproduce by pollination, fruit and seed production, and seed dispersal. | Pollination, reproduction, fruit, seed, dispersal | Learners can examine, make and/or use models of different types of seed to demonstrate dispersal methods; paper helicopters, hook-and-loop fasteners (e.g.Velcro®), floating balls, and parachutes.  Learners can create and/or annotate the diagrams of flowers and seeds to show adaptations. | Learners may not understand that the biological term ‘fruit’ includes any structure that contains a seed as they are likely to be more familiar with the everyday usage of the term for a narrow range of fruits. Show learners a wide range of fruits (e.g. nuts in their shells, grains, tomatoes, peppers) to explain that, biologically, fruit is a broad category of any structure that contains one or more seeds.  Some learners may believe that bees are the only pollinators of flowering plants. Give a wide range of other animal pollinators (e.g. insects, some small birds, reptiles and mammals). |
| **5Be.02** Describe how flowering plants are adapted to attract pollinators and promote seed dispersal. | Pollination, pollinator, seed, dispersal, adaptation |
| **5Be.01** Describe how plants and animals are adapted to environments that are hot, cold, wet and/or dry. | Environment, adaptation | Learners can make and/or annotate diagrams of different plants and their specific adaptations. | Learners may think that all plants need the same conditions to grow (often based on learners’ experience of local temperatures and water availability). It is important to expose them to the range of plants for which this is not the case; use secondary sources of information to illustrate plants that grow and thrive in extreme environments. |

# Unit 5.1 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
| --- | --- | --- |
| **5Bs.02** Identify the parts of a flower (limited to petals, sepals, anthers, filaments, stamens, stigma, style, carpel, and ovary). | **5TWSp.05** Describe risks when planning practical work and consider how to minimise them  **5TWSc.06** Carry out practical work safely. | **Flower dissection (requires additional resources)**  Start by reviewing the learners’ prior knowledge about the different parts of a plant: roots, stem, leaves and flower. Then ask learners if they know the names of any of the parts of the flower; write the key words to display to the whole class. Discuss how to check, and identify, the parts of a flower.  Provide a large flower to the learners (individually or in small groups) and ask them to identify the different parts through external observation only.  Can you see all the parts of the flower?  *Which parts of the flower can you see?*  Highlight that the internal parts of a structure cannot be seen by external observation.  Highlight the risks of dissection and discuss how learners can minimise the risk to themselves and others, e.g. only use equipment at tables, do not run around with equipment, take care of your hands when using equipment.  Demonstrate how to use dissection to identify the parts of a flower, dissecting from the outside and moving in towards the centre. As you go, remove one example of each feature, sticking them on a piece of paper (using tape) and adding a name label. Start with the petals and sepals. Once one or two petals are removed, show learners the male parts of the flower – the stamen made up of an anther and filament. A magnifying glass can be used to see pollen on the anthers. Then show learners the female parts (the stigma, style and ovary).  Learners can then dissect and label a flower themselves, then annotate a summary diagram.  This activity can be extended by learners dissecting different types of flowers and then comparing their dissections.  **Resources:** Variety of flowers with large heads, tweezers, scissors, magnifying glasses. |
| **5TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Labelled flower diagram**  Start by reviewing the learners’ prior knowledge about the different parts of a plant: roots, stem, leaves and flower. Then ask learners if they know the names of any of the parts of the flower; write the key words to display to the whole class. Review the parts learners already know and add to their vocabulary so all the key parts are identified as; petals, sepals, stamen, anther, filament, stigma, style, ovary.  Provide learners with a blank cross-section diagram of a flower (use a selection of different flowers if possible), and descriptions of each part of the flower. Learners label the diagram to show the key features of the flower.  Discuss with learners how the diagram acts as a model of a flower and represents the flower. We can make idealised models to show our understanding. Show an example of a simplistic flower diagram and explain how many flowers do not match this diagram but the model is useful for showing the common parts of a flower. Emphasise the model represents, and helps us describe in scientific terms, a flower.  **Resources:** Blank cross-section diagrams of flowers. |
| **5Bs.03** Describe the functions of the parts of a flower (limited to petals, anthers, stigma and ovary). | **5TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Researching functions of the parts of a flower**  Show learners a real flower, or a picture of one.  *What is the function of the petals? The anther?*  Ask learners to think about and share their ideas and then discuss as a whole class. Discuss how we can find and use a range of secondary information sources (i.e. information that other people have found and written down).  First give pairs of learners a different flower part (petals, anthers, stigma or ovary) to investigate, e.g. *What is the function of [insert part of the flower]?* Once they have answered the question, they can research another part of the flower; if there is not time for pairs to research all four part then make sure that the results of the research are shared. Reinforce to learners the need to use more than one secondary information source to check their initial findings.  During the lesson gather learners’ understanding about each part of the flower and identify where there are common understandings or differences. Where there are differences discuss the accuracy of the secondary information and provide them with the scientifically accurate function of the part.  **Resources:** Suitable books or web pages |
| **5Bs.01** Know that not all plants produce flowers. | **5TWSc.01** Sort, group and classify objects, materials and living things through testing, observation and using secondary information. | **Plant walk**  Look at pictures of plants. Ask learners:  *How can you tell if something is a plant?*  *What features are you looking for?*  Identify with learners that all plants are green, have roots and a stem.  In pairs, learners discuss and write answers to the following questions:  *Are trees plants?*  *Do all plants have flowers?*  Select answers at random and read to the whole class. Discuss whether there was a consensus and address any misconceptions.  Take learners on a walk in your local area (within the school grounds or further afield) and look for different plants. Try to find examples of non-flowering plants such as mosses, ferns and conifers.  Ask them to sketch (or photograph, if cameras are available) the plants. Focus on plants that have no flowers and discuss if they are still plants.  *Did you find more flowering or non-flowering plants?*  *Are there similarities or key features of non-flowering plants?*  As a class, classify all the plants seen as ‘flowering’ or ‘non-flowering’. Learners can use images of plants, or label plants in their environment, rather than removing plants from their environment.  This activity can be extended by providing learners with a simple key to help them identify different types of plant.  **Resources:** Plant identification key |
| **5Bp.02** Know the stages in the life cycle of a flowering plant. | **5TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Flowering plant life cycle**  Once learners have an understanding of the key features of a flowering plant, they can explore the function of these parts within the life cycle of the plant.  Show a suitable video (or animation) of the life cycle of a flowering plant life cycle to learners. They take notes of the different stages and the key events in the life cycle. From their notes, learners then draw, and label, a life cycle diagram.  What are the key stages in the life cycle of a flowering plant?  What changes occur to the plant through its life cycle?  Can you identify the stages at which the key parts appear and their functions?  Discuss how a life cycle diagram is one way of modelling scientific phenomena found in nature; in this case the life cycle of a flowering plant. Ask learners:  *Are there other models you could use to demonstrate your understanding?*  **Resources:** Video of the life cycle of a flowering plant |
| **5Bp.04** Describe seed germination and know that seeds, in general, require water and an appropriate temperature to germinate. | **5TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts.  **5TWSa.03** Make a conclusion from results informed by scientific understanding.  **5TWSa.04** Suggest how an investigation could be improved and explain any proposed changes.  **5TWSa.05** Present and interpret results, using tables, bar charts, dot plots and line graphs. | **Germinating seeds (requires additional resources)**  Learners should know that seed germination is the first stage of growth for a new plant (as part of their understanding of the life cycle of a plant). In this activity learners closely examine the process of seed germination and the conditions needed; they will see that soil is not essential for plant growth. Choose seeds that are easy to handle (e.g. beans).  Lead learners through the investigation procedure: they soak a sheet of paper towel with water and wrap 5 seeds in it; they place the wrapped seeds into a plastic bag and seal it; they place the bag in a dark space and leave it for three days.  At this stage you can set up a variety of control experiments to compare what happens; you will need locations with different temperatures and light levels (e.g. cupboard, windowsill, refrigerator). Possible control experiments include, but are not limited to, dry seeds sealed in a bag in a dark space; wet seeds sealed in a bag in a warm, light space; dry seeds sealed in a bag in a warm, light space; dry seeds sealed in bags in a cold space; wet seeds sealed in bags in a cold space.  Ask learners to make predictions about what they think will happen to their seeds and the control experiments. Discuss what their predictions are based on:  What previous scientific knowledge or understanding helps inform your prediction?  Do you have any experiences which are informing your predictions?  Check the seeds carefully by opening the bag and unwrapping it. Sketch (or photograph, if cameras are available) the seeds. Unwrap the seeds every 2 days, check and record progress in a dot plot (with conditions on the x-axis).  Once you have observed germination explore the following questions with learners, so they fully understand the process of germination and how it’s controlled:  At what stage would the seed need to be planted to continue to grow?  Plants need light to grow but why do most seeds not need light to germinate?  Why is warmth important for germination?  Why do seeds germinate in certain environmental conditions?  Help learners to identify conclusions based on the information gained from the investigation, by analysing their dot plots, and highlight how carrying out the investigation has developed their scientific understanding.  Learners evaluate the investigation and suggest what went well and what could be improved if they were to do it again:  How easy was the investigation to carry out?  Did the method give you the information you needed to draw conclusions?  What could you do differently next time to improve the investigation?  **Resources:** Seeds, plastic bags, paper towel |
| **5TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Secondary information on germination**  Highlight to learners the place of germination in the plant life cycle.  What conditions does germination require?  How could we find out the answer to this question without carrying out a practical investigation ourselves?  Discuss how we can find out answers by referring to the work of others recorded in secondary information sources (e.g. books, videos, articles, first hand experiences of other people, websites).  Learners then investigate the question through using a range of secondary information sources. There is also an opportunity here to invite a local member of the community who has direct experience of seed germination to visit the class. Learners can prepare questions for the visitor in advance.  Learners choose a method to present their findings to the whole class (e.g. a written statement, a diagram, a poster, or through role-play). Once all findings have been shared, lead the class to an agreed understanding of germination.  **Resources:** Range of secondary information sources |
| **5Bp.03** Describe how flowering plants reproduce by pollination, fruit and seed production, and seed dispersal. | **5TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Process of pollination**  Discuss with learners how we can research about the process of pollination. Explain that secondary sources of information can be used to build our own understanding. Ask learners:  How does pollination happen?  How could we find out the answer to this question without carrying out a practical investigation ourselves?  Learners use books, websites and/or videos to research the process of pollination. They choose how to present their findings to the rest of the class (e.g. a written statement, a diagram, a poster, or through role-play). Ensure that learners have understood that pollination happens when pollen grains are transferred to the stigma.  **Resources:** Books, websites or video clips |
| **5TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry. | **Process of fruit and seed production**  Review with learners the key steps in the life cycle of a plant and then focus class discussion on fruit and seed production. Explain that pollination is the introduction of pollen from one plant to another. Use a video (or diagram) to show learners the journey that pollen goes on once it reaches a new plant, i.e. how it moves to the ovary to fertilise the egg. Once the egg is fertilised it starts to form a seed.  If this is the seed, where is the fruit?  Why does a plant grow fruit?  What is the difference between a fruit and a seed?  Cut a fleshy fruit (e.g. apple) in half and identify the seeds within the fruit. Explain that the biological term ‘fruit’ refers to a structure that contains a seed and this one has edible flesh like many common fruits. Then show them other fruits that do not have edible flesh (e.g. bean pods, sycamore seed shells, peanut shell). Ask learners to draw labelled diagrams of a range of fruits and seeds.  Introduce an extended investigation to understand fruit and seed production, explaining that we will make observations of fruit growing on a plant for a period of more than eight weeks. While watching the fruit develop, learners make notes about the role of the flower and how fruits and seeds are produced.  If it is not possible to grow fruit in school for eight weeks, then learners can view, and discuss, a time-lapse video of fruit developing on a plant.  **Resources:** A variety of fruit (with edible and inedible flesh), plants |
| **5TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions**.** | **Process of seed dispersal**  Recap with the learners the key steps in the life cycle of a plant. Show them pictures of wild plants and ask questions to start them thinking about how the seeds of different wild plants are dispersed in different locations:  How did that plant get there?  If it was not purposefully planted by a human how did it get there?  Discuss the part that fruit plays in spreading seeds across a geographical area. Role-play a seed landing too close to a plant and not being able to grow once it has germinated. Explain why a seed that lands further away from the plant has a higher chance of survival.  Give pairs of learners a type of plant which has a different type of seed dispersal, e.g. water (coconut), wind (sycamore or dandelion), mechanical (bean), animal eating (mango), animal burying (acorns), animal fur (goosegrass). Local examples can be used. Learners then use secondary sources to find out how that plant disperses its fruit and seeds.  Recap with the learners why the dispersal of fruit and seed is so important for plants.  **Resources:** Photos of wild plants, secondary sources of information |
| **5Be.02** Describe how flowering plants are adapted to attract pollinators and promote seed dispersal. | **5TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry**.** | **Attracting pollinators**  Discuss as a class the role of animals, especially insects, as pollinators for flowering plants. Explain that, while some plants can be pollinated by wind or other methods, many plants are adapted to use insects by attracting them. Focus on how bees collect nectar and become coated in pollen during the process; this can be supported by showing a video of bees acting as pollinators. Discuss which plants a bee is most likely to visit:  Which plants do you think a bee will visit the most?  Why those plants?  Take learners around the school grounds (or local area) to look at different flowering plants. This activity is best completed during a period of time when flowers are being pollinated. Groups of learners focus on different flowers; they draw diagrams of plants and note any adaptations that may help to attract pollinators. If possible, learners identify pollinators that are visiting the plants and whether the pollinators have a preference.  Which flowers do you think are the best at attracting pollinators?  Do you think all the plants attract the same type of pollinator?  How do the pollinators behave when visiting the flowers?  Are all the flowers attracting pollinators in the same way?  Is it just the appearance of the flowers that attracts pollinators?  In the classroom, view videos of pollinators including non-insect pollinators (e.g. hummingbird).  **Resources:** Videos of pollinators, flowering plants |
| **5TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Promoting seed dispersal**  Review the importance of seed dispersal to plants; it enables seeds to germinate and new plants to grow. Discuss how there are many different ways seeds can disperse but each plant uses the method that is best suited to its environment. The plant is adapted to promote seed dispersal.  As a class, discuss how coconut trees disperse their seeds. Demonstrate that a coconut floats in water; if a real coconut is not available, show a video of a coconut floating in water. Ask learners:  *Why is this a good adaptation for a coconut?*  Demonstrate that the shape of a coconut means they roll quite easily.  *Why is this a good adaptation for a coconut?*  Discuss where coconut trees are usually found and how those adaptations help seed dispersal.  In the next activity, learners will think about a specific environment, work out what sort of fruit might disperse well, and build a representative model of the fruit. Demonstrate the steps of the process to the class. Begin by asking learners:  *If a plant grows on a mountain what sort of fruit would you expect?*  Show them how to use a range of materials (e.g. different types of paper, aluminium foil, sticky tape) to build a physical model of a fruit and explain the features you have given it. Discuss how the model you have made represents a possible fruit but it may not exist in reality; its purpose is to demonstrate the principle of fruit adaptation for seed dispersal.  Place learners into groups and assign each group a specific environment. Learners then create their models. As a class, review and compare the completed models. Show some images of real fruits and see if any of the models represent the real fruits. Ask learners questions in order to draw some key conclusions about plant adaptation for seed dispersal:  Why do different plants disperse their seeds in different ways?  What are the benefits of the different seed dispersal mechanisms?  How are plants adapted to disperse their seeds effectively?  How does the environment a plant is found in affect its seed dispersal mechanism?  **Resources:** Coconut, variety of materials to make fruits |
| **5Be.01** Describe how plants and animals are adapted to environments that are hot, cold, wet and/or dry.  (Note in this unit the focus is on plant adaptation only) | **5TWSc.01** Sort, group and classify objects, materials and living things through testing, observation and using secondary information.  **5TWSc.02** Complete a key based on easily observed differences. | **Plant adaptations in different environmental conditions**  Show learners a variety of videos showing how different plants (e.g. cactus plant) are adapted to their specific habitats. Ask learners:  What features does this plant have?  Why does this plant have these features?  How does each feature help the plant survive?  Provide a selection of pictures of differently adapted plants and different environments; include a wide variety of plants from around the world that have adapted to very different conditions. Learners match the plant with the most suitable environment; they should identify what adaptations of the plant allow it to survive in each environment.  Learners then match the plants to descriptions of them, their adaptations and what environment they are found in.  Provide a set of questions which learners can use to create keys to show how different plants are adapted to each environment and identify common adaptations plants have to an environment. For example,  Does the plant have a thick stem?  Does the plant have large leaves?  Discuss as a class, how plants are adapted to the environments in which they grow:  What are the most important adaptations plants have in order to survive?  How do environmental conditions affect the adaptations plants need in order to survive?  **Resources:** Video clips, plant picture cards, books or websites, questions to create keys |

