

Scheme of Work

Cambridge Primary

Science 0097

Stage 6

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 6.

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 6. 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 6 at 2.5 hours a week. The actual number of teaching hours may vary according to your context.

| Unit | Suggested teaching time |
| --- | --- |
| **Unit 6.1** Forces and movement, on Earth and beyond | 16% (12 hours) |
| **Unit 6.2** Human health and disease | 17% (13 hours) |
| **Unit 6.3** Materials, including rocks, and physical change | 17% (13 hours) |
| **Unit 6.4** Electricity, conductors and light | 15% (11 hours) |
| **Unit 6.5** Chemical changes and mixtures | 17% (13 hours) |
| **Unit 6.6** Ecosystems | 10% (7 hours) |
| **Unit 6.7** Puberty | 8% (6 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 6

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 6

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 6.1 Forces and movement, on Earth and beyond

| Unit 6.1 Forces and movement, on Earth and beyond |
| --- |
| Outline of unit: |
| In this unit learners will understand the difference between mass and weight, they will have opportunities to use the terms correctly. They will build on their knowledge of force diagrams and how to use them to show the forces acting on an object. They will also learn to describe, in detail, the forces acting on an object and how forces affect whether objects float or sink.  Learners will then consider the movement of objects in the Solar System and that the movement is caused by the forces that exist between them. (Stage 6 learners are expected to know forces affect the movement of objects in the Solar System and are not required to describe or explain how the forces create movement) |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * knowing that gravity is a force that acts on all objects on Earth * knowing gravity pulls objects down towards the centre of Earth * identifying that forces are responsible for making objects move * using force diagrams * knowing the names the planets in the Solar System and knowing their order from the Sun * describing the orbit of the Earth around the Sun. |
| Suggested examples for teaching Science in Context: |
| ***6SIC.01*** *Describe how scientific knowledge and understanding changes over time through the use of evidence gained by enquiry.*  Our understanding of the Solar System changed from geocentric (i.e. Earth at the centre) to heliocentric (i.e. Sun at the centre). This was first proposed by Nicolaus Copernicus in 1543 and then supported by astronomical observations from Galileo (i.e. the phases of Venus, the orbit of the four Galilean moons of Jupiter). Learners could explore how the evidence gathered by Galileo was used to bring about this change in understanding.  ***6SIC.02*** *Describe how science is used in their local area.*  Forces are all around us and nothing would function if they did not exist. Learners can identify forces in the world around them and consider what effect they are having, for example any object will move, speed up or slow down due to the forces applied to them. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
| --- | --- | --- | --- |
| **6Pf.01** Describe the difference between mass, measured in kilograms (kg), and weight, measured in newtons (N). | weight, mass, kilograms, grams, newtons, gravity | Learners can use plates of different sizes, representing different gravitational strengths, to create models to show their understanding of mass, weight and gravity. For example, an object is placed on a plate marked ‘Earth’; it has both mass and weight. If the object is moved to a different planet (or moon) with lower gravity the mass stays the same (i.e. the object has not changed) but the weight is lower. | Learners often use the term ‘weight’ when they mean ‘mass’ because ‘weight’ is used incorrectly in everyday life. It is important that learners understand the difference between mass and weight and the units associated with each. This will be resolved during the teaching of this unit. |
| **6Pf.02** Describe the effect of gravity and know that when gravity changes, the weight of an object changes but the mass does not. | gravity, weight, mass, pull |
| **6Pf.03** Use force diagrams to show the name, size and direction of forces acting on an object. | push, pull, gravity, normal force, applied force, friction | Force diagrams are representations themselves. As learners use and create force diagrams they will be using and creating scientific models. | Some learners may make force diagrams where the arrows showing the size and direction of the force do not follow the standard conventions. Stage 6 learners should be encouraged to use the standard conventions when drawing force diagrams; however they will meet the learning objective as long as the size and direction of the force is clear and can be explained by the learners. |
| **6Pf.04** Describe the effect of different forces on an object at rest and in motion. | push, pull, accelerate, decelerate, change, balanced, unbalanced | The effect of forces on objects can be described through the creation of force diagrams. | Some learners may believe that when an object is at rest there are no forces acting on it. It is important that learners understand that there are always forces acting on all objects, whether they are stationary or moving. |
| **6Pf.05** Recognise that the mass and shape of an object can affect if it floats or sinks. | buoyant force, mass, volume, displacement, float, sink | Learners can demonstrate their understanding about floating and sinking through creating force diagrams showing the how the shape and mass of an object affects the forces being applied to an object. | Some learners may believe that objects sink because they are heavy and float because they are light. It is important that learners understand that the mass of an object is not the only factor that determines whether it floats or sinks. The role of shape will be considered during this unit but there is no requirement to cover density at this stage. |
| **6ESs.01** Describe the relative position and movement of the planets, the Moon and the Sun in the Solar System. | gravity, orbit, Solar System, Sun, Moon, planets, satellite | Learners can act out a physical model of the Solar System to help their understanding of the relative position and movement of the planets, Moon and Sun.  Interactive Solar System models can be used to consolidate learning such as online simulations or by making and using an orrery. | Some learners may believe that the Earth stays still and all other objects in the Solar System orbit around the Earth.  It is important that learners understand that all objects in the Solar System are constantly in motion; planets orbit the Sun and moons orbit the planets. Learners need to recognise that the movement of planets and moons are affected by forces but, at this stage, they do not need to understand how. |