# Unit 5.2 Materials

| Unit 5.2 Materials |
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| Outline of unit: |
| This unit covers aspects of materials, states of matter, changes of state and dissolving. It uses water as the main example. Learners will understand the particle model as a method to describe different states and learn about the processes involved in materials changing state. They will investigate how some dissolve in liquids, and be separated again, relating this to real life experiences.  Learners will have opportunities to make predictions, plan and conduct appropriate investigations and reflect on their results. Ideally, learners will do many practical investigations using household items. If any of the investigations are not possible, then online video clips and simulations could be used as an alternative. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * knowing substances can exist as solids, liquids and gases * knowing some common solids, liquids and gases (e.g. carbon, iron, steel, water, vegetable oil, oxygen) * understanding ice, water and steam (i.e. water vapour) are different states of water * understanding melting, boiling and freezing are processes of changing state. |
| Suggested examples for teaching Science in Context: |
| ***5SIC.02*** *Describe how science is used in their local area.*  Learners can consider the importance of a substance being a solid, liquid or gas in their own lives and in their community. This can extend to local industry and how changing state, and dissolving, can be important processes.  ***5SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science.*  Many people need to understand about gases as part of their jobs or hobbies. For example, dentists and doctors who use anaesthetic gas and people who scuba dive professional or for a hobby. Someone who uses gases could discuss with learners what they do and how understanding gases helps them. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
| --- | --- | --- | --- |
| **5Cm.02** Understand that substances can be gaseous and know the common gases at room temperature (limited to oxygen, carbon dioxide, water (vapour), nitrogen and hydrogen). | Solid, liquid, gas, gaseous, state, matter, substance, oxygen, carbon dioxide, water vapour, nitrogen, hydrogen, properties | Learners can use diagrams to show their understanding that substances can be gaseous. | Learners may not believe that gases exist, as many are invisible. One way to show gases exist is to use a syringe to create bubbles in a water column, and then discuss what is in the bubble and how it is taking up space. (A water column can be made out of an upside-down, plastic bottle.) |
| **5Cm.01** Use the particle model to describe solid, liquids (including solutions) and gases. | Particle, solid, liquid, gas, energy | Learners, through the learning objective, will continue to develop their understanding of the particle model, which can be represented as a diagram, through explanation or through drama. | When learners use the particle model they may ‘incorrectly’ represent liquids being made of particles that do not touch each other; this is only true of particles in the gas phase. Clearly explain that, in a liquid, all particles are in contact with at least one other particle; they do not have be regularly ordered as you would show with particles in the solid phase. |
| **5Cp.02** Know the main properties of water (limited to boiling point, melting point, expands when it solidifies, and its ability to dissolve a range of substances) and know that water acts differently from many other substances. | Water, properties, boiling point, melting point, expand, solvent, freezing, solidify, dissolve | Learners can develop their use of the particle model to show the properties of water including how it expands when water solidifies. | Some learners may think that ice, water, steam and water vapour are different substances. Use a closed system (where it is clear that different substances are not being introduced) to demonstrate that one substance is changing state. |
| **5Cc.01** Describe the processes of evaporation and condensation, using the particle model and relating the processes to changes in temperature. | Evaporation, condensation, particle, temperature, gas, liquid | During this unit, learners will continue to develop their understanding of the particle model. Evaporation and condensation can be explained through linking the solid and liquid particle models with arrows and the use of drama. | Some learners may think that water condensing on cold glass has seeped through the glass. Move a cold surface from a dry environment to a humid environment to show learners that air contains water vapour which condenses on a cold surface. |
| **5Cp.01** Know that the ability of a solid to dissolve and the ability of a liquid to act as a solvent are properties of the solid and liquid. | Solid, solute, liquid, solvent, dissolve, soluble, insoluble, properties | Learners can develop their use of the particle model to show their understanding of dissolving and use labelled diagrams where the solvent and solid are labelled. | Some learners may think that substances disappear when they dissolve. Prove that the solid does not disappear by demonstrating that the weight of a solution is the combined weight of the solid and the solvent (weigh them separately before mixing). |
| **5Cc.03** Investigate and describe the process of dissolving and relate it to mixing. | Dissolving, solute, solvent, saturated, mixing | Learners can develop their use of the particle model to show their understanding of dissolving and use labelled diagrams where the solvent and solid are labelled. |
| **5Cc.02** Understand that dissolving is a reversible process and investigate how to separate the solvent and solute after a solution is formed. | Dissolving, reversible, irreversible, solvent, solute, solution, evaporation | Learners can develop their use of the particle model to show their understanding of dissolving and what happens when the process is reversed. Diagrams can also be used to show the separation technique used. | Some learners may think that dissolving a solute in a solvent is an irreversible process. The suggested activity for this learning objective will demonstrate that a solute can easily be recovered from the solution. |

# Unit 5.2 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
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| **5Cm.02** Understand that substances can be gaseous and know the common gases at room temperature (limited to oxygen, carbon dioxide, water (vapour), nitrogen and hydrogen). | **5TWSc.01** Sort, group and classify objects, materials and living things through testing, observation and using secondary information. | **Classifying gases**  Review of prior knowledge that materials are classified as solids, liquids and gases:  *Can you give me some examples of common solids, liquids and gases?*  Give pairs of learners cards of common substances (a range of solids and liquids including, but not limited to, oxygen, carbon dioxide, water (vapour), nitrogen, hydrogen). They use secondary information sources to support them finding out about, and then sorting, unknown substances into those that naturally occur as solids, liquids and gases.  What do all the gases have in common?  Are there any substances that could be in different groups under different conditions?  The activity can be extended by learners researching the properties and uses of the different gases.  **Resources:** Set of substance cards, secondary information sources. |
| **5Cm.01** Use the particle model to describe solid, liquids (including solutions) and gases. | **5TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **The particle model of a gas**  Recap prior learning that all matter is made of tiny particles: the particles are always moving (even in a solid they vibrate next to each other) and the behaviour of these particles determines which state that matter is in.  Present the particle model for a solid and liquid. Explain how the model helps us describe a solid or liquid and discuss the differences in the arrangement and difference in movement of the particles in solids and liquids.  *What do we think the particle model of a gas will look like?*  Learners, in groups, draw what they think on paper and then present their thinking with their reasoning.  Reveal the particle model of a gas to the learners and show it alongside the particle models for a solid and liquid. Discuss the changes that happen and understand there is a pattern to the change, where liquids have more energy than solid and gases more energy than liquids which affects the movement and organisation of the particles.  Discuss the properties of solids, liquids and gases and relate these properties to the particle model.  **Resources:** Blank particle model template, complete particle models for a solid and liquids |
| **5Cp.02** Know the main properties of water (limited to boiling point, melting point, expands when it solidifies, and its ability to dissolve a range of substances) and know that water acts differently from many other substances. | **5TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts. | **Properties of water**  Explain that only one substance on Earth exists in all three states naturally, let them discuss in pairs what they think it might be:  *What substance do you think it is? Why?*  Gather answers and then inform the learners that water is a unique substance because it exists under the normal conditions on Earth as a solid (ice), liquid (water) and a gas (water vapour).  Melting point  Give each learner an ice cube in a small container.  What do you think is going to happen to the ice cube over the next 10 minutes?  Is there anything you could do to speed the melting process up?  Explain that water freezes at 0°C and if it is warmer than that the process of melting begins. Get learners to observe their ice cube melting, and sketch it, every five minutes. You could make a time-lapse film if you have a camera.  *How long does it take to melt completely?*  Boiling point  Demonstrate that water boils at 100°C by heating some water in a saucepan and using a thermometer to show the temperature. Learners must remain at a safe distance and observe only.  What is going to happen to the water as it is heated up?  What do you observe as the water reaches boiling point?  What does it look like when water is boiling?  What can you see coming off the water as it boils?  Explain that when water boils steam is produced; steam rises because it is hot. You can use the particle model to explain that particles with more energy move around more, leading to more movement of the water. Learners may ask about the bubbles during boiling. Explain that the bubbles are formed because, at the boiling point of the liquid, the liquid changes state into a gas throughout the body of the liquid. The bubbles are mainly made of water vapour, with any other gases that are dissolved in the water.  Partly fill a jar (or plastic bottle cut in half) with water and mark the water level. Place the jar into a freezer. Ask learners:  *What do you think is going to happen to the water?* *Why?*  Take the jar out after 30 minutes and observe what has happened. Record observations again after another 30 minutes and if possible, within the next few days.  What has happened to the water?  Does that match what we predicted would happen?  When might we need to be aware of this phenomenon in our lives?  What does it mean for a lake or river that freezes, what happens to fish that live there?  What will happen when water freezes in a pipe?  What about water trapped in a crack in a wall (or floor)?  Explain that water expands (by about nine per cent) when it freezes; it is the only substance on Earth that does this. The expansion of water on freezing means a sealed drinks bottle could burst in a freezer. Show learners a picture of an iceberg and explain that frozen water (i.e. ice) floats on top of liquid water. Lakes and rivers start to freeze at the surface so there is still liquid water underneath the ice. So fish can continue to live in the liquid water beneath the frozen surface.  *Why is it dangerous to try to walk over a frozen pond (or river)?*  Make sure that learners understand that the frozen ice at the surface of a pond could crack under their weight and they would end up in deep, cold water.  Discuss with learners how water is different to other substances. Provide learners with a range of cards showing the properties of different substances. They then compare the properties and discuss how water is similar and different to other substances.  **Resources:** Ice cubes, small containers, freezer, jar, heat source, thermometer, saucepan, cards showing the properties of different substances. |
| **5Cc.01** Describe the processes of evaporation and condensation, using the particle model and relating the processes to changes in temperature. | **5TWSa.01** Describe the accuracy of predictions, based on results.  **5TWSa.02** Describe patterns in results, including identifying any anomalous results.  **5TWSa.05** Present and interpret results, using tables, bar charts, dot plots and line graphs.  **5TWSc.05** Take appropriately accurate measurements.  **5TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Evaporation and condensation**  Give learners three bowls (or other containers); they label them 1, 2 and 3. They accurately measure out 50 ml of water into each bowl and mark the water line. Tell them to place the three bowls in different locations (e.g. in the classroom, outside, in a refrigerator).  What do you think is going to happen to the water?  Do think the same thing will happen to each of the bowls? Why?  How do you think the behaviour of the particles will change in each of these bowls?  After 30 minutes see what has happened by comparing the current water level to the marked water line. Learners accurately measure the amount of liquid remaining and record their results in a table.  Was your prediction correct?  What do you think has happened to the water?  After another 30 minutes learners accurately measure the amount of water remaining.  What has happened to the water in the different bowls?  How has the location of each bowl affected what has happened?  Why is each bowl different, or the same?  Explain that evaporation is occurring, i.e. the amount of liquid is getting less because it is turning into a gas (i.e. water vapor).  *What factors have affected the rate of evaporation?*  Explain that temperature is the main factor affecting the rate of evaporation, but that wind and humidity also affect the process.  Ask learners to use their results to assess how accurate their original predictions were.  Learners draw a line graph of volume of water against time; they plot the results for the three bowls to show how the results are different for each location.  Ask learners:  *What is the opposite of evaporation?*  Listen to learners’ ideas and then explain the opposite of evaporation is when a gas changes state to a liquid and this is called condensation. Demonstrate condensation to the class by placing a bowl of water covered by plastic film under a light and placing ice (or a cold pack) on the plastic film. Discuss with learners what they think is happening. Explain that the heat from the light will increase the rate of evaporation and the ice will cool down the water vapour on the plastic film causing it to form droplets.  Model to learners how the particle model can be used to help explain evaporation and condensation by showing particles in a liquid gaining more energy and entering the gas state and particles in a gas losing energy and entering the liquid state. Learners then draw their own particles models for evaporation and condensation writing a description of what the model shows.  **Resources:** Containers, marker pens, plastic film, ice |
| **5Cp.01** Know that the ability of a solid to dissolve and the ability of a liquid to act as a solvent are properties of the solid and liquid. | **5TWSp.04** Plan fair test investigations, identifying the independent, dependent and control variables.  **5TWSc.06** Carry out practical work safely. | **Soluble and insoluble**  Give learners six labelled solids (e.g. sand, salt, sugar, flour, coffee, rice). Tell them that they are going to set up a fair test to investigate which of the solids are soluble in water. Ask learners questions to help them to plan their investigation:  *What are the control variables in the investigation?*  Learners need to keep the amount of water (solvent) and solid the same; to treat each solid the same (i.e. stir 10 times, or not stir at all) and to keep the temperature of the water (solvent) the same.  *What is the independent variable in the investigation?*  Remind learners that there should only be one independent variable in a fair test; in this case it is the solid added.  How are you going to measure the dependent variable?  How will you know if the solid has dissolved?  Ask them to suggest different ways they might measure whether the solid has dissolved.  Ensure that learners have fully planned their investigation (with a clear method) before they carry out the practical work. They record their results in a table alongside their predictions; you may provide a table or learners can draw a table themselves.  Discuss with the learners that a solid being able to dissolve and a liquid being able to act as a solvent are properties. Discuss with learners other properties of the solids and solvent used and ensure they include the ability to dissolve or act as a solvent to their properties.  **Resources:** Six solids, containers, stirring rods, spoons. |
| **5Cp.01** Know that the ability of a solid to dissolve and the ability of a liquid to act as a solvent are properties of the solid and liquid.  **5Cm.01** Use the particle model to describe solid, liquids (including solutions) and gases. | **5TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Soluble and insoluble**  Have a bottle of water, ideally in a transparent container, and some salt. Ask learners:  *What will happen when the salt is added to the water*?  Learners can discuss in pairs and then share their thoughts. Explain to learners that one of two things will happen: either the salt will dissolve (i.e. it is soluble) or not dissolve (i.e. it is insoluble).  Explain we will demonstrate what we mean by dissolve and not dissolve. Clear some space. Ask three quarters of learners to move about in pairs (representing liquid particles). The remaining one quarter of learners line up together as solid particles and then move into the ‘liquid’. Say that the solid is in the water but it has not dissolved; the solid is insoluble.  Then ask the liquid pairs to go and gently pull individual ‘solid’ learners out of the ‘solid rows’ and into the ‘liquid’. Explain how some solids can break up in a liquid and the particles (or small groups of particles) move with the liquid particles. This is a type of mixing, where solids and liquids are mixed. The solid particles are so small they are not visible (i.e. they look like they are part of the liquid) but they are still there mixed up with the liquid.  Show the above as diagrammatically using the particle model.  **Resources:** Bottle of water, salt |
| **5Cc.03** Investigate and describe the process of dissolving, and relate it to mixing. | **5TWSp.01** Ask scientific questions and select appropriate scientific enquiries to use.  **5TWSp.02** Know the features of the five main types of scientific enquiry. | **How much salt can dissolve in water?**  Introduce the activity by asking learners:  How much salt can dissolve in water?’  How would you carry out an investigation to see how much salt dissolves in water?  What equipment would you need to carry out your investigation?  Which of the five types of scientific enquiry would the investigation be?  Explain that the type of scientific enquiry would be ‘observing over time’ as they would be adding more and more salt to the water.  Ask learners to put 100 ml of water in a container and mark the water line with a marker pen. They then add one level teaspoon of salt.  What happens to the salt?  Why do you think that happens?  What could you do to get the salt to dissolve?  Explain that in cold water salt is not very soluble and that they will need to stir the water; stirring increases the surface area to allow the solvent to dissolve the solid. Learners mix the water/salt mixture by stirring until all the salt has dissolved.  How do you know when all the salt has completely dissolved?  How many times did you need to stir the mixture before all the salt had fully dissolved?  Learners repeat the process, one teaspoon of salt at a time, until no more salt will dissolve.  How do you know no more salt is going to dissolve?  How many teaspoons of salt have dissolved in the water?  What has happened to the volume of the water?  Why do you think the volume of the water has increased?  Tell learners that they have made a ‘saturated’ salt solution which means no more solute will dissolve. Relate this back to the particle model and explain that the space between water particles is filled with salt particles but both the salt and water particles can move freely so it is still a liquid.  This activity could be extended by repeating the investigation using warm water to see if there is a difference in the amount of salt that dissolves.  Health and safety: Do not let learners taste the salt solution.  **Resources:** Salt, container, teaspoons, stirring rods (optional) |
| **5Cc.02** Understand dissolving is a reversible process and investigate how to separate the solvent and solute after a solution is formed. | **5TWSa.03** Make a conclusion from results informed by scientific understanding.  **5TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Retrieving a solid from a solution**  Present the learners with a saturated salt solution explaining how it was made.  Where did the salt go?  Where do you think it is now?  Look at a particle model of the solution to show the solid is mixed with the liquid.  *Is there any way of getting the salt back?*  Learners pour 50 ml of saturated salt solution into a shallow plastic dish and place it on a windowsill or other flat surface and mark the level of the solution in the dish.  *What do you think is going to happen?*  Leave the salt solution for a week and then check it.  What has happened to all the water?  What is left in the dish?  How could we have collected the water as well?  Explain that all the water has evaporated leaving the salt behind. Depending on how slowly the water evaporates there might be large salt crystals formed; a slow rate of evaporation creates better crystals. The water can could be collected by condensing it on a cold surface as it evaporated; you could use a condenser to demonstrate this to the learners. Explain that this process is used in the commercial production of sea salt.  Clear some space in the room and get learners to move around in pairs within the space to represent liquid particles. Tell the learners to move quicker, representing an increase in energy.  What happens to the particles?  As the learners move around the class with more energy, what state have they now become?  The liquid particles have now become a gas by the process of evaporation.  Start again with three quarters of the learners in pairs representing liquid particles and the remaining one quarter of learners representing solid particles that are dissolved in the liquid. Apply energy again, the increase in energy turns the liquid particles into gas particles, and the solid particles move faster but they remain as solid particles.  *Do you think the solid will evaporate with the water?*  Support learners in seeing that the liquid particles will become gas particles, but the solid particles will remain as solid particles. We now have the solid back.  **Resources:** Saturated salt solution, shallow plastic dishes |