# Unit 6.1 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
| --- | --- | --- |
| **6Pf.01** Describe the difference between mass, measured in kilograms (kg), and weight, measured in newtons (N). | **6TWSc.01** Sort, group and classify objects, materials and living things through testing, observation and using secondary information.  **6TWSc.04** Decide when observations and measurements need to be repeated to give more reliable data.  **6TWSc.05** Take appropriately accurate measurements.  **6TWSa.05** Present and interpret results using tables, bar charts, dot plots, line graphs and scatter graphs. | **Mass and weight**  Give pairs of learners an object and ask them to estimate the weight of the object. Now ask them to estimate the mass of the same object. Compare their answers. Some learners may become confused by the question as they will not know what mass is. If this is the case, discuss what they think mass is.  *What units have you used for mass?*  *What units have you used for weight?*  *What is the difference between mass and weight?*  Explain that mass is a measure of how much matter an object is made of and it is measured in kilograms (kg).  The weight of an object is a measure of the effect of gravity on that object. Weight is measured in newtons; the unit was named after Sir Isaac Newton.  Give each pair four objects of different mass; they sort them from the smallest mass to the largest mass.  *How did you know which object had the smallest mass?*  Ask them to measure the mass of each object (in kilograms) using a weight scales and record the measurements in a table. The results can then be presented in a bar chart.  Ask learners to measure each mass several times. Discuss how they need to ensure their measurements are accurate as inaccuracies can occur during measurement. If they find inaccuracies in their measurements, discuss where they may have come from (e.g. different position on the weighing scales, other material being measured by accident).  Explain that we often use the term ‘weight’ to describe how ‘heavy’ something is; this ‘everyday’ convention is incorrect but based on the fact that the force of gravity on Earth is constant. The correct scientific term is ‘mass’.  **Resources:** Weighing scales, everyday objects of different masses |
| **6Pf.02** Describe the effect of gravity and know that when gravity changes, the weight of an object changes but the mass does not. | **6TWSm.01** Describe how a model can help us understand and describe scientific phenomena and ideas.  **6TWSa.05** Present and interpret results using tables, bar charts, dot plots, line graphs and scatter graphs | **Changing weight**  Hold an object (that will not break) up in front of the class and drop it.  *Why did the object fall down?*  *How strong is the pull force?*  Gravity on Earth has a value of 9.8 newtons/kg of mass, which is a measure of how strong it is. So, to calculate the weight (in newtons) of an object you multiply its mass (in kg) by 9.8.  Provide learners with a range of objects (of different masses) and labels with their masses. Ask learners to put the objects in order of increasing mass. Ask learners to calculate the weight of the objects they have and record their weight next to the mass.  *Does the order of the objects change if you use weight instead of mass?*  The order of the objects stays the same; this is because the gravity on Earth is constant regardless of where you are and so pulls down on all objects to the same extent.  Show learners an image of a car.  *What do you think the mass of the car is?*  *What units would you use for the mass of the car?*  Explain that an average-sized car has a mass of about 1000 kg.  *What is the weight of the car if it is on Earth?*  *What units would you use for the weight?*  To calculate the weight of the car on Earth learners multiply the mass (1000 kg) by the strength of gravity on Earth (i.e. 9.8 newtons/kg) to get a weight of 9800 newtons.  *What would happen to the mass of the car if we took it to the Moon?*  *What would happen to the weight of the car if we took it to the Moon?*  The mass of the car would stay the same (i.e. 1000 kg) as no matter has been added to it or taken away. The weight of the car would change. The gravity of the Moon on its surface is approximately the gravity of Earth, so the car’s weight would be of what it was on Earth (i.e. approximately 1633 newtons).  Explain that gravity is a property of anything that has mass, and the strength of gravity varies by the mass producing it. The greater the mass, the greater the strength of gravity. This means gravity has different strengths on different planets in the Solar System, as summarised in the table below:   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Planet | Mercury | Venus | Earth | Mars | Jupiter | Saturn | Uranus | Neptune | | Mass of planet (1024 kg) | 0.330 | 4.87 | 5.97 | 0.642 | 1898 | 568 | 86.8 | 102 | | Gravity (N/kg) | 3.7 | 8.9 | 9.8 | 3.7 | 23.1 | 9.0 | 8.7 | 11.0 |   Provide learners with the data table. Ask learners to create a scatter graph using the data (mass of planet on the x-axis and gravity on the y-axis) and ask learners to calculate what the weight of the car would be on each planet. Remind them that the mass of the car is always 1000 kg.  Explain to learners that we cannot take a car to the different planets to measure their weight. However, this thought exercise acts as a model for us to consider how weight can change if the strength of gravity changes.  **Resources:** Table listing the gravity of different planets, image of a car, objects with mass labels |
| **6Pf.03** Use force diagrams to show the name, size and direction of forces acting on an object. | **6TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry. | **Ball force diagrams**  Place a ball on a flat surface. Elicit learners’ prior understanding of how to describe the forces acting on the ball and how to represent this with force diagrams.  *What forces are acting on the ball?*  *How can you show those forces in a diagram?*  Draw a force diagram for the ball on the flat surface showing an arrow representing a pull force pulling the ball down (i.e. gravity) and an arrow, the same size, showing the particles in the table pushing the ball up (i.e. normal force) against the force of gravity.  Remind learners that the size of the force is represented by the size of the arrow. In the case of the ball, as it is not moving, the forces are the same size.  Ask learners to draw the forces acting on the ball if it is pushed gently across the surface.  *What forces are needed to make the ball move?*  *What other forces start acting on the ball as soon as it starts moving?*  *Is gravity, or the normal force, changing?*  To get the ball to move a force needs to be applied to it. An arrow can be shown for applied force on the left side of the ball. As soon as the ball starts moving, a friction force begins to act between the ball and the surface. An arrow can be shown for friction on the right side of the ball.  When the applied force is only just larger than the friction force the ball does not move very far.  Ask learners to draw the forces acting on the ball if it is pushed harder across the surface.  *What force is needed to make the ball move*  *What other forces start acting when the ball starts moving?*  *If we apply a larger force how will the ball move in relation to before?*  *How do the arrows change?*  *Is gravity, or the normal force, changing?*  When the applied force is much larger than the friction force, the ball moves faster and further than before.  Ask learners to think of other simple situations and draw force diagrams for them showing the direction, size and type of forces acting.  **Resources:** Ball, flat surface |
| **6Pf.04** Describe the effect of different forces on an object at rest and in motion. | **6TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts.  **6TWSa.01** Describe the accuracy of predictions, based on results. | **Effect of forces**  Place an object on a table. Push the object so it moves but then stops either when the applied force is taken away or shortly after due to friction.  *What does it mean if an object is at rest?*  *What forces are always acting on an object when it is at rest?*  *How do you describe the forces acting on an object at rest?*  If an object is at rest it is stationary. It will always have gravity pulling it down and the normal force, from the surface it is on, pushing it up. The forces will be ‘balanced’.  Ask learners to think about things they can do when they apply a force (e.g. change the shape of an object, make an object move); give learners an opportunity to demonstrate some of them.  *What can a force do to an object?*  Perform the following demonstrations to show the four things that a force can do. Ask learners to consider how the forces are acting in each demonstration. Alternatively, if resources allow, ask learners to try each activity for themselves.  Before each demonstration ask learners to predict what they expect to happen based on their prior knowledge and wider experience. You might need to scaffold the discussion about learners’ predictions, For example, provide learners with –er –er sentences such as “the greater the force I apply the faster the object moves”  After each demonstration, discuss the results and how accurate their initial predictions were.  Accelerate (i.e. cause an object to start moving or speed up)  Place a ball (or toy car) on a flat surface.  *What forces are acting on the object?*  *How can I make the ball speed up/accelerate?*  *What is going to happen when I push the object?*  The object, at rest, has gravity pulling it down and the normal force pushing it up – the forces are balanced. To make the object move you need to apply a force (push or pull it).  You can also cause a moving object to accelerate. Push the object gently, and then give it another push, in the same direction, to make it move faster.  Learners can draw force diagrams of the ‘unbalanced’ forces acting on the object that cause it to accelerate.  Decelerate (i.e. cause a moving object to slow down)  *Does an object, once moving, keep moving for ever?*  *What happens to the moving object?*  *Why does the object slow down and stop?*  The object you pushed across the surface will slow down and stop, as long as no more force is applied to it. The force of friction, between the moving object and the surface, starts slowing the object down as soon as it starts moving. Demonstrate applying a force opposite to the movement which, combined with friction, slows an object down quicker.  Learners can draw force diagrams of the ‘unbalanced’ forces acting on the object that cause it to decelerate.  Change direction  Roll a ball along a flat surface. Show learners how the ball stays in a straight line in the direction in which it was pushed.  *How could you get the ball to change direction?*  *Can you think of any situations where objects change direction?*  *What will happen if I apply a force to the moving object in a different direction?*  You can change the direction of the ball by applying a force to it at an angle.  Roll the ball along the surface and ask one of the learners to push it from the side to change the direction it is moving in.  This occurs in sports where a moving ball is struck and changes direction (e.g. football, hockey, cricket, tennis).  It also happens when two cars crash, and the force of the impact causes them to change direction.  Conclude that a force can cause an object to change direction.  Change shape  Hold a flat piece of paper up.  *How can I change the shape of the paper?*  *What is going to happen when I apply a force to the paper?*  Demonstrate folding, tearing and crumpling up the paper; ask learners:  *How are the forces acting in each situation?*  Explain that ‘folding’ uses pushes, ‘tearing’ uses pulls in opposite directions and ‘crumpling’ uses pushes in towards a centre point.  Alternatively, demonstrate other examples of forces changing the shape of an object (e.g. stretching an elastic band/spring, inflating a balloon, crushing a tin can, bending a piece of metal wire). Ask learners to describe how the forces are acting in each situation.  Conclude that a force can change the shape of an object.  Summarise that anything which happens by the action of a force can be put into one of these four categories, or a combination of them.  Learners may think that a ‘twist’ is another thing that a force can do. Show learners removing a screw cap from a jar (or bottle); explain that a twist is simply a combination of a pull (accelerating an object in one direction) and a second pull (accelerating it in another direction).  Discuss with learners how they can apply their new understanding gained from looking at these scenarios to help them make more accurate predictions going forward. Ask learners to make predictions for new objects in scenarios they have already explored; highlight how scientific practice involves developing knowledge/understanding and using it to support scientific thinking.  **Resources:** Ball, jar or bottle with screw cap |
| **6Pf.05** Recognise that the mass and shape of an object can affect if it floats or sinks. | **6TWSa.03** Make a conclusion from results informed by scientific understanding.  **6TWSa.04** Suggest how an investigation could be improved and explain any proposed changes.  **6TWSc.06** Carry out practical work safely. | **Floating, sinking and boats**  Present a range of everyday objects to the learners; include at least one very heavy object, one very light object and one object that is made of metal. Ask learners to predict what will happen when the objects are placed in a container of water.  *Why do some objects float in water, while others sink?*  *Can you think of other objects that float and objects that sink?*  *What do objects that float have in common?*  *What do objects that sink have in common?*  Show learners an image of a boat made of metal.  *How does the boat float if it is made of metal? Why does it not sink?*  Give each pair of learners a small ball of aluminium foil and ask them to try and get it to sink in a small container of water.  *How are you going to get the foil to sink?*  *What can you do to the foil to change it?*  Learners need to make the foil as small as possible by folding it and squashing it. Eventually it will sink.  *Have you changed the mass of the foil?*  *What has changed about the foil that has made it sink?*  Explain to learners that they have not changed the mass of the foil, but they have changed its shape to the point where it sinks.  Before the aluminium is folded and squashed it floats because a lot of the ball is in contact with the water; the buoyant force from the water is equal to gravity.  After being folded and squashed, the aluminium foil is much smaller so there is a lot less contact with the surface of the water; the buoyant force is now less than gravity and so the ball sinks. By changing the shape of the aluminium foil we are changing the surface area that the buoyant force can push against.  Show learners an image of a boat made of metal (e.g. a cruise ship) and explain how the shape of the boat helps explain why it can float even though it is made of metal.  Give pairs of learners a small square of aluminium foil (8 cm x 8 cm) and ask them to make a boat that will hold 5 marbles without sinking. Let them experiment with different shapes and see what is most effective. Test each boat by carefully loading five marbles onto it and seeing if it floats for one minute.  *What conclusions can you draw from the success of the different shaped boats?*  *Which shapes of boats are the most effective?*  *Why are some shapes more effective than others?*  Discuss how making clear conclusions helps scientists to refine thinking and consider what else to investigate. Sometimes conclusions raise new questions, sometimes conclusions identify where things went wrong and sometimes conclusions give a chance to describe new understanding.  Discuss with learners if based on their conclusion, or observations, there is anything that could be improved and suggest changes.  From their work, learners see the shape of the boat is important. The shape also needs to give the boat stability, so it does not tip over.  **Resources**: Containers, aluminium foil, marbles, a range of everyday objects |
| **6ESs.01** Describe the relative position and movement of the planets, the Moon and the Sun in the Solar System. | **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas.  **6TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions.  **6TWSa.05** Present and interpret results using tables, bar charts, dot plots, line graphs and scatter graphs | **The Solar System**  Ask learners to draw a diagram, with arrows and labels, to show how they think the objects in the Solar System move relative to each other. This is an opportunity to revise previous learning, remind them of the names and order of the planets, if appropriate.  Explain that the planets are orbiting the Sun at different distances and at different speeds.  In a large outdoor space, create a giant physical model of the Solar System to show the scientific understanding of the relative position and movement of the planets. (Note: This cannot be a ‘scale model’ due to the size of the real objects being modelled but it can act as a useful model to show our understanding of relative position and movement of the planets. One learner stands in the centre representing the Sun. Eight learners, representing the planets, stand at different distances from the Sun and walk around the Sun, keeping the same distance away.  If there is not space to do the human Solar System activity, show learners an interactive model that illustrates the movement of the planets.  Learners use secondary information sources to research the distance of each planet from the Sun and the time it takes each planet to orbit the Sun (e.g. Earth – 1 year). They collect their findings in a planetary data table and then they create a bar chart with time on the y-axis and planet on the x-axis.  Explain to learners, that as well as orbiting the Sun, every planet spins around its own axis; a single rotation of a planet gives one day (including the night). Each planet spins at a different speed so their days are not the same length (e.g. on Earth a day is 24 hours, on Mercury a day is 1407.5 hours).  Learners research how long each planet takes to spin on its axis and add their findings to their planetary data table. They can represent their data using a bar chart.  *What do you notice about the time it takes a planet to orbit the Sun and the distance it is away from the Sun?*  *Which planet do you think is orbiting fastest, why?*  *Which planet is spinning around its own axis slowest?*  *Which planet stands out as having surprising data when comparing the length of 1 orbit (i.e. a year) to the length of 1 spin (i.e. a day)?*  Learners can identify patterns and/or unexpected findings in their data (e.g. the further away the planets are from the Sun the longer it takes them to orbit).  Discuss with learners that, so far, we have not included moons in our model or data collection. Clarify that a moon is an object that orbits a planet. Both are natural satellites. Highlight that the Earth is a natural satellite to the Sun as it orbits the Sun.  *How long does the Moon take to orbit the Earth?*  The Moon takes a total of 28 days to orbit the Earth; this time period is called a lunar month. The lunar month is used in the calendars of many ancient civilisations and in some religious calendars.  Reform the human model of the Solar System; add in the Moon and as many other moons as possible, the moons orbiting their respective plants as the planets orbit the Sun. For planets with many moons (such as Jupiter and Saturn), discuss how the human model of the Solar System may not be the most effective way to show them as there is not much physical space and there are not enough learners to be individual moons.  **Resources:** Secondary information sources |