# Unit 5.3 Forces

| Unit 5.3 Forces |
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| Outline of unit: |
| This unit covers forces and how they act. Learners will be able to name forces, describe the situations forces are observed in and the actions that forces have. They will be able to describe how forces act in opposite pairs and that forces can be balanced or unbalanced in different situations. They will learn how to draw force diagrams showing the forces acting in different situations.  Magnetism is also covered to ensure there is clarity about the links between magnetism and forces. Learners will learn about magnetic materials and how they differ from magnets and understand relative magnetic strength.  Learners will have opportunities to discuss the different types of scientific enquiry, make and test predictions and understand the importance of repeating measurements. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * knowing forces are pushes and pulls that are defined by their size and direction * identifying forces can cause objects to change speed (i.e. accelerate/decelerate), direction and/or shape * knowing different types of forces act in different situations * knowing magnets attract some materials * describing some uses for magnets. |
| Suggested examples for teaching Science in Context: |
| ***5SIC.02*** *Describe how science is used in their local area.*  Learners will be familiar with many local situations in which forces operate, e.g. the seesaw, swings and slide in the play park; watching cars or bicycles; playing sport. Spend time discussing all the different places learners will encounter forces in their lives.  ***5SIC.03*** *Use science to support points when discussing issues, situations or actions.*  Encourage learners to discuss the forces they are encountering in everyday activities.  ***5SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science.*  Everyone uses forces in their everyday lives. Engineers, architects and builders specifically need to understand different forces and how they can impact on the structures they are building. Train designers are using magnets to develop the next generation of trains (e.g. ‘Maglev’) that could change travel around the world.  ***5SIC.05*** *Discuss how the use of science and technology can have positive and negative environmental effects on their local area.*  Introduce learners to the way the force of the wind, or falling water, can be used to turn turbines and generate renewable electricity. By considering how they use technology in orbit (e.g. satellites) the environmental impact of space flight could be discussed because the force required to exit the Earth’s gravitational field uses up a lot of resources. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
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| **5Pf.01** Identify a range of forces (limited to gravity, applied forces, normal forces, upthrust, friction, air resistance and water resistance) | Gravity, normal force, applied force, upthrust, friction, air resistance, water resistance, balanced, unbalanced | Learners can use diagrams to represent the range of forces. | Some learners may believe that heavy objects fall faster because gravity pulls them down more strongly; gravity acts equally on all objects but, on Earth, other factors (e.g. air resistance, upthrust) affect the rate of falling of an object. This misconception will be addressed through coverage of the learning objective. |
| **5Pf.02** Know that an object may have multiple forces acting upon it, even when at rest. | Balanced forces, unbalanced forces, gravity, normal force, applied force, friction | Learners can use force diagrams, of their own design, to show multiple forces acting on an object. | Some learners may believe that a resting object has no forces acting on it; gravity is always acting on an object but it is balanced by the normal force from the surface acting in the opposite direction (i.e. perpendicular to the surface). This misconception will be addressed through coverage of the learning objective. |
| **5Pf.03** Use force diagrams to show the name and direction of forces acting on an object. | Size, direction, effect | Learners will use force diagrams extensively within this unit. | It is good practice at this stage to support learners in drawing force diagrams according to convention i.e. arrows in the correct place, size and direction. |
| **5Pe.01** Know that forces act over a distance between magnets, and between a magnet and a magnetic material. | Magnet, magnetic, magnetic material, attract, magnetic field | Learners can be shown a diagram of a magnetic field showing how it extends beyond the magnet. | Some learners may believe that magnets ‘stick’ to metal rather than magnets ‘attract’ some metals. Demonstrate that magnets are not ‘sticky’ because they do not stick to everything. Alternatively, show learners that a magnetic material is still attracted to a magnet when they are separated by a sheet of paper. |
| **5Pe.02** Know the difference between a magnet and a magnetic material. | Magnet, magnetic, magnetic material | Learners can use diagrams, and appropriate models, to show the difference between a magnet and a magnetic material. | Some learners may believe that magnetism is transferred (e.g. rubbed off) from a magnet onto a material turning it into a magnet; magnetism is a change in the properties of the material and not a transfer of anything. This misconception will be addressed through coverage of the learning objective. |
| **5Pe.03** Know that magnets can have different magnetic strengths. | Magnet | Learners can use diagrams to show their understanding that magnets can have different strengths. | Some learners may believe that the strength of a magnet depends on its size (i.e. bigger means stronger). Instead the strength of a magnet depends on the shape, the material and how it was made (not its size). This misconception will be addressed through coverage of the learning objective. |

# Unit 5.3 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
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| **5Pf.01** Identify a range of forces (limited to gravity, applied forces, normal forces, upthrust, friction, air resistance and water resistance) | **5TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry. | **Forces demonstrations**  Carry out the following demonstrations for learners to observe and allow learners to participate if possible. Learners record their observations in diagram form. Ask learners questions to help structure the discussion and guide learners to understand the nature of each type of force. Learners can then record the type of force they observed and an explanation (or diagram) of how it works.  Gravity  Drop a ball from as high as you can.  What happens to the ball when I let go of it?  Does it always fall the same way?  What is causing it to fall?  Where does gravity come from?  What other effects does gravity have?  Explain that the ball falls straight down because it is pulled towards the centre of the Earth by gravity that comes from the mass of the Earth. Gravity is the force that pulls every object towards the centre of the Earth; it also keeps the Moon in its orbit.  Some learners may believe that gravity pulls down some objects more strongly than others. In order to address this misconception, drop two solid objects of different masses (and sizes) from head height to show they hit the floor at the same time. Carefully select the two objects and do not drop them from higher than your head otherwise other forces (i.e. air resistance, upthrust) will have a significant and visibly different effect on the two objects; this would reinforce rather than correct the misconception.  Learners draw labelled diagrams of what happens when objects are dropped.  Normal force  Place a ball, or toy car, on a flat surface.  What forces are acting on the object?  If gravity is pulling the car down then why is it not moving towards the centre of the Earth?  Why is it not sinking?  Where could the opposite force be coming from?  Explain that forces always work in pairs and in opposite directions (this is Newton’s Third Law although learners do not need to know the name at this stage). So, if gravity is pulling the object down there must be a force pushing the object up and, because the object is not moving, the forces must be equal (balanced). The ‘pushing up’ force exerted on an object by the surface that it is resting on is called the normal force.  Learners draw a diagram of an object at rest on a flat surface showing gravity pulling it down and the normal force pushing up; there is no need to introduce force diagrams at this stage, learners choose how they want to show the forces.  Applied Force  Place a toy car (or a ball) on a flat surface.  *What forces are acting on the object while it is not moving?*  Give the object a short push across the surface, then give it a continuous push.  What happened to the object when it was pushed for a short time?  What happened when the object was pushed continuously?  What caused it to move?  Remind learners that when an object is not moving (i.e. at rest) the forces acting on the object are balanced (i.e. gravity pulling it down and the normal force from the surface pushing back up). When the object is pushed another force is applied; the object starts to move because the forces are unbalanced and it moves in the direction that the force is applied in.  After a short distance, depending on the size of the push, it slows down and stops. When a continuous contact force is applied the object continues to move.  Learners draw a diagram of an object on a surface and describe what will happen when a force is applied to the object.  Upthrust  Inflate a balloon and place it in a water tank (or sink) full of water. Invite learners to try and push the balloon under the surface of the water.  What do you feel when you push the balloon down?  Why does it feel as if the balloon is pushing up against your hand?  What forces are acting on the balloon?  Learners feel the upthrust from the water; the force pushes the balloon up against the pull of gravity. In this case the upthrust on the balloon is larger than the weight of the balloon so it is pushed up (i.e. it floats). Upthrust acts on all objects when they are placed in water whether they float or sink.  Learners draw a diagram of the balloon in the water and write a sentence to describe what they felt when they pushed down on the balloon.  Friction  Learners should have prior knowledge of ‘friction’ from Stage 3. Remind learners about the ‘applied’ force demonstration and how the car slowed down and stopped after a while.  *What do you think caused the car to slow down and stop?*  Roll a ball down a ramp (e.g. a sloped book resting on a stack of books) onto a smooth surface (e.g. tiles, wooden floor) and observe how far it rolls; you can measure the distance if there is time. Then roll the same ball down the same ramp onto a rough surface (e.g. carpet) and observe how far it rolls; you can measure and compare the distances.  What is the difference between the behaviour of the ball on the two surfaces?  Why does it stop much sooner on the rough surface?  What forces do you think are acting on the ball?  Explain that the friction from any surface will cause the ball to slow down. There is much more friction between the ball and the rough surface (than on the smooth surface) so the ball stops much quicker. Friction acts between any object that is in contact with a surface or another object.  Learners draw a labelled diagram of a ball rolling along a surface and describe the forces acting on it, (i.e. gravity and friction) and the effect that the forces have (i.e. the ball will eventually stop rolling as friction slows it down).  Air resistance  Take two identical sheets of paper, roll one into a small ball and keep the other flat. Drop both pieces of paper from the same height at the same time and observe what happens.  Why do the pieces of paper fall at different rates?  How is gravity affecting both pieces of paper?  What other forces are acting on the paper?  Explain that objects travelling through air are in contact with the mixture of gas particles that make up the air a force like friction slows them down. This force is called air resistance. The effect of air resistance depends on the surface area of the object travelling through it; the flat piece of paper travels much slower than the rolled-up ball, even though they are the same mass, because it has a much larger surface area. Air resistance is the force that makes parachutes work; the large surface area of the parachute increases the air resistance and slows down the descent.  Learners can feel the effect of air resistance for themselves by running in an open space with and without a large sheet of cardboard. They will find it is much harder when they have the cardboard. This also explains the shape of high-speed trains, rockets and sports cars, and why racing cyclists try to minimise their body shape.  Learners draw a labelled diagram of the two pieces of paper falling; they write a short description of which forces are acting on the paper and the effect the forces have.  Water resistance  Make two identical lumps of playdough (or clay) into boats; they should both have flat bottoms so that they will float. Give one a pointed front, and the other a flat front.  *What do you think will happen when I drag these in water?*  Use string and a force meter to pull the boats through water in a tank (or sink).  Which one travels through the water faster?  Which one requires the most force to move?  What forces are acting on the boats?  Explain that, just like in air, the objects are travelling through particles of water that have a friction-like effect on the object. We call this water resistance and it affects objects with a larger surface area more than those with a small surface area. The flat-fronted boat experiences greater water resistance because it has a larger surface area, so it travels slower through the water. Water resistance affects all objects moving through water; swimmers and boat designers find ways to overcome the resistance so that movement is more efficient.  Learners draw a labelled diagram of the two objects travelling through water and show the forces acting on them and the effect they have.  **Resources:** Ball, toy car, ramp, paper, cardboard, water tank, balloon, modelling dough, string, forcemeter |
| **5Pf.02** Know that an object may have multiple forces acting upon it, even when at rest. | **5TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts. | **Paired forces**  Give pairs, or small groups, of learners a ball (or a toy car).  Tell them to place their object on a flat surface and observe it.  What forces are acting on the object?  What force acts continuously on every object on Earth?  What are the forces doing to the object?  Why is the object not moving?  Explain that gravity is continuously acting on all objects trying to pull them down; if the object is not moving down then an opposite force, the normal force, must be balancing gravity.  Forces always act in pairs, and in opposite directions to each other.  How could we make the object move?  What do you predict will happen to the object if a force is applied?  Which direction will the object start moving in?  Is there another way to make the object move?  What do you predict will happen to the object once it starts moving?  What scientific knowledge have you got to support your prediction?  The easiest way to move the object is by applying a force to it (i.e. pushing it); the object will start moving in the direction of the push. Two things happen as soon as a force is applied to the object: the force causes the object to move and an opposite force that resists the movement, in this case friction, will also start acting on the object. The friction starts to slow the object down until it stops. How quickly the object comes to a stop depends on the amount of friction which depends on both the object and the texture of the surface.  Ask learners to draw a diagram showing the forces acting on the object when it is at rest and when a force is applied to it. Learners can choose how they represent the forces in the diagram.  **Resources:** Balls or toy cars. |
| **5Pf.03** Use force diagrams to show the name and direction of forces acting on an object. | **5TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Force diagrams**  Present a range of force diagrams to the learners, each showing a different way to represent the forces. Learners discuss, in pairs, the advantages and disadvantages of each type of force diagram. As a class, discuss how consistency will help us all understand the same idea; so we need to use force diagrams in the same way if it is to be a commonly-used model (or representation). Explain that there is a standardised way to represent the forces acting on an object; these standard force diagrams show the name, direction and size of each force acting on an object.  Show learners a few examples of simple, standard force diagrams.  How is the direction of the force shown?  How is the size of the force shown?  Which force must always be shown?  Explain to learners that they should ensure that force arrows that are meant to be the same look as similar as possible (i.e. the same length and thickness).  Set up the scenarios below and discuss with learners what forces are acting on the object.  Get them to draw accurate force diagrams for each situation.  Place a toy car on the table and leave it alone. (Balanced forces: gravity pulls it down; the normal force pushes it up.)  Roll a ball slowly across a table. (Balanced forces: gravity pulls it down; the normal force pushes it up. Unbalanced forces: a pushed, applied force causes it to roll; friction slows it down by pulling it. The applied force is larger than friction to start with which is why it moves.)  Drop a sheet of paper from as high as possible. (Unbalanced forces: gravity pulls it down; air resistance pushes it up. Gravity is larger than the air resistance which is why it falls.)  Ask learners to think of simple everyday scenarios that they encounter and draw force diagrams to show how the forces are acting.  **Resources:** Examples of force diagrams, toy car, ball |
| **5Pe.01** Know that forces act over a distance between magnets, and between a magnet and a magnetic material. | **5TWSp.05** Describe risks when planning practical work and consider how to minimise them  **5TWSc.06** Carry out practical work safely. | **Magnet maze**  Ask learners to tell you what they already know about magnets.  Present magnets to learners. Explain that magnets have to be treated carefully because they can be damaged and/or cause damage to electronic equipment.  *What steps are you going to take to ensure your magnet does not get damaged, or cause damage?*  Learners must keep magnets away from electrical equipment and ensure they do not get dropped on a hard surface.  Remind learners that magnets can attract magnetic materials; this can be done with a practical demonstration.  Give learners a small whiteboard (or a piece of card), a magnet and a paper clip. Ask them to draw a maze with a start and a finish. Then they use the magnet (underneath the whiteboard) to guide the paper clip through the maze, from the start to the finish.  How easy is it to control the paper clip’s movement?  How can the magnet cause the paper clip to move when they are not touching each other?  Explain that magnets have an invisible magnetic field around them which affect nearby objects, including making them move, without having to touch them. Show learners a diagram of a magnetic field. Use photos, videos and/or a demonstration of iron filings to help learners visualise the magnetic field  These activities will address the misconception that magnets and magnetic materials ‘stick’ to each other; they show that a magnet affects magnetic materials without any direct contact.  **Resources:** Magnets, paper clips, small whiteboards |
| **5Pe.02** Know the difference between a magnet and a magnetic material. | **5TWSc.01** Sort, group and classify objects, materials and living things through testing, observation and using secondary information. | **Magnetic or non-magnetic**  Provide learners with a variety of different materials. Learners test each material by touching it with a magnet; they then group the materials into those that are magnetic and those that are not.  What similarities are there between the magnetic materials?  Were there any materials that you were surprised by?  Can you predict whether a material will be magnetic or not?  Learners then see if magnetic materials can attract each other.  *Do any of the magnetic materials attract each other when the magnet is not there?*  Discuss how magnetic materials are not magnets themselves; they are made to be magnetic through the magnets invisible field that affect them.  *Do you think magnetic materials can be made into magnets?*  Explain that magnetic materials generally contain iron. Most magnetic materials are not magnets but it is possible to make a magnet out of a magnetic material. Give each learner a magnet and an iron (or steel) nail; steel is a metal which contains iron. Ask learners to try and pick up a paper clip with the nail.  *Is the nail a magnet?*  The nail is not a magnet but can be made into a magnet by stroking it repeatedly with the same end of a magnet; the more times the nail is stroked, the stronger the resulting magnet will be. Demonstrate the technique and then learners magnetise their own nails. They test whether the nail has become a magnet by trying to pick up a paper clip.  *What do you think has happened to the nail?*  Explain that magnetism has not been ‘rubbed off’ the magnet onto the nail. Introduce a model to help learners understand what is actually going on. The nail is made of iron particles that can all be thought of as ‘mini-magnets’ which are facing in random directions. When the nail is stroked with the magnet the ‘mini-magnets’ are pulled so they all face in the same direction giving the nail a north pole and a south pole; it has been turned into a magnet.  The effect can be reversed by dropping the nail several times onto a hard surface which causes all the ‘mini- magnets’ to be mixed up again. There are online descriptions of this process, including video clips, to help learners understand this concept.  **Resources:** Magnets, nails, paper clips |
| **5Pe.03** Know that magnets can have different magnetic strengths. | **5TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry.  **5TWSc.04** Decide when observations and measurements need to be repeated to give more reliable data.  **5TWSc.05** Take appropriately accurate measurements.  **5TWSa.05** Present and interpret results, using tables, bar charts, dot plots and line graphs. | **Strength test**  Give learners a range of different sized and shaped magnets; include some neodymium magnets if possible.  *Can you predict the strength of a magnet based on its size or shape?*  Learners attach a paper clip to their magnet, then more paper clips to the first paper clip to create a chain until no more paper clips are attracted; only the first paper clip should be in contact with the magnet. They repeat each measurement multiple times to give a reliable result and record their results in a suitable table.  Learners repeat the procedure for each of the different magnets they have been given. Explain that this is a fair test so the method should be followed in the same way for each magnet.  Why is it important to repeat measurements?  What do you do with your repeated results?  Explain that repeating measurements gives more reliable results and instruct learners to take an average of the measurements to get their result for each magnet. Learners represent their results in a bar chart to show the various strengths of the magnets.  Explain how each paper clip becomes magnetised through the ‘mini-magnets’ in each paper clip aligning to create a north and south pole. The stronger the original magnet, the stronger the alignment is throughout the paper clip creating a stronger ‘paper clip magnet’; although the ‘paper clip magnet’ is always weaker than the one that created it. This process is repeated for every paper clip added: the first paper clip makes the second a magnet; the second makes the third a magnet etc. The strongest original magnet can ‘hold’ the most paper clips as it creates stronger ‘paper clip magnets’ through the chain until the last ‘paper clip magnet’ is too weak to attract the weight of the next paper clip.  **Resources:** Range of magnets, paper clips |

# Unit 5.4 Animals

| Unit 5.4 Animals |
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| Outline of unit: |
| Learners will study the digestive system of animals (including humans). They will understand the importance of an adequate, balanced diet and become aware of the health implications of a poor diet.  They will consider the specific adaptations of animals living in different environments and then focus on the adaptations of predator and prey animals.  Learners will have opportunities to classify animals; they will develop a classification key to identify different species. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * understanding animals must eat to survive * knowing the digestive system is one of the major body systems of animals * identify that animals live in different environments across the world. |
| Suggested examples for teaching Science in Context: |
| ***5SIC.01*** *Describe how scientific knowledge and understanding changes over time through the use of evidence gained by enquiry.*  Learners can discuss how our understanding about the digestion system has changed over time. Historical records about diets throughout history can be used to show how thinking has changed over what is adequate and healthy to eat. Learners can consider how science has helped us understand dietary requirements better.  ***5SIC.03*** *Use science to support points when discussing issues, situations or actions.*  Learners can use knowledge of balanced diets when discussing health issues related to eating.  ***5SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science.*  Healthcare professionals need to know about the digestive system, diet and possible health complications. This unit provides a good opportunity to invite a health professional (e.g. a doctor, nurse or dietitian) into the classroom to discuss their work and the need for an adequate and balanced diet. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
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| **5Bs.04** Describe the human digestive system, including the functions of the organs involved (limited to mouth, oesophagus, stomach, small intestine, large intestine and anus), and know that many vertebrates have a similar digestive system | Mouth, oesophagus, stomach, small intestine, large intestine, anus, vertebrates, digestion, digestive system | Learners could create (or annotate) diagrams of the digestive system to show their understanding.  They could make a physical model (e.g. a bag for a stomach, stockings for intestines) to represent the digestive system. | Some learners may believe that the stomach absorbs food; they need to understand the specific functions of the different parts of the digestive system. This misconception will be addressed through coverage of this learning objective. |
| **5Bp.01** Know that animals, including humans, need an adequate, balanced diet in order to be healthy. | Balanced diet | Learners can create (or annotate) a diagram showing their understanding of an adequate and balanced diet.  They could also create a representation by using paper plates and drawing and/or sticking on images of foods and drinks. | Some learners may believe that all animals need the same balanced diet; they should be made aware that different species have different dietary requirements. |
| **5Be.01** Describe how plants and animals are adapted to environments that are hot, cold, wet and/or dry.  (In this unit only the adaptations of animals will be covered) | Adaptation, environment | Learners could create (or annotate) diagrams of animals which highlight the adaptations that help them to survive in a specific environment. | Some learners may think that there are some places on Earth where no animals live; they should understand that, although some environments look like no animals live there, animals inhabit almost every environment on Earth and that these animals have specific adaptations to do so. |
| **5Be.03** Describe the commons adaptations of predator and prey animals. | Adaptation, predator, prey | Learners could create (or annotate) diagrams of prey and predator animals, which highlight the adaptations that help them to survive in a specific environment. | Learners may think animals can only be a predator or a prey; some animals can be both.  Ask learners to look at animals that are both predator and prey and identify the adaptations that support them surviving as both predator and prey. For example, a bird eats grasshoppers and is eaten by a fox. |