# Unit 6.2 Human health and disease

| Unit 6.2 Human health and disease |
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| Outline of unit: |
| In this unit learners will develop an understanding of two of the major body systems of humans, and most vertebrates; the respiratory system and the circulatory system. They will understand that these two systems are fundamental for human life and many of the processes of the human body.  They will also develop their understanding about disease and how many diseases are caused by a variety of pathogens. Learners will consider how diseases spread through a population in a variety of ways and how the spread of disease can be controlled by good hygiene and other preventative measures. They will also learn about the human body’s physical defences against disease.  This unit provides many opportunities for learners to use and develop models alongside using a range of secondary information sources. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * knowing that humans need oxygen to survive, and we breathe it in * knowing that blood is essential for humans and it is moved round the body by the heart * understanding that humans catch diseases that make them ill * explaining that hygiene is important for preventing the spread of disease. |
| Suggested examples for teaching Science in Context: |
| ***6SIC.03*** *Use science to support points when discussing issues, situations or actions.*  The knowledge of pathogens and how they spread is important in all communities. Learners can discuss local health issues (e.g. any local outbreaks of diseases and how they were managed, any specific measures in place to prevent outbreaks).  ***6SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science****.***  The science in this unit is used by healthcare workers to diagnose and treat people who are ill. If possible, local healthcare workers can come in and talk to learners about their roles and why they need to have a good understanding of the science of the human body. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
| --- | --- | --- | --- |
| **6Bs.02** Describe the human respiratory system in terms of oxygen from the air moving into the blood in the lungs and know that many vertebrates have a similar respiratory system. | inhale, exhale, trachea, lungs, bronchi, bronchioles, alveoli, red blood cells | Learners can demonstrate their understanding of the human respiratory system by drawing a diagram of the organs.  Learners can construct a physical model of the respiratory system with a cardboard sheet, tube and balloons. Use the tube to model the trachea; ensure it is sealed at one end and make two holes (opposite each other). Attach the balloons to the tube so the opening of one balloon is secure against one hole. Attach the balloons to two pieces of card so the balloons are sandwiched between them. Learners holding the model securely can model muscles moving by pulling the cards apart, inflating the balloons in the process. (Similar to how bellows work)  Oxygen moving from the lungs into the blood can be modelled by learners: Some learners wear something red (i.e. blood); others form a line and link arms (i.e. the lining of the lungs) and others hold balls of the same colour (i.e. oxygen). As the ‘blood’ learners, move in a circle past the ‘lungs’ the learners with the ‘oxygen’ balls pass the oxygen over the learners being the lining of the lungs to the blood. | Some learners may think air is just breathed in and out. Learners do not need to know the full composition of air but they should know air contains oxygen. It is important that learners understand that oxygen from the air is essential to humans (and many animals) so their respiratory systems are designed to obtain oxygen. This misconception will be addressed through coverage of the learning objective.  Learners may develop during this unit the misconception that lungs are empty sacs rather than a complex tree/sponge like structure to maximise surface area. To address this misconception, diagrams and images of the lungs showing their structure can be shown to learners. If appropriate, you could also demonstrate the dissection of a lung to learners (following your schools health and safety guidance) |
| **6Bs.01** Describe the human circulatory system in terms of the heart pumping blood through arteries, capillaries and veins, describe its function (limited to transporting oxygen, nutrients and waste) and know that many vertebrates have a similar circulatory system. | blood, heart, arteries, veins, capillaries, circulation, vertebrates | Learners can demonstrate their understanding of circulatory systems by drawing (or using) the circulatory systems of a range of different animals (e.g. mouse, cat, bat, fish).  Simple pumps can be used to model the heart. The pump can be attached to pipes with different diameters to model the flow of blood through different types of blood vessel.  A large diagram of the circulatory system (including capillaries) could be drawn with chalk on a large outdoor surface. Learners then move around the diagram, following the arteries, capillaries and veins like a one-way road system. Balls of different colours can be used to represent nutrients, oxygen and carbon dioxide. Learners pick up nutrients at the intestine, swap carbon dioxide for oxygen at the lungs, and swap oxygen and nutrients for carbon dioxide at the muscles. | Some learners may think that the heart is the shape of a ‘love heart’ and sits on the left side of the chest. They may also believe the heart ‘thinks’. Learners need to understand that the heart sits behind the centre of the breastbone and is not ‘love heart’ shaped. Its size is roughly the same as one fist. It is connected to the rest of the circulatory system. Learners also need to understand the heart is a muscle with the function of pumping blood around the body. Our thoughts are determined by the brain not the heart. These misconceptions will be addressed through coverage of the learning objective. |
| **6Bp.02** Know that some diseases can be caused by infection with viruses, bacteria, parasites or fungi that can be passed from one host to another. | pathogen, infection, virus, bacteria, parasite, fungi, host | Diagrams of the source of each infection and how they are transmitted, can be used by learners to demonstrate their understanding.  The transmission of infectious diseases can be physically modelled using objects (or flour); the objects can be passed between learners and left in their environment for others to be ‘infected’ by. | Some learners may think that all diseases are caused by the same infection or source of infection.  It is important that learners understand that there are a wide range of pathogens that can cause different diseases. This misconception will be addressed through coverage of the learning objective. |
| **6Bp.03** Describe how good hygiene can control the spread of diseases transmitted in water, food and body fluids, and describe ways to avoid being bitten by insect vectors. | hygiene, transmitted, transmission, insect vector, disease | Learners can cover their hands in a mixture of flour (or similar) in vegetable oil. This models pathogens on their skin. They can then learn effective ways to clean their hands.  To model insect vectors, have some learners role play being an insect. The insects have a straw which they have to try to get to touch the skin of a non-insect. Learners who are not insects can role play covering themselves with materials, making the air colder so insect stay away or spraying repellent around. | Learners may believe having close contact with someone with an infectious disease means you automatically catch that disease. Transmission of a disease depends on the vector of transmission. For example, malaria is transmitted through insect bites rather than contact.  Learners may also believe that many infections are airborne when most are transmitted through physical contact.  These misconceptions will be addressed through coverage of the learning objective. |
| **6Bp.04** Know that humans have defence mechanisms against infectious diseases, including skin, stomach acid and mucus. | pathogen, secretion, barrier, mucus, infectious disease | A diagram of the human body showing physical barriers to pathogen infections can be used by learners to demonstrate their understanding.  Physical models can be made from salt (i.e. a pathogen), plastic food wrap (i.e. human skin), vinegar (i.e. stomach acid) and glue (i.e. ‘mucus’). They can be used to represent each defence mechanism where:   * the pathogen cannot get through skin * the pathogen is dissolved in stomach acid * the pathogen cannot move when it is bound by mucus | Some learners may not have considered the role of skin, stomach acid, or mucus in defending the body from disease. It is important learners understand some parts of the body only exist to defend the body from disease and other parts can have multiple purposes which include defending the body from disease.  This misconception will be addressed through coverage of the learning objective. |