# Unit 5.4 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
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| **5Bs.04** Describe the human digestive system, including the functions of the organs involved (limited to mouth, oesophagus, stomach, small intestine, large intestine and anus), and know that many vertebrates have a similar digestive system | **5TWSm.01** Know that a model presents an object, process or idea in a way that shows some of the important features.  **5TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Demonstration of the human digestive system**  The following practical can be carried out by learners in small groups or, if necessary, it can be a teacher‑led demonstration. Several versions of the demonstration can also be found online and adapted to suit your situation.  *What do you think happens to your food when you eat it?*  Explain to learners that a complex series of processes are carried out as food passes through the digestive system, from mouth to anus. This practical activity is a model of what happens; it shows the key features of the digestive system.  Cover the table in newspaper and use a plastic (or aluminium) tray to catch any mess. Put a cracker, a third of a banana and 50 ml of water (to represent saliva) in a plastic bowl. Mash it up with a fork; this represents the chewing of food in the mouth.  Put the chewed-up food, with some orange juice (representing stomach acid), into a small, sealable plastic bag; the bag represents the stomach. Squeeze the air out and seal the bag. Smash the mixture inside by squeezing the bag for one minute; this mimics the action of our stomach walls breaking down food.  Cut a small hole in the corner of the bag and push the contents into a stocking (or one leg cut from a pair of tights) which represents the small intestine; this should be done over a tray. Squeeze the food slowly through the stocking. The liquid that ends up in the tray represents nutrients that are absorbed by the body and used for growth and energy. The food that remains inside the stocking is the waste that cannot be absorbed.  Cut the toe off the stocking and squeeze the remaining food out of the end onto some paper towels; they represent the large intestine. Squeeze the remaining food in the paper towels to get as much of the remaining water out. This process also gathers any remaining salts that the body needs.  Place the remaining undigested food into a bag; the bag represents the rectum. This is where the waste (the undigested food) is stored until it is removed. Cut a hole in the bag to represent the anus. When you go to the toilet, your body pushes the food waste out of the anus, and out of the body. Squeeze the bag so the food waste is deposited onto a tray. This represents going to the toilet.  Learners observe the different processes and then draw a labelled diagram of the digestion system from mouth to anus. They label the parts of the system and the processes that happen at each stage.  Recap the key features of the model and how they help our understanding of the human digestive system.  Learners can then use secondary information sources (e.g. books, internet) to research the digestive systems of other vertebrates. They can see which vertebrates have digestive systems that are similar to humans and identify any key differences in the digestive systems of those vertebrates that are not similar. For example, cows have a complex stomach system to support the digestion of grass but is otherwise similar in structure to the human digestive system. Learners present their results to the class.  **Resources**: Bananas, cream crackers, plastic bowls, forks, water, orange juice, sealable plastic bags, scissors, stockings, paper towels, plastic trays, secondary information sources. |
| **5Bp.01** Know that animals, including humans, need an adequate, balanced diet in order to be healthy. | **5TWSc.01** Sort, group and classify objects, materials and living things through testing, observation and using secondary information. | **Weekly food diary**  Learners keep a diary of what they eat in the course of a week; they note down approximate portion sizes and which of the major food groups their food fits into (i.e. fruit and vegetables, starchy carbohydrates, oils and fats, dairy, protein).  Discuss the difference between an adequate diet (how much is eaten) and a balanced diet (what is eaten).  Learners can use secondary information sources to research the importance of diet to human health and then present their findings to the class:  Why is a balanced diet so important for humans?  What happens if someone’s diet misses out one of the major food groups?  Why is an adequate diet so important to humans?  What health issues are associated with poor diet?  This activity can be extended by providing a range of food packaging to learners. They read the nutritional labels, sort food into main groups and investigate the salt and sugar content. Learners can use secondary information sources to understand the importance and dangers of salt and sugar in their diet.  *Why do we need salt and sugar in our diet? Why is too much salt or sugar bad for us?*  **Resources**: Food diary, food packaging, secondary information sources. |
| **5Be.01** Describe how plants and animals are adapted to environments that are hot, cold, wet and/or dry. | **5TWSc.01** Sort, group and classify objects, materials and living things through testing, observation and using secondary information. | **Animal adaptations in different environments**  Remind learners that plants adapt to live in different environments. Explain that this is true for animals also. Show learners videos showing animals (e.g. polar bear and camel) that live in different environments and how they have adapted to their habitats.  What features does this animal have?  Why does this animal have these features?  How does each feature help the animal survive?  Provide a selection of pictures of differently adapted animals and different environments - learners decide which environment each animal would most likely be found and match the animal to a suitable environment. Learners should identify what adaptations of the animal allow it to survive in each environment by annotating the images.  Include a wide variety of animals from around the world that are adapted to very different conditions. Learners then match the animals to descriptions of them, their adaptations and where they are found.  What are the most important adaptations animals have in order to survive?  How do environmental conditions affect the adaptations animals need in order to survive?  **Resources:** Video clips, animal picture cards, books, websites |
| **5Be.03** Describe the common adaptations of predator and prey animals. | **5TWSc.02** Complete a key based on easily observed differences. | **Predator versus prey**  Remind learners that animals can be predators and/or prey.  Where do animals get their food from?  Do you know any examples of animals that are predators, prey or both?  Give learners a set of animal picture cards; there should be a mixture of predators and their prey. Learners look for clues in order to sort the cards into those that are predators and those that are prey.  What do you notice about the predators and prey?  Are there similarities?  Are there adaptations that are shared by all of the predators or prey?  Are there any animals that are both predator and prey?  Ask learners to match up each predator with their prey; they explain why they have made their choices. Afterwards, give learners written descriptions of the specific adaptations each animal has and ask them to match these to the pictures.  Provide learners with a classification key for the animals provided; they complete the sheet by answering the yes/no questions so that each animal can be written into the predator or prey group (e.g. *Do the animal’s eyes face forward?*). For animals that are both predator and prey they can be put through twice to show how they can belong in both groups.  This activity can be extended by learners designing their own pairs of animals where one animal is the prey and the other is the predator. They describe the adaptations that would help each animal to survive.  **Resources**: Predator and prey picture cards, written descriptions, a classification key sheet. |

# Unit 5.5 Waves

| Unit 5.5 Waves |
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| Outline of unit: |
| This unit covers sound and how it moves through a medium, such as air or water, and is caused by vibrations at the sound’s source. Learners will begin to associate sound to the scientific idea of waves.  Learners will investigate making sounds and how the pitch and volume can be changed.  Learners will have opportunities to ask scientific questions, choose equipment when doing an experiment and identify patterns in results. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experiences of:   * knowing air surrounds us and it is made up of different gases * making noise and how to change the volume of the noise (e.g. using their voices). |
| Suggested examples for teaching Science in Context: |
| ***5SIC.02*** *Describe how science is used in their local area.*  Learners can do a sound walk in their local area. They think about the pitch and volume of what they can hear. They can also consider how some sounds are made on purpose and others are not.  ***5SIC.03*** *Use science to support points when discussing issues, situations or actions.*  Learners can discuss the issues around wearing headphones to listen to music and/or being in locations where sound is particularly loud (e.g. airport runways, music festivals). This would include explaining the potential damage that loud sound can have on the ears.  ***5SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science.*  Musicians and sound technicians understand how sound is produced. Architects apply their knowledge of how sound travels when they are designing buildings. This could be an opportunity to invite in a member of the community, who plays a musical instrument, to discuss the science behind what they do.  ***5SIC.05*** *Discuss how the use of science and technology can have positive and negative environmental effects on their local area.*  Learners can discuss how animals can be affected by very high pitch and very loud sounds. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
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| **5Ps.01** Investigate how sounds are made by vibrating sources. | Vibration vibrating, particles, source, medium, wave | Learners could use diagrams to show their understanding of how vibrations travel from a source through the air to our ears.  Learners can use the particle model to support their understanding of how sound is made. | Some learners may believe sound moves between particles. Instead particles move and transfer energy in a chain.  This misconception will be addressed through coverage of the learning objective. |
| **5Ps.02** Describe sounds in terms of high or low pitch and loud or quiet volume. | Pitch, volume, high, low, loud, quiet | Learners could use diagrams to show their understanding of pitch and volume. | Some learners may believe that pitch and volume are the same thing and/or that hitting an object harder may change its pitch rather than change the volume.  These misconceptions will be addressed through coverage of the learning objectives. |
| **5Ps.03** Investigate how to change the volume and pitch of sounds. | Pitch, volume, high, low, loud, quiet |

# Unit 5.5 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
| --- | --- | --- |
| **5Ps.01** Investigate how sounds are made by vibrating sources. | **5TWSp.01** Ask scientific questions and select appropriate scientific enquiries to use. | **Sound**  Ask learners what they already know about sound and what questions they have about it. These might include: *How do we make sounds? Where do sounds come from? How does sound get to our ears? How can we make different sounds?*  Ask learners if they can suggest possible ways to investigate their questions:  *What types of enquiry could you use?*  If necessary, suggest that observations over time or pattern seeking might be appropriate for investigating sound.  Remind learners we are surrounded by air, which is a mixture of different gases. Explain that all sounds are the result of vibrations from a vibrating source which cause air particles to move and that vibrations can be made in a variety of ways.  One simple way for humans to make sound is to speak. Show learners how to investigate the way they use their vocal chords to speak and make different sounds; they place their fingers on their neck and feel different vibrations when they hum at different pitches.  *How are these vibrations made?*  Explain that air, from the lungs, is pushed through the vocal chords which cause the particles in the air to vibrate. Different movements of the vocal chords cause different vibrations in the air which produces different sounds.  Learners make simple cup telephones with string. They investigate how the tightness of the string affects the ability to hear sound.  Why can you not hear the other person when the string is held or slack?  What happens when the string is pulled tight?  Explain to learners that the sound of the other person can only be heard if the string can vibrate.  Learners observe the vibrations of tuning forks when they strike them with the heel of their hands or on their knees (tuning forks should not be struck on a hard surface). Show them vibrations by touching a tuning fork to the surface of a dish of water and/or a ping pong ball.  Tell learners that musical instruments produce sound in different ways. Give learners a selection of instruments (e.g. violin, guitar piano, trumpet, clarinet, drum). Ask them how they could investigate the way in which each instrument makes vibrations and then sort them into groups.  *How does each different instrument produce vibrations?*   * Violin: strings can be plucked, or the bow scraped against them * Guitar: strings are plucked * Piano: strings are hit with a small hammer (this can be seen if the piano is opened up) * Trumpet: vibrations are made by the player’s mouth and then travel through instrument * Clarinet: vibrations are made in the reed and then travel through the instrument * Drum: the skin is hit with a drumstick (rice placed on the drum skin can be seen to vibrate).   Recap with the learners that sound is made through the vibration of an object or a material.  **Resources:** Tuning forks, musical instruments, plastic cups, string, rice, table tennis ball |
| **5Ps.02** Describe sounds in terms of high or low pitch and loud or quiet volume. | **5TWSa.02** Describe patterns in results, including identifying any anomalous results. | **Pitch and volume**  Play learner some sounds on a stringed musical instrument (if an instrument is not available a video recording can be used). Play a high note and a low note (using open strings).  Can you hear the difference between the two sounds?  What is the difference between them?  What do you know about the strings that made the different sounds?  Explain that high and low describe the pitch of the sound. The high note is produced by a thinner string than the low note.  Is there another way to make a high and a low note? (i.e. by changing the length of the string).  What patterns are there in producing higher-pitched and lower-pitched sounds? Are there any exceptions?  Once learners understand pitch, introduce the idea of volume.  How can I change the volume of the sound?  What patterns are there in producing louder or quieter sounds? Are there any exceptions to this pattern?  Ask learners to speak in different pitches and volumes whilst placing their fingers on their neck to sense the vibrations. They describe the sounds as high or low (pitch), loud or quiet (volume).  Give learners ranking scales for pitch and volume and illustrate how they can use them to compare the pitch and volume of different sounds. For example,  Pitch   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |   where 1 is low pitch and 10 is high pitch  Volume   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |   where 1 is quiet and 10 is loud  Make, or play, a range of sounds to the learners. As they rank each sound, learners will become familiar with the range of sounds around them. Throughout the task, stop regularly and ask the learners to identify any patterns and any results that appear out of place (i.e. anomalous). At the end of the task look at the whole range of results. Highlight that pitch and volume are not always related (e.g. a high-pitched sound is not always loud).  This activity can be extended by using an online tone generator to show different pitches and volumes. Test learners hearing by getting them to raise their hands when they can first hear the sound (low pitch) and when they stop being able to hear it again (high pitch).  **Resources:** Stringed musical instrument, other objects to make sounds. |
| **5Ps.03** Investigate how to change the volume and pitch of sounds. | **5TWSc.03** Choose equipment to carry out an investigation and use it appropriately.  **5TWSa.04** Suggest how an investigation could be improved and explain any proposed changes. | **Making musical instruments**  Show learners that the volume of the sound produced by a stringed musical instrument depends on how hard you pluck the string. You can also demonstrate this by striking a drum softly and then harder. Explain how the sound of the instrument is changed by the way in which it is played.  Provide learners with an opportunity to ask any questions they have about sound based on what they now know.  Learners then create musical instruments that can producing different pitches and volumes of sound from the resources available (e.g. glass bottles, tin cans, metal spoons, plastic and/or cardboard boxes, a variety of elastic bands). Since this activity gives learners an opportunity to use their new knowledge of pitch and volume, do not give learners any more information to start with and let them choose which equipment to use.  Learners might fill cans with different amounts of water and then strike them with a metal spoon; they could make string instruments using elastic bands stretched over a box.  Ask learners to evaluate their instruments:  Have they managed to meet the criteria of producing different pitches and volumes?  How could they improve their instruments?  What different materials could be used to make them?  Explore how the learners designed their musical instruments so that different vibrations are created which produce different sounds; remind them that it is the nature of the vibration that affects the volume and pitch of the sound that is heard.  Health and safety: Be aware of the risks associated with using elastic bands. Remind learners to wear safety goggles and to not stretch the bands too far to minimise the risk of them snapping.  **Resources:** Materials and equipment to make musical instruments, safety goggles |