# Unit 6.2 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
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| **6Bs.02** Describe the human respiratory system in terms of oxygen from the air moving into the blood in the lungs and know that many vertebrates have a similar respiratory system. | **6TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Respiratory system**  Discuss with learners that all animals, including humans, need to eat, drink water, move, excrete and breathe.  *Why is breathing so important?*  *What do animals (including humans) need from the air?*  Explain to learners that animals need oxygen, in air, to survive. The oxygen is used by the bodies of animals to release energy from the food that the animal has eaten. However, the oxygen needs to get to the different parts of the body. The function of the respiratory system is to get oxygen into the blood so it can be transported around the body.  Give learners a blank diagram of the human respiratory system to label. Alternatively, they can draw and label their own.  Watch an animation which show how the respiratory system works; learners make notes and label their diagrams as they watch the animation. The animation can be shown multiple times over the lesson and the diagram completed gradually.  Discuss how a human breathes in through their mouth and nose; the air passes down the trachea through the bronchi into the lungs. There are two lungs within the chest cavity. Once in the lungs, the oxygen can then move from the lungs into the blood as the lungs are covered in blood vessels. If possible, show an image of lungs that reveals the blood vessel network.  Ask learners to close their mouths and breathe through their noses only; then instruct them to breathe through their mouths only. Explain that their noses and mouths are connected and they can breathe in through their nose and out through their mouth.  *Do all animals have a similar respiratory system to humans?*  *What are the similarities and differences of the respiratory systems between different vertebrates?*  Learners, working in pairs, use secondary information sources to research how other animals’ respiratory systems work. They can draw labelled diagrams of the respiratory systems and highlight similarities and differences to the human system.  Learners then share their diagrams and understanding with each other. During this any misconceptions or errors can be corrected.  **Resources:** Blank diagrams of the human respiratory system, secondary information sources |
| **6Bs.01** Describe the human circulatory system in terms of the heart pumping blood through arteries, capillaries and veins, describe its function (limited to transporting oxygen, nutrients and waste) and know that many vertebrates have a similar circulatory system. | **6TWSp.01** Ask scientific questions and select appropriate scientific enquiries to use.  **6TWSp.02** Know the features of the five main types of scientific enquiry.  **6TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Circulatory system**  Watch a video (or animation) of the human circulatory system and ask learners to note the main parts of the system and what they do.  *What does the heart do?*  *What are the different types of blood vessels and what do they do?*  Learners, using secondary information sources, research answers to these questions and others they have. Discuss with learners that research is one of the five types of scientific enquiry. Some learners may be able to identify blood vessels close the surface of their skin to support their research through observation.  Once research is completed, clarify with the learners:   * The heart is a pump that pushes blood around the body. * Arteries are thick blood vessels that carry high-pressure blood away from the heart. * Veins are thinner vessels that carry blood back to the heart. * Capillaries are very fine, thin-walled vessels that allow the transfer of materials in and out of the blood.   Learners show their understanding by labelling a blank diagram of the human circulatory system.  Blood has many functions including transporting oxygen, nutrients and waste (e.g. carbon dioxide) to all organs. Ask groups of learners to research one of these functions answering questions like:  *Where does the blood transport oxygen from?*  *Where does the blood transport nutrients to?*  *Does this happen in a blood cell or in the liquid part of blood?*  *Why are these functions important?*  Each group can present their research to the rest of the class in a form of their choosing, for example a poster or a news report. Ensure that all learners have an opportunity to learn about all three functions.  Many vertebrates have an almost identical circulatory system. If you can acquire an animal heart which is approved in your school and country for use in science lessons, you could demonstrate a dissection of it to show the different parts of the heart. If doing a dissection, please refer to the notes in the introduction to this scheme of work relating to the safe use of biological materials.  There are videos online that show you what to do. If the activity is unsuitable in your setting, learners can research the circulatory systems of other vertebrates, using secondary information sources, and compare them to the human system.  Ask learners to propose questions about the human circulatory system that they would like to answer and, having considered the different types of scientific enquiry, suggest how they would answer them. Discuss how each scientific enquiry type could be used, summarising their key features, and identifying which method is the most appropriate enquiry for the questions. For example:   * How does the heart rate change during exercise? A fair test may be the best enquiry type that focusses on what happens to one variable (i.e. heart rate) while controlling the others. * How long does it take for the heart rate to return to normal after exercise? This variable could be observed over time.   Learners link their questions to an enquiry. If time permits in the unit provide opportunities for learners to investigate their questions and extend their learning through self-study.  **Resources:** Video of human circulatory system, secondary information sources, blank human circulatory system diagram, animal heart for dissection (optional) |
| **6Bp.02** Know that some diseases can be caused by infection with viruses, bacteria, parasites or fungi that can be passed from one host to another. | **6TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Infection and spread of disease**  Discuss with learners that a disease is something that has a negative affect on a living thing; it can make a living thing uncomfortable, cause illness or cause death.  *What diseases do you know?*  *What causes them?*  *How they are spread?*  Learners carry out research, using secondary information sources, to produce fact cards for some common diseases, including what causes them and how they are spread. Include diseases that are caused by a variety of infectious agent; viruses (e.g. common cold, influenza, measles, Ebola); bacteria (e.g. cholera, tuberculosis); parasites (e.g. malaria, toxoplasmosis, schistosomiasis) and fungi (e.g. athletes’ foot, histoplasmosis).  Learners share the information they have researched. They can group the diseases in various ways (e.g. what causes them, how dangerous they are, how they are transmitted, how they can they be treated or prevented, where they occur most commonly).  Discuss how diseases caused by viruses, bacteria, parasites and fungi are passed by human-to-human contact, in water, air or by insect bites.  **Resources:** Secondary information sources |
| **6Bp.03** Describe how good hygiene can control the spread of diseases transmitted in water, food and body fluids and describe ways to avoid being bitten by insect vectors. | **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas.  **6TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions.  **6TWSp.01** Ask scientific questions and select appropriate scientific enquiries to use. | **Hygiene**  Show learners pictures of different ways diseases can be passed from one host to another (e.g. a mosquito biting a human, hand shaking, sneezing, feet in a pool of water) and elicit prior understanding.  *Can you think of any other ways diseases can spread?*  Diseases can be spread through contact with saliva, blood, urine or faeces. They can also be spread by contaminated food and water or by insect vectors (e.g. mosquitoes can spread malaria and other diseases).  *What can you do to avoid spreading diseases?*  *Is it always possible to prevent a disease from spreading?*  *What might be the barriers to preventing the spread of disease?*  Explain that the most important factor in stopping the spread of disease is hygiene.  Handwashing  Explain that the proper washing of hands can stop many diseases. This should be done after going to the toilet, handling animals, cleaning, playing outside, gardening, taking the rubbish out, etc. Hands should also be washed before preparing and eating food.  Use a model to show learners how important is to wash their hands properly:   * Mix flour (or similar) in vegetable oil. * Learners put the mixture on their hands; they make sure that there is some flour all over their hands, including between their fingers, on the front and back of their hands and under their fingernails. * Learners then try to wash off the flour/oil mixture using cold water. * Even after washing their hands, it is likely that learners will still have some flour between their fingers and under their nails. * Discuss the results with learners. Elicit that if each bit of flour was a bacteria (for example) then they could still transmit diseases by touching things. * Repeat the activity but this time learners wash their hands with warm, soapy, water. They identify the difference those changes make. * Demonstrate how to do a proper handwash (similar to those used by medical professionals). Information on how to do this can be found online.   Avoiding insect bites  *What diseases are spread by insect bites?*  *Where are these diseases most common?*  *What can be done to avoid being bitten?*  Explain that malaria is the most well known disease that is spread by insects; it is spread when mosquitoes carrying the malaria parasite bite an uninfected person.  Using secondary information sources, learners can research what can be done to reduce the likelihood of being bitten by mosquitoes; they create information leaflets (or a drama) to explain how to stay safe in areas where malaria is common. These can include:  Approaches to decrease the number of mosquitos:   * avoid standing water * use insecticides to kill mosquitos.   Approaches to decrease the number of bites:   * fit mosquito screens over windows * sleep under a mosquito net * wear light colours so it is easier to identify if mosquitos land on you * wear long sleeves and long trousers * stay indoors at dawn and dusk * wear insect repellent.   Discuss with learners other aspects of hygiene that are important for the local context (e.g. safe disposal of sewage, making sure water is safe to drink, methods for storing food correctly).  **Resources:** Pictures of how diseases are transmitted, secondary information sources, vegetable oil, flour |
| **6Bp.04** Know that humans have defence mechanisms against infectious diseases, including skin, stomach acid and mucus. | **6TWSp.01** Ask scientific questions and select appropriate scientific enquiries to use. | **The human body’s defences**  Explain that our bodies are constantly under attack from a variety of organisms that cause disease (e.g. bacteria, viruses, parasites and fungi). Our bodies have physical defence systems to prevent us getting ill all the time.  Give groups of learners a set of cards with different body parts and secretions (e.g. skin, stomach acid, mucus, nasal hair, saliva, blood clot, sweat, ear wax, fingernails, freckles, hair, earlobes, urine, muscles and kneecaps). Ask them to group their cards into those that are part of the body’s physical defence system and those that don’t have a defensive role; they have to justify their selections with at least two reasons. (Note: skin, stomach acid, mucus, nasal hair, saliva, blood clot, sweat are involved in defending the body).  *What questions can you ask to help you decide?*  *Which type of enquiry would help you find out the answers?*  *How do you think each of the physical defence mechanisms works to stop pathogens invading our bodies?*  Explain to learners that they will not be able to carry out the enquiries they suggest as research into human diseases is very tightly controlled by robust, ethical rules.  Most of the defence mechanisms are physical barriers that stop pathogens entering the body in the first place (e.g. skin). Others kill the pathogens (e.g. stomach acid, chemicals in sweat).  Learners label a blank outline of a human with all the physical barriers to infection.  **Resources:** Defence mechanism card sets, blank outline of a human, secondary information sources |

# Unit 6.3 Materials, including rocks, and physical change

| Unit 6.3 Materials, including rocks, and physical change |
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| Outline of unit: |
| This unit covers a range of properties of materials and substances and how they change under specific conditions. Learners will continue to develop their understanding of the particle model in the context of boiling and evaporation; they will understand that different substances change state at different temperatures and that many physical changes of substances are reversible.  Learners will apply their knowledge of substances and physical change within the context of rocks. Learners develop their understanding of how different types of rock are formed, and how each type of rock is part of the rock cycle.  Finally learners will consider how fossils are formed and why fossils are important to help us understand Earth’s past. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * identifying that substances can change state between solid, liquid and gas * knowing some common gasses (i.e. oxygen, carbon dioxide, hydrogen) * understanding that some changes to substances can be reversed (e.g. mixing) * knowing that there are different types of rocks * knowing fossils are impressions, or remains, of things that were once alive. |
| Suggested examples for teaching Science in Context: |
| ***6SIC.01*** *Describe how scientific knowledge and understanding changes over time through the use of evidence gained by enquiry.*  Much of what we know about the prehistoric Earth has come from the fossil records collected around the world. Fossils provide valuable evidence that can help understanding of the past. Our understanding of fossils has changed over time. Learners can look at what early scientists thought about fossils, and their understanding of what dinosaurs looked like, and compare those views to those of modern scientists.  ***6SIC.02*** *Describe how science is used in their local area.*  The knowledge of thermal conductivity is applied when designing and building houses in all environments in order to keep them warm or cool. Learners can consider how insulation is used in their local environment, for example in insulating buildings or cold storage units.  ***6SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science****.***  The study of geology is very important in developing our knowledge of different environments, finding mineral deposits and other resources and selecting appropriate building materials. Learners can consider the importance of geology to their area/region; if possible, a geologist can visit the class and discuss their job.  ***6SIC.05*** *Discuss how the use of science and technology can have positive and negative environmental effects on their local area.*  Rocks are often studied to find deposits of natural resources which are then mined. Learners can consider the impact of mining in general and more specifically if it has impacted their local environment. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
| --- | --- | --- | --- |
| **6Cp.02** Know that gases have properties including mass. | gas, mass, oxygen, carbon dioxide, nitrogen, helium, properties | The particle model can be used to help learners understand substances in the gas phase can have properties including mass. | Some learners may think that an invisible gas does not have any mass.  It is important that learners understand that gas is a substance, like anything else, and it has mass among other properties. This misconception will be addressed through coverage of the learning objective. |
| **6Cp.01** Know that the temperature at which a substance changes state is a property of the substance. | boiling, melting, freezing, solidifying, solid, liquid, temperature, property, substance, state | The particle model can be used to explain how the change of state of a substance is related to the behaviour of particles. Learners can create a human particle model, where each learner represents a single particle, and model the link between the movement of particles and the temperature. | Some learners may think that all substances have the same melting points and boiling points.  It is important that learners understand that all substances have different properties, including different melting points and boiling points. This misconception will be addressed through coverage of the learning objective. |
| **6Cc.03** Describe the difference between boiling and evaporation. | boiling, evaporation, heat, energy | The particle model can be used by learners to show their understanding of boiling and evaporation and support them in describing the difference. | Some learners may think that evaporation involves water on a surface ‘boiling’.  It is important that learners understand that molecules of water do not need to be at 100 oC to evaporate from a surface. They should also understand that boiling occurs when gas bubbles form throughout the whole volume of a liquid; the substance changes from the liquid to the gas state throughout its volume not just at the surface.  These misconception will be addressed through coverage of the learning objective. |
| **6Cc.01** Identify and describe physical changes that are reversible**.** | substance, state of matter, solid, liquid, gas, shape, reversible, irreversible, boiling, melting, freezing, solidifying, condensation | Learners can draw diagrams connected by arrows to demonstrate their understanding of physical changes; they use two arrows (or a double-headed arrow) to show a reversible change. | Some learners may believe that some materials do not undergo physical changes that are reversible because the conditions for change are outside of standard conditions learners are regularly exposed to. For example metals will melt under very high temperature.  It is important learners understand that all substances can undergo physical change and some of these physical changes are often reversible. This misconception will be addressed through coverage of the learning objective. |
| **6ESp.01** Know that rocks can be classified as metamorphic, igneous and sedimentary and describe the identifying features of each type of rock. | rock, metamorphic, igneous, sedimentary | Learners can draw diagrams showing their understanding of the different classification of rocks and label the identifying features. | Some learners will believe that rock is a material and there is only one type of rock.  It is important that learners understand that there are many different types of rock, with different properties and formed in different ways. This misconception will be addressed through coverage of the learning objective. |
| **6ESc.01** Describe the rock cycle and the formation of metamorphic, igneous and sedimentary rocks, in terms of solidification, erosion, sedimentation, burial, metamorphism and melting. | rock cycle, metamorphic, igneous, sedimentary, magma, solidification, erosion, sedimentation, burial, metamorphism, melting, pressure | A physical model (e.g. wax crayons, chocolate) of the rock cycle can be used to reinforce or demonstrate learning.  Learners can draw a diagram of a cross section of the Earth’s crust to illustrate the rock cycle. | Some learners may think that all rocks are formed by molten rock from volcanos, and that rock lasts forever once made.  It is important that learners understand that different rock types are made in different ways and that rock is cycled through a number of processes. This misconception will be addressed through coverage of the learning objective. |
| **6ESp.02** Describe the way fossils can form in sedimentary rocks. | fossil, sedimentary, geological time | Learners can use a series of diagrams (or create a timeline) to represent fossil formation.  The process of fossilisation can be physically modelled by making impressions of a toy animal in dough then pouring quick setting plaster into the impression. | Some learners may think that fossils are the actual bones of dead animals.  It is important that learners understand that fossils can include biological material but often refer to impressions that skin, feet and bone have left in earth. This clarification can be discussed when teaching this objective if required. |

# Unit 6.3 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
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| **6Cp.02** Know that gases have properties, including mass. | **6TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts.  **6TWSc.06** Carry out practical work safely. | **Gas properties**  Explain to learners some of the essential and everyday uses of gases (e.g. humans need oxygen to live, for plants to grow, to fly, to parachute, for fuel, in light bulbs). We are surrounded by air, which is a mixture of different gases, but we can’t see it, so  *How do we know air is there*?  Air resistance  Ask learners to predict what will happen if you drop a sheet of paper. Ask them to explain their predictions.  When you drop the sheet of paper, elicit that it floats down slowly. Help learners to explain that this is due to air resistance caused by gases in the air. Similarly, learners can move their hand through the air quickly and feel the air resistance.  Explain the impact of air resistance on a falling object can be represented with a particle model diagram showing particles in the gas phase hitting the object as it falls and exerting a force. Draw the particle model diagram and discuss with learners what it shows.  Conclude that some of the ways we know there are gases present is that we can feel them and observe the effects of them.  Gases have properties that we can test  Start by demonstrating the properties of oxygen. Animals need oxygen to survive and it is also necessary for combustion (i.e. burning). Light a candle and let it burn for a minute; explain that it is only burning because oxygen is present. Then, place a glass over the candle and allow learners to observe what happens. Alternatively, show learners a video of this experiment.  *Why does the candle go out after a short while?*  *What is happening to the gasses contained within the glass?*  The candle goes out quite quickly as the oxygen in the glass is used up. Once all the oxygen is go the flame can no longer burn.  Conclude that one of the ways we know there are gases present is that we can observe the effects of them and the effect of not having them.  Gases have mass  Give learners the statement: ‘air has mass’  *Do you think this is true or false?*  *How could we find out?*  Discuss their ideas for finding out if air has mass. If appropriate, suggest that they can identify that air has mass by using a metre ruler as a balance, suspended from a piece of string, and two balloons. Put a small amount of air into one of the balloons, and fully inflate another identical balloon. Attach each balloon to opposite ends of the balance and observe what happens. This activity can be done as a class demonstration or, if resources allow, learners can conduct the experiment themselves.  The fully-inflated balloon moves down as the air inside it has much greater mass than the partially-inflated balloon. Show learners videos of this demonstration, to start the discussion about whether air has mass.  **Resources:** A glass, candle, metre rulers, string, balloons |
| **6Cp.01** Know that the temperature at which a substance changes state is a property of the substance. | **6TWSc.03** Choose equipment to carry out an investigation and use it appropriately.  **6TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions.  **6TWSc.06** Carry out practical work safely.  **6TWSa.05** Present and interpret results using tables, bar charts, dot plots, line graphs and scatter graphs | **Changes of state**  Present a range of substances (i.e. solids, liquids and, if possible, gases) to learners. Discuss if substances only exist in one state:  *Why does a substance change state?*  *Why does water freeze and melt?*  *Can all substances change state?*  Place learners in groups. Explain to learners they are going to investigate what conditions will melt an ice cube the fastest. Let them choose the equipment to melt their ice cube, making a selection from a range of possible equipment (e.g. magnifying glasses, torches, candles, cloths, warm water, and hammer). Ensure different groups use different equipment. Once all groups have their equipment, give each group an ice cube and a container then start a time.  *Who can melt the ice cube the fastest with the equipment you have?*  Encourage learners to take care when they are using heat sources or a hammer. Remind them that water and electricity are potentially dangerous together; the torch should never be in contact with the ice cube or melting water.  *What do you need to do to melt the ice cube?*  *Can you remember what temperature ice starts to melt at?*  As the groups complete their experiment collect note their equipment set ups and time it takes to melt their ice cubes into a class table. Once all the results are in, discuss what the results tell us. Learners create bar charts of the class findings and identify that the equipment that heated up the ice cube the most melted the ice cube the fastest.  Ask learners:  *How would you turn the water back into a solid?*  To solidify the water, the temperature needs to be lowered below 0 oC. Learners could place the container in a freezer, if available, and look at it again later.  *Do all substances melt/freeze at the same temperature?*  If learners say ‘yes’, then ask them to spot substances that are solids, liquids or gases at room temperature in the class room. Elicit the idea that these substances must have different melting and freezing points to water. Then explain that all substances have a different melting/freezing point (i.e. this is a unique property of each substance).  Show learners videos of different substances being melted and/or frozen; discuss the differences and why they might be important. There are some interesting substances that you can look at as examples:   * Aluminium must be melted in a container with a higher melting point so the container stays solid. * Gallium is a metal that is solid at room temperature, but melts at human body temperature (i.e. 37 oC). * Mercury is a metal that is liquid at room temperature. * Carbon Dioxide, when heated up, goes straight from a solid to a gas. (This is called sublimation but learners do not need to know this term at this stage) * Nitrogen becomes a liquid at -195 oC.   Learners, using secondary sources of information, can research the melting/freezing points of a variety of substances and display their data on a line graph to show the differences.  **Resources:** Ice cubes, containers, torches, candles, cloths, warm water, hammers, freezer, secondary sources of information |
| **6Cc.03** Describe the difference between boiling and evaporation. | **6TWSc.03** Choose equipment to carry out an investigation and use it appropriately.  **6TWSc.06** Carry out practical work safely. | **Boiling and evaporation**  Show learners a container where steam is visibly rising from hot water contained within it. Ensure learners maintain a safe distance from the container and do not touch the hot water. Learners discuss the following questions with a partner before sharing with the wider class:  *What is happening here?*  *Is the water evaporating or boiling? Why?*  If possible, using a thermometer, take the temperature of the water and note that it is under 100 oC. Explain to learners that they are seeing steam which is condensation of water droplets in the air. As the droplets in the steam disperse then the steam disappears.  The aim of the following activities is for learners to identify that evaporation and boiling are two separate processes.  Evaporation  *What is evaporation?*  *Where do we see evaporation happening?*  *What factors affect how quickly evaporation happens?*  Explain how we feel evaporation of sweat from our skin, can see puddles that dry up and can see washing that dries. The speed of evaporation is affected by the temperature, wind, humidity and surface area.  Use a particle model to show evaporation is a phenomenon that occurs at (or near) the surface of a liquid.  Explain to learners they are going to do an investigation; what conditions will evaporation happen quickest under? Provide them with the freedom to select any available equipment you are able to provide, including equipment that would not be appropriate to use. Review the equipment they suggest and ensure learners have considered how to be safe with any equipment they select. Ensure the learners use a thermometer (or data logger) to record temperatures.  *What did you do to it?*  *What equipment did you choose to carry out their investigation?*  *Why that equipment?*  *What temperature did evaporation take place at?*  Boiling  *Where do you see boiling happening?*  *What do you see when water is boiling that you do not see when it’s evaporating?*  *What is boiling?*  If possible, demonstrate practically by boiling water in a transparent kettle (or pan of water). Follow the Health and Safety guidance for your school for using boiling water in class, and keep learners at a safe distance for this demonstration. Alternatively, show learners a video of boiling water.  Explain how boiling occurs when a liquid reaches a temperature where the change of state from liquid to gas happens throughout the body of the liquid not just at the surface. For this to happen the liquid must be heated up to the boiling point; this requires a lot of energy (i.e. heat) to be put into the liquid.  The boiling point of water is approximately 100 oC. (Note: impurities in a liquid can affect its boiling point.) When water boils the liquid water enters the gaseous state within the body of the liquid which creates bubbles of water gas; as the gas cools it becomes water vapour in the atmosphere. In contrast, evaporation happens at temperatures well below the boiling point of the liquid; it only happens at the surface of the liquid where liquid particles have enough energy to become water vapour.  Use a particle model to show what happens in the body of the liquid when boiling occurs. Learners they create their own diagrams, with labels, to show their understanding.  **Resources:** Cloths, kettle, heat source, range of equipment for learners to choose from |
| **6Cc.01** Identify and describe physical changes that are reversible. | **6TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry. | **Reversible physical changes**  Define for the learners that a physical change can be a change in state or a change in shape of a substance (e.g. melting ice, rolling a sheet of paper into a ball, crushing a tin can). Explain that a physical change does not produce a new substance and is usually reversible.  *Can you think of an example of a physical change?*  *Can it be reversed?*  *Are there physical changes that you encounter in your day to day life?*  For the series of observations ensure learners keep notes about each physical change.  Demonstrate safely breaking some glass (e.g. a glass bottle) as an example of physical change. This can be done by wrapping the glass in a towel and with learners standing back dropping a heavy item on the wrapped glass, or hitting the wrapped glass with a hammer. The form of the bottle has changed in a way that is hard to reverse, but the glass has not changed at all as it is still glass. Ensure the glass is disposed of safely. Show learners a video of glass being melted and reformed into new objects so they can see the glass being physical changed.  Give each learner a sheet of paper.  *Can you physically change the sheet of paper you have?*  Learners can change roll the paper into a ball or fold it to change its shape. Explain that rolling and folding changes the shape (or form) of the paper; there has been a physical change but not a chemical change.  *Is the change reversible?*  *Can you change the paper back into its original shape?*  If they have folded the paper it is quite easy to unfold it and flatten it out again. If they have rolled it into a ball it is harder to unroll it and get back to the original sheet but can still be reversed. Explain that some physical changes are easier to reverse than others but a physical change does not change what a substance is. Paper is still paper even after a change of shape.  Give the learners, working in pairs, small containers of dry sand and let them feel it:  *What does the sand feel like?*  *Can you make a tower with the sand?*  Provide the learners containers with water. Tell them to add a small amount of water until the sand is wet.  *Now the sand is wet, how is the sand different to when it was dry?*  *Can you make a tower now that the sand is wet?*  Explain to learners that the mixing of the sand and water is a physical change; they have mixed together and the physical properties of the mixture are different to its components. Ensure that learners understand that the sand and water have not reacted with each other so there is no chemical change.  Learners can record the physical properties of the sand before (and after) the water was added by writing descriptions of dry sand and wet sand.  *Is this change reversible? How can we get back the original sand sample?*  The change to the physical nature of the sand can be reversed by warming it up and evaporating the water. Learners place their wet sand sample in a warm place (e.g. on a windowsill in sunshine) and leave it until the water has evaporated; the process might take a day.  *What do you observe about the sand now?*  *What are its physical properties?*  *Can you make a tower?*  The sand is now dry again; it has gone back to how it was before the water was added. The physical change has been reversed.  Learners summarise their observations by drawing a series of diagrams showing the physical changes and how they are reversible.  **Resources:** Glass, heavy item/hammer, a video of glass being melted, sheets of paper, containers, sand |
| **6ESp.01** Know that rocks can be classified as metamorphic, igneous and sedimentary, and describe the identifying features of each type of rock. | **6TWSc.02** Complete a key based on easily observed differences.  **6TWSc.01** Sort, group and classify objects, materials and living things through testing, observation and using secondary information. | **Types of rock**  Gather a range of visually-different rocks from the three types of metamorphic, igneous and sedimentary. Present the rocks to learners, introducing the concept that there is more than one type of rock.  *Can you sort them?*  *How did you decide this?*  *Can you group any of them together?*  *What made you group those rocks together?*  Explain that there are three different types of rocks (i.e. metamorphic, igneous and sedimentary). Discuss how they are made by different processes in different conditions which leads to their own distinguishing features.  Learners write descriptions for the different rocks they have; they focus on appearance and texture. Learners then use a rock classification key to identify a variety of rocks as metamorphic, igneous and sedimentary.  Note: If time allows, learners can test the rocks for other properties (e.g. hardness, permeability) to help sort them.  *Do the different rock types have specific features and properties that can be clearly identified?*  Learners, in groups, summarise the findings by producing key facts about each type of rock.  **Resources:** A range of rocks, a rock classification key |
| **6ESc.01** Describe the rock cycle and the formation of metamorphic, igneous and sedimentary rocks, in terms of solidification, erosion, sedimentation, burial, metamorphism and melting. | **6TWSm.01** Describe how a model can help us understand and describe scientific phenomena and ideas.  **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas.  **6TWSc.06** Carry out practical work safely. | **Rock cycle**  Present an example of a metamorphic rock, igneous rock and sedimentary rock and describe them to the learners.  *Where do rocks come from?*  *Why are there three main types?*  *Are the three types linked in any way?*  After gathering responses, introduce the concept of the rock cycle. Show learners a diagram of the rock cycle and discuss each part. Explain that the rock cycle takes place over a very long period of time (i.e. tens of millions of years) and this means rocks can change from one type to another. This is often used as an example of our dynamic Earth.  Explain that you are going to use a wax crayon model to show how the rock cycle works as we cannot observe the real rock cycle due to the timescales involved. Discuss how this model will help us think about something that is very hard to observe. At each stage of the process learners should keep a small sample of their ‘rock’ to one side so they can compare the different types at the end.  Firstly, show learners a variety of colours of wax crayons and explain that they represent different rocks. Grate the wax crayons explaining that rocks undergo constant erosion by rain. The eroded rock is carried by water and deposited on river beds and the sea bed, this process is called ‘sedimentation’. Learners then make layers of grated wax on a piece of aluminium foil. Encourage learners to use the relevant vocabulary (i.e., ‘rocks’, ‘erosion’, ‘sedimentation’) to describe what they have done.  Then explain that, over millions of years, layers of sediment are buried and compressed by the sediment above it. The layered material resulting from this process is called ‘sedimentary rock’. Learners model ‘burial’ by placing another piece of foil, and then some heavy books, on top of their layers of wax crayon; they press down hard for 2 to 3 minutes. Learners use the vocabulary ‘burial’ and ‘sedimentary rock’ to describe what they are doing and the outcome.  Sedimentary rock can then become further squashed and heated; the chemical and/or physical changes to the rock creates ‘metamorphic rock’. Learners take their sedimentary rock sample and wrap it up in the aluminium foil. They submerge it in hot water for a few minutes and then put it back under the books and press down; they repeat these steps several times. The resulting material represents metamorphic rock which is formed when heat and pressure are applied.  Metamorphic or sedimentary rock can move lower into the crust and eventually melt into molten rock (i.e. ‘magma’). When molten rock cools and solidifies, usually after the magma emerges from the Earth’s crust as ‘lava’, it becomes ‘igneous rock’. To model this, collect the ‘metamorphic rock’ from all the learners onto a piece of aluminium foil and heat them until they melt. The heating can be done by using a cooker, candle heater, hairdryer or another heat source. You will need to do this step for learners to minimise the risk to them. Ensure this is done safely according to your schools Health and Safety policies. Mix the sample while it is in a liquid state, representing magma, and then let it cool. The wax crayon now represents igneous rock.  Igneous rock can also be further squashed and heated to become metamorphic rock. Divide the wax representing igneous rock between the learners. Learners take their igneous rock sample and wrap it up in the aluminium foil. As before, if they repeatedly submerge their sample in hot water for a few minutes and then put it back under the books and press down, they resulting material will represent metamorphic rock, which is formed when heat and pressure are applied.  Show the rock cycle as a diagram to the learners and discuss how we have modelled each step. Discuss if the model that was helpful. Learners can draw and label their own rock cycle.  **Resources:** Rock samples, wax crayons, grater, aluminium foil, heat source, hot water, |
| **6ESp.02** Describe the way fossils can form in sedimentary rocks. | **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Fossil formation in sedimentary rocks**  Show learners images of a range of fossils including the impressions of bones, skin, footprints and the remains of Ice Age animals (e.g. mammoth).  *What is a fossil?*  *Where do we find fossils?*  *How do you think fossils are formed?*  *Where do they come from?*  *What does where we find fossils tell us about how they formed?*  Explain that a fossil is the preserved remains, impression or trace of bones, shells, skin, and other features of living thing from a past geological age. They are usually found in sedimentary rock.  Fossils have taken many years, sometimes millions of years, to form so they are our best source of information about the pre-historic past of the Earth.  Many fossils are found underground which tells us that, in general, they form when a living thing, or something that used to be alive, gets buried. They are also found on the Earth’s surface which tells us that the Earth is still evolving and changing in various ways (e.g. tectonic plates, erosion and volcanic activity)  Learners watch a video (or animation) of fossil formation to help them understand the process. Learners take notes from the video and then draw a labelled timeline of the steps of fossil formation. Alternatively, show learners a series of diagrams illustrating the steps can be used.  Learners can then physically model the process. Provide learners with some soft material (e.g. dough) to make an impression in. They make an impression of a toy dinosaur (or a piece of material with a textured pattern to represent skin) in the dough, remove the toy and make a cast of the impression using clay (or quick setting plaster). Once the clay is set , the cast of the impression can be removed from the dough.  Discuss with learners how accurate this physical model is of the process of fossil formation:  *In what way does this model help our understanding?*  *What are the key differences between the model and what really happens?*  Discuss how the model may help us but it is important to know it is not what really happens. If useful show the video (or animation) from earlier again.  **Resources:** Images of fossils, video of fossil formation, dough, toy dinosaurs, clay |