# Unit 5.6 Planet Earth

| Unit 5.6 Planet Earth |
| --- |
| Outline of unit: |
| The first part of this unit covers the Earth’s place in the Solar System and how the orientation and orbit of the Earth affect the climate and seasons. Learners will also research satellites and their place in the Solar System.  The second part of the unit covers processes of evaporation and condensation on Earth: the importance of our atmosphere and how the water cycle ensures the survival of living things. Learners will be introduced to a definition of the term ‘pollution’ and research the negative impact humans have on our environment. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * The knowing the Earth is one of a group of planets in the Solar System * knowing the Sun is a star * understanding we are surrounded by air which is a mixture of different gases * describing the processes of evaporation and condensation. |
| Suggested examples for teaching Science in Context: |
| ***5SIC.01*** *Describe how scientific knowledge and understanding changes over time through the use of evidence gained by enquiry.*  Human understanding of the sun, the Solar System and our place within it has changed dramatically over time. Learners can research what people used to believe, compare it to what we know now, and some of the evidence involved in changing our understanding.  ***5SIC.02*** *Describe how science is used in their local area.*  In many parts of the world the lack of clean water for drinking is a major issue. Learners can investigate how water is treated in their local area.  ***5SIC.03*** *Use science to support points when discussing issues, situations or actions.*  Pollution of the air, oceans, waterways and land is a major issue. Learners can debate what can be done to reduce the impact of humans on our planet.  ***5SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science.*  Environmental scientists have an increasingly important role in our global society. Astronomers and astrophysicists study space and the astronomical bodies. Learners could research these scientists, contact them online (supervised by the teacher) and/or invite them to visit the school.  ***5SIC.05*** *Discuss how the use of science and technology can have positive and negative environmental effects on their local area.*  Clean air and clean water are two of the major environmental issues facing humans at the moment. Learners can develop their understanding of the global ecosystem and the impact we have on the environment. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
| --- | --- | --- | --- |
| **5ESs.01** Describe the orbit of the Earth around the Sun (limited to slight ellipse, anticlockwise direction and the duration). | Earth, Sun, orbit, duration, year, leap year, slight ellipse, anticlockwise, planets | Learners can create (or annotate) diagrams, physical models, drama and/or online simulations to help describe the orbit of the Earth around the Sun. | Some learners may believe that the Earth stays still while the Sun goes around it. This misconception will be addressed through coverage of this learning objective. |
| **5ESs.02** Describe how the tilt of the Earth can create different climates and seasons over the year in different places. | Earth, climate, tilt, seasons, sun, orbit | Learners can create (or annotate) diagrams, physical models and/or online simulations to describe how the tilt of the Earth leads to the seasons and contributes to climate variation. | Some learners may believe that different seasons are caused by being closer to, or further away from, the Sun. This misconception will be addressed through coverage of this learning objective. |
| **5ESs.03** Know that a satellite is an object in space that orbits a larger object and a moon is a natural satellite that orbits a planet. | Satellite, orbit, moon, planet | Learners can create (or annotate) diagrams to describe satellites orbiting a larger object (e.g. the Moon and the ISS orbiting the Earth, a moon orbiting another planet, the Earth as a satellite of the Sun).  Learners can use a physical model, drama or online simulations to describe satellites, both natural and artificial. | Some learners may believe that the Moon is a planet. Check that learners understand the definitions of planets and moons and that there are many moons in our Solar System. Use the example of the Moon as a natural satellite that orbits planet Earth when teaching this objective. |
| **5ESp.01** Know that the Earth is surrounded by a layer of air called the atmosphere, which is a mixture of different gases (including nitrogen, carbon dioxide and oxygen). | Earth, air, atmosphere, gas, nitrogen, carbon dioxide, oxygen | Learners can create (or annotate) a diagram of the Earth and its atmosphere, including identifying the composition of the atmosphere. | Some learners may believe that air contains nothing. Show learners that their breath contains water vapour (i.e. gas) by asking them to breathe out on a cold surface; the water vapour in the air that they breathe out condenses and can then be seen.  Learners can also look at steam which seems to disappear; explain that the visible water droplets change to an invisible gas.  Some learners may believe that air is a single gas rather than a mixture of many gases. This misconception will be addressed through coverage of this learning objective. |
| **5ESp.03** Understand that pollution is the introduction of substances by humans that harm the environment and identify examples of pollution. | Pollution, pollutant, environment,  man-made | Learners can use diagrams to show their understanding of what pollution is and to represent examples of pollution. | Some learners may believe that the term ‘pollution’ also applies to natural phenomena (e.g. volcanoes, animals, natural forest fires) that can harm the environment. Clearly explain that pollutants only exist because of human activity and therefore the term does not apply to that the natural emissions from the Earth. This will be reinforced through coverage of the learning objective. |
| **5ESc.01** Describe the water cycle (limited to evaporation, condensation and precipitation). | Water cycle, evaporation, condensation, precipitation | Learners can observe (or create) a miniature model of the water cycle. A container is filled with sand at one end (land), water at the other end (sea) and then is covered by plastic film. The cold temperature found over land at high altitude is simulated by ice placed on the cover. When a lamp (the Sun) is used at the water end of the container the water heats up and evaporates.  Learners can also use drama or annotate a diagram of the water cycle to show their understanding. | Some learners will believe that rain is made in the air, rather than being part of the water cycle This misconception will be addressed through coverage of this learning objective. |
| **5ESp.02** Understand that most water on Earth is not pure and has dissolved substances in it. | Earth, water, pure, substances, dissolved | Learners can use the particle model to show their understanding that water contains a range of dissolved substances in it. | Some learners may believe that water is pure if no impurities can be seen; instead water can contain dissolved impurities that cannot be seen. Remind learners that when salt or sugar are added to water they dissolve, creating impure water, and can no longer be seen.  Some learners may believe that it is only safe to drink pure water. Ensure that learners understand the difference between pure water and clean water. Clean water usually describes drinkable water that is not harmful and contains dissolved substances that are beneficial to humans. Pure water will not contain any beneficial substances so is actually less good for humans than clean water. |

# Unit 5.6 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
| --- | --- | --- |
| **5ESs.01** Describe the orbit of the Earth around the Sun (limited to slight ellipse, anticlockwise direction and the duration). | **5TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Earth and Sun model**  Recap previous learning about the parts that make up the Solar System.  What objects are in our Solar System?  What object is at the centre of the Solar System?  How do all the objects in the Solar System move?  Explain that the Solar System is made up of a star, the Sun, in the centre with a collection of planets, moons, dwarf planets and asteroids going around it. All the objects in the Solar System ‘orbit’ the Sun, this means that they go around the Sun. Model this by walking around an object several times.  Ask one learner to stand in the middle of a large space and hold up a picture of the Sun. Another learner, holding a picture of the Earth, walks around the Sun in an anticlockwise direction. Explain that the Earth’s orbit is slightly elliptical (i.e. like a slightly squashed circle). You can mark this out with small plastic cones for the learner to follow.  What do you notice about the distance between the Earth and the Sun as it orbits?  How long do you think it takes the Earth to orbit the Sun?  Explain that the slightly elliptical orbit means that the Earth is closer to the Sun at some points in its orbit than others. It takes 365 and a quarter days for the Earth to orbit the Sun. It is impractical to have ‘quarter-days’ in a year so they are ‘saved up’. There is an extra day, February 29th, once every four years (i.e. a leap year has 366 days).  Other planets that learners are aware of can be added into the model, each planet should also orbit the Sun in an anticlockwise direction, to give a more complete picture of the Solar System. Note: Pluto is no longer classed as a planet so should not be included in this model.  Give learners the opportunity to be the Sun and/or the Earth to reinforce the anticlockwise, slight elliptical nature of its orbit.  Learners draw a labelled diagram of the Earth orbiting the Sun; they use arrows to show the direction of the orbit. Remind them of the anticlockwise rotation of the Earth from previous learning which can also be indicated on their diagram.  **Resources:** Earth and Sun pictures, small plastic cones |
| **5ESs.02** Describe how the tilt of the Earth can create different climates and seasons over the year in different places. | **5TWSm.01** Know that a model presents an object, process or idea in a way that shows some of the important features. | **Seasons and climates**  Ask the learners to discuss in pairs:  Which places on Earth have seasons?  What are spring, summer, autumn and winter like?  Where do seasons come from?  Listen to their ideas and use these to inform the focus of the activity.  Explain that we will be using a globe (or ball) as a model of the Earth to help us understand phenomena about the planet. Tilt the globe by about 25 degrees as you rotate it.  How long does it take the Earth to do one full rotation?  What do you notice about the Earth as it rotates?  What effect do you think this has?  Remind learners that it takes 24 hours (i.e. one calendar day) for the Earth to do one full rotation; this gives us our day and night. The Earth has a 23.5 degrees tilt in relation to the Sun which means parts of our planet are further away from the Sun than others. This explains why different parts of Earth experience both different climates and the seasons at different times of year.  Use a marker to represent a location near the top or bottom of the globe. A learner shines a light, representing the Sun, at the globe. Rotate the globe, keeping it tilted at around 25 degrees. Ask learners to describe how much light the location on the globe receives.  Keeping the model tilted in the same direction around the light walk anticlockwise and in a slight ellipse and look again at how much light the location gets. This difference in light levels affects the amount of energy, and therefore heat, which affects the temperature and is mainly responsibility for the change in seasons.  Repeat the exercise with the marker on the ‘middle’ of the globe (i.e. at the equator). Describe how this part of the world receives a more consistent amount of light; it is less affected by the tilt of the Earth so experiences less seasonal variability.  Give the learners an opportunity to experiment with the model themselves and describe it to each other. Their understanding about how the tilt of the Earth creates different climates and seasons over the year in different places can be captured in a diagram or video.  **Resources:** Globe, torch |
| **5ESs.03** Know that a satellite is an object in space that orbits a larger object and a moon is a natural satellite that orbits a planet. | **5TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Satellites and moons**  Discuss with the learners:  What is a satellite?  Are all satellites artificial?  What are the main satellites in our Solar System?  Learners use secondary information sources (i.e. books, websites) to find answers to the questions and then feedback to the class.  Explain that a satellite can be artificial or natural. Artificial satellites are sent into space to orbit a planet and collect/send information back to Earth (e.g. the International Space Station, ISS). Natural satellites are objects in space that orbit a planet or star (e.g. planets, moons and asteroids).  Learners draw a labelled diagram of the Earth with the Moon and ISS orbiting it as satellites.  This activity can be extended by learners drawing labelled diagrams involving other natural and artificial satellites. These might include the Earth as a natural satellite of the Sun, a moon of Jupiter being a natural satellite of Jupiter, an asteroid being a natural satellite of the Sun, a telecommunications satellite being an artificial satellite of Earth and satellites sent to Mars being artificial satellites.  **Resources:** Books, websites |
| **5ESp.01** Know that the Earth is surrounded by a layer of air called the atmosphere, which is a mixture of different gases (including nitrogen, carbon dioxide and oxygen). | **5TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **The atmosphere**  Recap prior learningabout gases in the air around us. Discuss with learners if air is everywhere.  *Does air keep going and going?*  In space there is no air, which is why astronauts need special suits and habitats to live in space.  Explain, using a model (either a diagram or a physical representation of the Earth) that the Earth is surrounded by a layer of air and we call this the atmosphere.  *What are the different gases in the atmosphere?*  Learners use secondary information sources (i.e. books, websites) to research key facts about the gases that make up the atmosphere, including nitrogen, carbon dioxide and oxygen. They should find out the composition of the atmosphere and collect their findings in a table.  They create (or annotate) a diagram that shows the atmosphere as a layer of air around the Earth and other key facts they have found.  This activity can be extended by learners researching the atmosphere of other planets.  **Resources:** Books, websites |
| **5ESp.03** Understand that pollution is the introduction of substances by humans that harm the environment and identify examples of pollution. | **5TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Pollution**  Learners use relevant websites to research the following questions:  What is pollution?  Which parts of the Earth are affected by pollution?  What are the main human activities responsible for pollution?  What are the main effects of pollution?  How are humans trying to tackle the issues caused by pollution?  Check that learners understand that pollution is the introduction of substances, by humans, that harm the environment. Discuss how natural emissions (e.g. volcanoes, natural forest fires) are not classed as pollutants as they are naturally occurring. Pollutants are substances that would not be in the natural world if not for humans. This is why carbon dioxide from human activity is pollution, but carbon dioxide from natural sources is not.  Discuss how pollution can happen on different scales: local (e.g. littering) and global (e.g. emissions of carbon dioxide).  Ask learners to use secondary information sources to research one type of pollution. Ensure there is a range across the class and, if necessary, give examples of pollution to research (e.g. river pollution from manufacturing waste, microplastics in the ocean, pollution from transport, oil spillage in the ocean). Learners prepare a short presentation to deliver to the class outlining the causes of the pollution, the effects it has and what can be done to reduce its impact.  **Resources:** Websites |
| **5ESc.01** Describe the water cycle (limited to evaporation, condensation and precipitation). | **5TWSm.01** Know that a model presents an object, process or idea in a way that shows some of the important features. | **Water Cycle model**  Recap previous work on evaporation and condensation with specific reference to water. Explain that in nature, many things are in a cycle and this includes water.  What does the word ‘cyclical’ mean?  What does cyclical mean for the water on Earth?  Explain that the water on Earth cycles round and round using three main processes: evaporation, condensation and precipitation.  Learners make a miniature model of the water cycle and observe what happens; instructions can be found on the internet. For example, a container is filled with sand at one end (land), water at the other end (sea) and then is covered by a plastic cover. The cold temperature found over land at high altitude is simulated by ice placed on the cover. Use a lamp (the Sun) at the water end of the container to heat the water up until it starts to evaporate. Then, ask learners:  What do you notice happening to the water?  Can you identify three processes that are happening? What are they?  The water evaporates due to the heat. The water particles gain energy and change state from a liquid to a gas. The water vapour rises and it loses energy to the cold cover (where the ice is); it condenses back to liquid water. The condensed water (representing clouds) forms droplets on the cover, gathers together and gets heavy, and then precipitates (falls like rain).  Learners draw a labelled diagram of the water cycle showing the three processes. Beside each process, they write a short description of what is happening in that part of the cycle.  **Resources:** Container, water, sand, ice, plastic cover, lamp |
| **5ESp.02** Understand that most water on Earth is not pure and has dissolved substances in it. | **5TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts. | **Pure water**  Show the learners an image of the Earth from space.  What do you notice about the surface of the Earth?  What type of water is most of the Earth covered with?  Explain that more than 70% of the Earth’s surface is covered with water but over 96% of the water is salt water in the oceans. Of the remaining 4% that is fresh water and over 60% of that is frozen in the ice caps. Only about 0.3% of fresh water is accessible in lakes and rivers.  Collect as many different types of water as you can: rain water, sea water, river water, tap water, bottled water. Learners evaporate the water in shallow dishes and observe what happens, by leaving the dishes in a warm environment.  *What do you predict will be left after each water sample has evaporated?*  Learners observe the water samples over time and see if anything is left after the water has evaporated. Most of the samples should leave behind some sort of residue.  Explain that pure water (i.e. liquid containing only water particles) is very uncommon and is mostly created in scientific laboratories. Almost all water contains some dissolved substances: usually minerals and salt, sometimes some particulate matter too.  Help learners understand that impure water is not the same as dirty water. Dirty water is not safe for drinking because it contains solids, dissolved substances and or things that cause diseases that would be harmful to drink. To be safe to drink water is treated to remove these harmful substances but other dissolved substances (e.g. minerals that are important for health) are kept in the water. For this reason clean water is not ‘pure’ because it will contain some dissolved substances.  This is a good opportunity to reinforce messages about what sources of water are safe to drink locally, and to make learners aware that the rules are different in different parts of the world (e.g. tap water is safe to drink in some places but not in others).  **Resources:** Samples of water, shallow dishes |