# Unit 6.4 Electricity, conductors and light

| Unit 6.4 Electricity, conductors and light |
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| Outline of unit: |
| In this unit learners will continue to develop their understanding about phenomena that are abstract and difficult to conceptualise.  Learners will consider aspects of electrical circuits: they need to be closed to work, they need an energy source and there are international conventions on how circuit diagrams are drawn. They will also learn the difference between series and parallel circuits.  Learners will then investigate electrical conductivity and the related concept of thermal conductivity.  Learners will end the unit by considering light by investigating how light travels and how it can be manipulated using mirrors. They will explore the phenomena of reflection and refraction. They will then apply their understanding of light to investigating why the Moon appears to change shape over a lunar month. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * knowing that electrical energy comes from a cell (battery) * understanding that components (e.g. a lamp) require electricity to function * understanding the role of a switch in opening and closing a circuit * observing how changing the number or type of components in a series circuit can affect a lamp * knowing some materials are good electrical conductors and others are good electrical insulators * understanding that there are many different materials and they have very different properties * being aware that the Moon is a natural satellite of Earth and it is not a light source. |
| Suggested examples for teaching Science in Context: |
| ***6SIC.01*** *Describe how scientific knowledge and understanding changes over time through the use of evidence gained by enquiry.*  People have studied the Moon and its phases for thousands of years; the first calendars were all lunar based and the Moon has been, and is, an important part of many cultures around the world. This led humans to want to investigate the Moon further and deepen their understanding of its relationship with Earth. When learning about how the Moon appears to change over a lunar month, learners can consider previous theories/beliefs about the Moon and how scientific enquiry provided evidence to explain the phenomenon that has been observed throughout human history.  ***6SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science.*  Knowledge of electricity (and electrical circuits) is fundamental in a wide range of jobs, such as engineering and electronics. If possible, invite some people who work with electricity (e.g. electricians, circuit designers) to speak to the learners about their work. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
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| **6Pe.01** Use diagrams and conventional symbols to represent, make and compare circuits that include cells, switches, lamps and buzzers. | cell, component, circuit diagram, circuit, buzzer, switch, lamp | Circuit diagrams using conventional symbols are scientific models. By covering this learning objective, learners will use and apply models and representations. | Learners can make mistakes identifying and drawing symbols especially the difference between a single cell and a battery.  Incorrect use of symbols can lead to misconceptions about how circuits and circuit components work. Learners require significant practice in using and drawing circuit diagrams to ensure they develop understanding and fluency to minimise the risk of misconceptions arising. |
| **6Pe.02** Make simple circuits and compare the brightness of lamps in series and parallel circuits. | series, parallel, circuit, lamp | Learners can draw circuit diagrams, using conventional symbols, of the circuits they have made. They can highlight the difference between series and parallel circuits. | Learners can confuse series and parallel circuits. Provide learners will opportunities to read circuit diagrams of both series and parallel circuits.  Learners may believe the colour of the wires affects how the circuit works. Provide learners with wires that only differ by colour (i.e. the metal within them is the same) and demonstrate the colour of the wire has no effect. |
| **6Cp.03** Understand that electrical conductivity and thermal conductivity are properties of a substance.  Note: The objective here focuses on electrical conductivity. | conductor, conductivity, insulator, insulation, electricity | Learners can participate in a role play to represent electrical conductivity. Learners link arms in a circle (representing a wire), with each learner representing a wire particle. Two learners within the circuit, representing cells that provide the energy, move side to side. If the wire is a conductor then the learners pass on the movement all the way around. If the wire is an insulator the learners resist the movement (i.e. prevent the energy flowing around the circuit) or reduce the movement. | Learners may believe a material being a conductor or insulator is an either or situation when in reality it is a scale. This can be discussed and shown by comparing different conductors and showing how a materials is a better or worse conductor than another. |
| **6Cp.03** Understand that electrical conductivity and thermal conductivity are properties of a substance.  Note: The objective here focuses on thermal conductivity. | conduct, insulate, conductor, conductivity, insulator, insulation, thermal, heat, energy | Learners can participate in a role play to represent thermal conductivity. Learners form two lines and at each end there are buckets; one of the buckets is filled with balls that represent energy.  Learners can represent a thermal conductor by picking up balls and moving them down the line to the bucket at the other end.  Learners can represent a thermal insulator by slowly picking up and moving balls; many of the learners being very slow or refusing to take the balls. | ‘Some learners may believe that a coat ‘actively warms you up’ rather than understanding that a coat prevents heat moving from the body into the environment. The clarification that an insulator inhibits the transfer of energy and a conductor enables the transfer of energy will be addressed through coverage of the learning objective. |
| **6Ps.01** Describe how a ray of light changes direction when it is reflected from a plane mirror. | ray, light, reflected, reflect | Diagrams showing how light travels in straight lines and reflects off a plane mirror can be used to support learning. | Learners may believe all objects emit light (i.e. are sources of light) which is why objects can be seen.  This misconception can be addressed by placing objects in a dark places and showing learners they cannot be sources of light as they cannot be seen. |
| **6Ps.02** Describe how a ray of light changes direction when it travels through different mediums and know that this is called refraction. | ray, light, refraction, refract, medium | Diagrams illustrating how light refracts in different mediums can be used to support understanding. | Learners can see light refracted by some mediums (e.g. water) but may struggle to understand that light also changes direction when it travels through transparent and opaque mediums, changing direction as it goes. This misconception can be addressed by learners placing a pencil into a cup of water and observing how the pencil appears to change shape. |
| **6ESs.02** Observe and describe the changes in the appearance of the Moon over its monthly cycle. | Moon, Sun, Earth, orbit, phase, terminator | The phases of the Moon can be physically modelled in the class by moving a painted ball (half white and half black) around a learner (representing the Earth), similar to the orbit of the Moon around the Earth.  Learners can draw a series of diagrams showing the phases of the Moon to represent their understanding. | Some learners may still think that the Moon is a light source, or that the phases of the Moon are caused by the shadow of the Earth. It is important that learners understand that the Moon is not a light source, it reflects light from the Sun, and that the phases are caused by its relative position to Earth and not by the Earth’s shadow. This misconception will be addressed through coverage of the learning objective. |

# Unit 6.4 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
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| **6Pe.01** Use diagrams and conventional symbols to represent, make and compare circuits that include cells, switches, lamps and buzzers. | **6TWSc.03** Choose equipment to carry out an investigation and use it appropriately.  **6TWSc.06** Carry out practical work safely. | **Circuits**  Discuss with learners what they currently know about electricity and circuits. Collect their ideas together as a class list and if required note any misconceptions that need to addressed over the unit.  Present learners with an investigative questions: How many different circuits can we make from the same set of equipment?  Give groups of learner’s time to choose different electrical components (i.e. wires, cells, switches, lamp, motors and buzzers). Ask them to construct a range of circuits. Before they start, discuss how to be safe with electricity:  *What should we do and not do with electricity?*  *What are the risks when working with electricity?*  *How can we be safe when building circuits?*  Once learners have made some circuits, ask them to share their first. Discuss if anyone recorded the first circuit they made. Ask all groups to record their circuits so there is a record of them.  They will often draw something like this:  C:\Users\Paul\Desktop\Camb Curriculum\Project 4 STAGE 6\Circuits.jpg  Compare the drawings of different groups and identify if they have drawn the same components different.  *Is this useful?*  *If Group A was shown Group B’s drawing would they know what it means?*  Explain that there is an international convention for drawing circuits that means anyone in the world can understand them.  Show learners how to draw a circuit diagram for the simple circuit (containing the lamp) according to the international convention. They then draw the diagram for themselves.  C:\Users\Paul\Desktop\Camb Curriculum\Project 4 STAGE 6\Circuit diagram.jpg  Provide the learners with a range of circuit diagrams that include electrical components available for them to use, such as:  C:\Users\Paul\Desktop\Camb Curriculum\Project 4 STAGE 6\Circuit switch.jpg  C:\Users\Paul\Desktop\Camb Curriculum\Project 4 STAGE 6\Circuit buzzer & Switch.jpg  Learners build the circuits represented by the diagrams. Ensure that they can explain why they are choosing each component. Learners then continue to investigate how many circuits they can build using the equipment available, this time recording their circuits using appropriate circuit symbols.  Note: For the circuit symbols used and assessed as part of Cambridge Primary Science programme please refer to the appendix in the Cambridge Primary Science Curriculum Framework.  **Resources:** Circuit components, circuit diagrams |
| **6Pe.02** Make simple circuits and compare the brightness of lamps in series and parallel circuits. | **6TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts.  **6TWSc.06** Carry out practical work safely. | **Series and parallel circuits**  Give learners circuit cards of the following two diagrams:  *How bright will the lamps be in each circuit?*  *Why do you think the lamps will be that bright?*  *What prediction will you make?*  *Why is that your prediction?*  *What knowledge is helping you with that prediction?*  1 - Series  C:\Users\Paul\Desktop\Camb Curriculum\Project 4 STAGE 6\Circuit bulbs series.jpg  2 - Parallel  C:\Users\Paul\Desktop\Camb Curriculum\Project 4 STAGE 6\Images\Parallel Circuit.jpg  Explain to learners that they will build the two circuits and observe what happens. Before they start building their circuits, discuss how to be safe with electricity.  *What should we do and not do with electricity?*  *What are the risks when working with electricity?*  *How can we be safe when building circuits?*  Provide the learners with electrical components to build the two circuits. In pairs the learners build the circuits and record their observations.  Discuss with learners how their observations compare to their predictions.  *What is the difference between the series and parallel circuits?*  *How is the brightness of the lamps affected by the way the circuits are arranged?*  In the first circuit the lamps are in series; the two lamps follow on from each other and share the energy as it flows round the circuit. This means each lamp will be half as bright as a single lamp would have been.  In the second circuit the lamps are in parallel. The two lamps are in two different circuits and so both receive the same amount of energy from the cell. This explains why both lamps will be as bright as a single lamp would have been. (Note: In parallel circuits the cell will run out of energy twice as quickly).  **Resources:** Circuit components, circuit diagram cards |