# Sample Lesson 1

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| --- | --- |
| CLASS: | |
| DATE: | |
| **Learning objectives** | **5Cp.01** Know that the ability of a solid to dissolve and the ability a liquid to act as a solvent are properties of the solid and liquid.  **5TWSp.04** Plan fair test investigations, identifying the independent, dependent and control variables. |
| **Lesson focus /**  **Success criteria** | I can describe the properties of solid including if it dissolves  I can describe the properties of a liquid including if it acts as a solvent  I can plan a fair test investigation, identifying the variables involved |
| **Prior knowledge /**  **Previous learning** | Learners will benefit from knowing some of the properties of water. They will also benefit from understanding what happens to a soluble solid when it dissolves in water; in particular the particles of the solute are still present but cannot be seen  Previous experience of carrying out fair test investigations will also be beneficial and allow learners to continue to develop their enquiry skills in this lesson. |

**Plan**

| **Timing** | **Planned activities** | **Notes** |
| --- | --- | --- |
| **Introduction** | Start with a quick recap of prior learning about properties of water and the main features of a fair test investigation  *Can you give me examples of solids (solutes) you know that dissolve in water?*  Set the context by explaining that you have a number of solid substances and you need to know which ones dissolve in water and which ones do not. Learners are going to work in pairs to plan a fair test investigation to discover which of the solids are soluble and which are insoluble. | None |
| **Main activities** | Give pairs of learners six labelled solids and ask them to plan their investigation.  Ensure that learners have fully planned their investigation before they start to carry out the practical work, by asking learners:  *What are the control variables in the investigation?*  Learners need to keep the amount of water (solvent) and solid the same, they need to treat each solid the same (e.g. stir 10 times, no stirring), the temperature of the water needs to be the same.  *What is the independent variable in the investigation?*  Learners should recognise that there is only one independent variable in a fair test and, in this case, it is the solid added.  *What is the dependent variable in this investigation?*  *How are you going to measure the dependent variable?*  *How will you know if the solid has dissolved?*  Ask learners to suggest different ways they might measure whether the solid has dissolved.  Learners predict whether each solid will be soluble or insoluble before testing it.  Learners record their results in a table alongside their predictions; provide a table or learners could draw their own.  Discuss with learners that the ability of a solid to dissolve is a property and the ability of a liquid to act as a solvent is a property. To demonstrate this set up a ‘lava lamp’; pour some water into a container, on top of the water pour some vegetable oil. Discuss how the vegetable oil is a different liquid. Pour some salt onto the surface of the oil. The salt will not dissolve in oil (the oil is not a solvent for salt) and sink. When it sinks into the water it takes some of the oil with it. The salt then dissolves in the water and the oil that was dragged down not returns to the oil layer. At the boundary of oil and water, some of the salt returns to a solid and pulls the oil down. This demonstrates that solids dissolves in some solvents and not others, and not all liquids are solvents. | Fair Test planning template  Six solid samples (i.e. sand, salt, sugar, flour, coffee, rice)  Containers  Stirring rod  Measuring spoon (or teaspoon)  Container  Vegetable oil  Water  Salt |
| **End/Close/ Reflection/ Summary** | Learners compare their results with other groups to see if they agree on which solids were soluble and which were insoluble.  Learners write up their investigation under the following headings:  Question  Hypothesis  Apparatus  Control Variables, Independent Variable, Dependent Variable  Method  Results  Conclusion  *When do you see these soluble solids dissolving in everyday life?*  *What other solids could be tested?*  *What further investigations could be done?* | None |

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| --- |
| **Reflection Use the space below to reflect on your lesson. Answer the most relevant questions for your lesson.** |
| *Were the learning objectives and lesson focus realistic? What did the learners learn today? What was the learning atmosphere like? What changes did I make from my plan and why?*  *If I taught this lesson again, what would I change?*  *What two things went really well (consider both teaching and learning)?*  *What two things would have improved the lesson (consider both teaching and learning)?*  *What have I learned from this lesson about the class or individuals that will inform my next lesson?* |
| **Next steps**  **What will I teach next, based on learners’ understanding of this lesson?** |

# Sample Lesson 2

|  |  |
| --- | --- |
| CLASS: | |
| DATE: | |
| **Learning objectives** | **5Pe.03** Know that magnets can have different magnetic strengths.  **5TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry  **5TWSc.04** Decide when observations and measurements need to be repeated to give more reliable data |
| **Lesson focus /**  **Success criteria** | I can describe the magnetic strength of a magnet  I can make observations and record my results  I can decide when to repeat observations and why I repeated them |
| **Prior knowledge /**  **Previous learning** | Learners will benefit from knowing that, generally, magnetic materials are made of iron or steel.  Previous experience of testing whether a material is magnetic or not and identifying the difference between magnets and magnetic materials will be required.  It would be beneficial for learners to understand magnets can attract magnetic materials at a distance. |

**Plan**

| **Timing** | **Planned activities** | **Notes** |
| --- | --- | --- |
| **Introduction** | Recap prior learning about magnets. List their experiences as a class list and if required note misconceptions for addressing.  Individual learners explore attraction and repulsion between two magnets. They explore how the magnets work over a distance.  *What do you notice about the magnets when they move towards each other?*  *Why do they not need to be touching to have an effect on each other?*  Discuss how magnets attract and repulse and how magnets produce a magnetic field which is why they can act at a distance. Explain that the strength of the magnetic field can vary by magnets. | Magnets (two per learner) |
| **Main activities** | Give learners a variety of magnets (i.e. different sizes, different shapes). Explain they are going to investigate how strong the magnetic field of each magnet is.  Learners attach paper clips to each magnet in a chain to investigate how many paper clips each magnet can attract. Only the first paper clip should be in contact with the magnet. The more paper clips a magnet can ‘hold’ the stronger the magnetic field.  Learners record their results in a suitable table; they repeat each measurement multiple times to give a reliable result. Learners can decide how many times to repeat their measurements.  *Why is it important to repeat measurements?*  *What do you do with your repeated results?*  Once learners have got a set of results they believe are reliable discuss.  *How does the size of a magnet affect its strength?*  *Is there a link between size and strength?*  Discuss how the size of a magnet is not related to the strength of the magnet. Explain how in this investigation each paper clip becomes magnetised through the ‘mini-magnets’ in each paper clip aligning to create a north and south pole. The stronger the original magnet, the stronger the alignment is throughout the paper clip creating a stronger ‘paper clip magnet’; although the ‘paper clip magnet’ is always weaker than the one that created it. This process is repeated for every paper clip added: the first paper clip makes the second a magnet; the second makes the third a magnet etc. The strongest original magnet can ‘hold’ the most paper clips as it creates stronger ‘paper clip magnets’ through the chain until the last ‘paper clip magnet’ is too weak to attract the weight of the next paper clip.  This activity can be extended by testing the strength of a magnet in other ways (e.g. How far away can a magnet attract a paper clip? How thick a barrier can a magnet attract a paper clip through?) | Variety of magnets  Paper clips |
| **End/Close/ Reflection/ Summary** | Learners compare their results with the rest of the class to check their reliability.  *What conclusions can you draw from your results?* |  |

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| **Reflection Use the space below to reflect on your lesson. Answer the most relevant questions for your lesson.** |
| *Were the learning objectives and lesson focus realistic? What did the learners learn today? What was the learning atmosphere like? What changes did I make from my plan and why?*  *If I taught this lesson again, what would I change?*  *What two things went really well (consider both teaching and learning)?*  *What two things would have improved the lesson (consider both teaching and learning)?*  *What have I learned from this lesson about the class or individuals that will inform my next lesson?* |
| **Next steps**  **What will I teach next, based on learners’ understanding of this lesson?** |

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