| **6Cp.03** Understand that electrical conductivity and thermal conductivity are properties of a substance.  Note: for this activity the focus is on electrical conductivity | **6TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts.  **6TWSa.01** Describe the accuracy of predictions, based on results.  **6TWSa.02** Describe patterns in results, including identifying anomalous results.  **6TWSc.06** Carry out practical work safely. | **Electrical conductivity**  Describe to the concept of electrical conductivity as one of the physical properties of substances. Electrical conductivity is a measure of how good the substance is at supporting the transfer of electricity. Electrical conductors are good at conducting electricity and electrical insulators inhibit the transfer of electricity  Give learners a variety of substances (e.g. paper, rubber, steel nail, copper nail, brass drawing pin, coins of known metals, cotton, polyester, leather, plastic, wood). Ask them to predict which will be good conductors and which will be good insulators:  *Which substances do you think will be good electrical conductors? Why?*  *Which do you think will be good insulators? Why?*  Ensure learners make predictions referring to their existing scientific understanding.  Learners sort the substances into two groups (i.e. conductors and insulators) based on their predictions.  Before they start testing their substances, discuss how to be safe with electricity.  *What should we do and not do with electricity?*  *What are the risks when working with electricity?*  *How can we be safe when building circuits, especially with the substances being tested?*  Ask learners to build the following circuit to test their predictions, explaining that they will complete the gap in the circuit by attaching wires to each substance being tested in turn:  C:\Users\Paul\Desktop\Camb Curriculum\Project 4 STAGE 6\Circuit testing.jpg  *How will you know if the substance is a good conductor or if it is an insulator?*  If the lamps lights up then the substance is a conductor, if it does not light up (or is very weak) then the substance is an insulator.  Learners record their results in a table and check whether their predictions were correct.  *What conclusions can you draw from your results?*  *What similarities do all the conducting substances have?*  *Were there any substances that surprised you?*  *How accurate were your results compared to your predictions?*  **Resources:** Circuit components, a range of substances to test |
| **6Cp.03** Understand that electrical conductivity and thermal conductivity are properties of a substance.  Note: for this activity the focus is on thermal conductivity | **6TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry.  **6TWSc.05** Take appropriately accurate measurements.  **6TWSc.06** Carry out practical work safely. | **Thermal conductivity**  Explain that all materials are made of different substances; some substances are good at insulating against heat loss and other materials are good at conducting heat. The ability of a material to conduct heat well or poorly is a physical property.  Show learners an image of something cooking in a pot. Present them with a metal spoon and a wooden spoon.  *Which spoon should you use to stir the food? Why?*  Discuss with learners that metal is a good thermal conductor so the thermal energy being applied to the cooking pot will transfer through the metal to your hand which may burn you.  However, the wooden spoon is a poor thermal conductor (i.e. it is an insulator) as the material inhibits the transfer of heat energy.  *Where else do you see examples of different substances being used because they are good thermal conductors or insulators?*   * Many kitchen utensils have both metal and plastic/rubber parts. The metal part is strong and rigid but, because metal is also a very good thermal conductor, the handles are made from a very good thermal insulator (e.g. plastic, rubber) which stops us burning ourselves when using it. * Air is a very good thermal insulator; it is used between the two panes of glass within double-glazed windows to stop heat transfer in/out of a building. * In general, metals are much better thermal conductors than non-metals. Diamond is a notable exception; it is an excellent thermal conductor even though it is not a metal.   Explain to learners that they will be given an ice cube and their challenge will be to stop the ice cube from melting. Explain they will be investigating what substances are thermal insulators and what ones are thermal conductors. Provide learners with a range of materials (e.g. newspaper, aluminium foil, plastic food wrap, plastic sheeting, different fabrics, bubble wrap). They choose materials to wrap their ice cube in; they can use two layers of the same material if they want.  Give pairs of learners an ice cube. Using scales, they measure the mass of their ice cube before they start and record it as the starting mass.  Learners then wrap their ice cube in their chosen material and secure it with an elastic band. Leave one ice cube unwrapped as a control.  When the control ice cube has melted, learners unwrap their ice cubes and measure the mass again to see how good their choices of insulating material were. They record the new mass of the solid ice, as final mass, and calculate how much mass has been lost as liquid water.  *Why did wrapping the ice cubes stop them from melting?*  *Which materials were the most effective thermal insulators?*  Learners share their results with each other and create a class ranking of the best insulator to the worst.  Explain that wrapping up the ice cubes slowed down the speed of melting as the material layer inhibits the transfer of thermal energy from the surrounding air to the ice cube. Some materials are better thermal insulators than others, such as thicker materials, those with air trapped within them (e.g. bubble wrap); these materials are more able to limit the thermal energy that gets to the ice cube.  Explain that insulators can keep warm things warm, e.g. we wear thick coats in cold weather to slow down the transfer of our body heat into the environment. Insulators can also keep cold things cold, e.g. we use cool boxes made of insulating material to prevent the heat on a warm day from getting to cool food items.  **Resources:** Metal and wooden spoon, a range of materials to be tested, ice cubes, scales, elastic bands |
| **6Ps.01** Describe how a ray of light changes direction when it is reflected from a plane mirror. | **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Reflections**  Show a mirror to the class.  *What can you see in the mirror?*  *How is that image being seen?*  *What is a mirror made of? Can we see that material?*  Remind learners that light travels in straight lines. Demonstrate that light cannot travel around a corner by continuing to talk to learners while you walk around a corner; they will no longer be able to see you.  Show learners a diagram of light traveling in a straight line from a light source, reflecting off a plane mirror and then entering the eye. Explain that light is not changed when it is reflected by a plane mirror so we see an object as if a mirror was not involved (no change in colour or shape).  Present learners with another model of the process of light being reflected off a plane mirror. Show them a ball, explaining that it represents light, and roll it over a smooth floor towards a wall at an angle; it will bounce away from the wall at an angle. If necessary place a smooth surface on the floor to roll the ball over.  Learners, working in groups of four, can role play the reflection by representing the light source, the mirror’s surface, an eye/person and one learner using string to represent the light ray. The ‘string’ learner starts at the ‘light source’ who takes hold of the end of the string, then moves as the light ray would move drawing the string out in straight lines as they move.  In a dark room, provide learners with the opportunity to see the reflection of a light ray from a light source (ideally a ray box with a thin slit to produce a beam) off a plane mirror at an angle. This activity can be extended by measuring the angles of incidence and reflection to identify whether there is a pattern in how the light changes direction when it reflects from a plane mirror surface.  Alternatively, if ray boxes are not available, torches can be used to provide a beam of light; cover the torch with card and make a small pin hole in the centre.  **Resources:** Ball, string, mirrors, light source, |
| **6Ps.02** Describe how a ray of light changes direction when it travels through different mediums and know that this is called refraction. | **6TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry. | **Arrows that change direction**  Show learners a large, clear container of water; place a pen (or pencil) half in and half out of the water. Ask learners to look at the object from different positions.  *What do you observe about the object?*  In addition, a coin can be dropped in a glass of water which, if done in the right way, can look as if the coin disappears.  Explain how light travels through many different mediums (i.e. materials or mixtures) such as air, glass, plastic and water. Discuss everyday examples that learners may have experienced without realising it, such as light passes through glass (when they look out of a window); through water (so they can see the bottom of a glass of water) and through the lenses of glasses/sunglasses allowing them to see.  Demonstrate what happens to light when it travels through water. Draw an arrow pointing to the left on a piece of paper. Move the arrow behind the container of water; ask learners to observe what happens:  *What happened to the arrow?*  *Why do you think it changed direction?*  *What is happening to the light as it travels through the water?*  The direction of the arrow was reversed (i.e. it now points to the right). As light moves from the air to the water it slows down slightly causing it to bend. This process is called ‘refraction’ and it causes the light beams to cross over and the image appear to be reversed. Draw a diagram to help explain to learners what is happening.  In a dark room, learners direct a light ray from a light source (ideally a ray box with a thin slit to produce a beam) into a range of different mediums (e.g. water in a container, vegetable oil in a container, a glass block, a clear plastic block). They observe if the light beam changes in any way as it passes through the different medium. Learners can note their observations as diagrams and/or in a table where they write descriptions of their observations.  Alternatively, if ray boxes are not available, torches can be used to provide a beam of light; cover the torch with card and make a small pin hole in the centre.  **Resources:** Clear container, arrow drawn on paper, a range of different mediums, light source (ray box or alternative) |
| **6ESs.02** Observe and describe the changes in the appearance of the Moon over its monthly cycle. | **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Moon phases**  Show learners an image of the full Moon, a half Moon, and a crescent Moon.  *What do you notice about these images of the Moon?*  *Why does the Moon appear to change shape?*  *Why does it seem to disappear at certain times of the month?*  *What is the Moon?*  *Why do we see the Moon?*  The moon is a natural satellite of Earth (i.e. it orbits the Earth); it is made of rock.  *How do we see any object?*  We can see the Moon from Earth because light from the Sun reflects off the Moon down to the surface of the Earth.  However, from our position on Earth the Moon appears to change shape from day to day; this phenomenon is called the ‘phases of the Moon’. The phases of the Moon are caused by different amounts of the Moon reflecting the light from the Sun because the position of the Moon, relative to the Earth, changes day to day.  Show, and explain, a physical model of the phases of the Moon. Give one learner a painted ball (half white and half black) which represents the Moon. They walk around another learner (representing the Earth) in a circular route, modelling the lunar orbit around the Earth, ensuring the white side of the Moon always faces the direction designated as the Sun. The ‘Moon’ learner pauses at key points, and the ‘Earth’ learner describes what they can see of the Moon; this should happen when a full Moon can be seen (i.e. all of the side of the Moon that faces the Sun is facing the Earth) and when the Moon cannot be seen (i.e. only the dark side of the Moon is facing us). Between these two events, different amounts of the side of the Moon that faces the Sun can be seen on Earth.  Explain how this is a helpful model of what really happens; scientists would need to be far away from Earth and the Moon in order to make observations of the phenomenon.  **Resources:** Images of the Moon, painted ball |

# Unit 6.5 Chemical changes and mixtures

| Unit 6.5 Chemical changes and mixtures |
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| Outline of unit: |
| In this unit learners will understand how chemical reactions result in the formation of new substances and how to recognise when a chemical reaction has occurred.  They will then consider mixtures including dissolving by investigating how dissolving is affected by temperature. Learners will then expand their understanding of mixtures to looking at soils which are different mixtures of many different substances.  By considering chemical change and mixtures together there is the opportunity to ensure learners have clarity between the two concepts and do not mistake mixtures for chemical change or think adding two substances together always results in a chemical change.  This unit provides opportunities for learners to observe and carry out experiments involving chemical reactions and dissolving. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * understanding that substances can physically change and these changes can be reversible * knowing some substances will react to form new substances * using the particle model to explain how a solid dissolves in a solvent |
| Suggested examples for teaching Science in Context: |
| ***6SIC.05*** *Discuss how the use of science and technology can have positive and negative environmental effects on their local area.*  Soil quality is essential to growing crops successfully. Discuss with learners which crops are grown locally and whether the types of crops grown has changed over time due to a change in the soil quality. Discuss the actions local farmers take to try and keep the soil quality suitable for growing their crops. Learners could complete a project on which human activities have an effect on the soil and how that affects the ability of farmers to grow successful crops. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
| --- | --- | --- | --- |
| **6Cc.04** Understand that chemical reactions involve substances, called reactants, interacting to form new substances, called products. | reactants, products, chemical reaction, burning | It may be appropriate to introduce basic word equations for chemical reactions, such as:  Reactant A + Reactant B 🡪 Product C and Product D  There is no requirement at this stage to introduce symbol equations or to balance symbol equations. | Some learners may think that chemical reactions always form one product. It is important that learners understand that chemical reactions usually have more than one product. This misconception can be addressed during the teaching of this unit. |
| **6Cc.05** Observe and describe the evidence that a chemical reaction has taken place (limited to a gas being produced, colour change and change in temperature). | gas, colour change, odour, temperature | Learners can use diagrams to record their observations of a chemical reaction has taken place. | Some learners may believe that every time they see one of the characteristics of a chemical reaction that a chemical reaction is happening. Provide examples where a chemical reaction is not happening (e.g. the presence of gas bubbles in a fizzy drink, the colour change when paints are mixed).  Ensure learners understand that they are looking for signs of a change, and the products are different substances to the reactants. It is also important to address specific misconceptions as they arise. |
| **6Cc.02** Describe how temperature affects solids dissolving in liquids and relate it to the particle model. | solid, liquid, temperature, particles, energy | As learners apply the particle model in this unit, they will be using and applying a scientific model. | Learners may believe cold liquids do not dissolve anything as they are cold. They may also believe that any amount of substance can dissolve in a liquid if the liquid is heated enough. Show learners that dissolving can occur in liquids at a wide range of temperatures (including cold liquids) so they can understand the full effect temperature has on dissolving solids. |
| **6ESp.03** Know that there are different types of soils and they can be classified based on their clay, sand and organic content. | soil, clay, sand, geological, mineral, organic | Learners can use diagrams to represent their understanding of the different types of soil.  Learners can create physical models that represent soil mixtures and/or the variation and change within a soil type; they combine different coloured balls (representing different components of soil, e.g. organic material, sand) in different ratios. For example, one set of balls represents a soil that contains a lot of organic material and a second set of balls represents a soil that has lots of sand. | Some learners may think that all soil is the same especially if there is limited variation of soil in their local area.  Learners may also believe that soil does not contain living things, some of which are not visible to the eye and can be harmful if ingested or inhaled.  It is important that learners understand that soils are mixtures, including living things, and there are a variety of soil types with different features and properties. This misconception will be addressed through coverage of the learning objective. |
| **6ESp.04** Know that soil composition can change, which can support, or hinder, plant growth. | organic, environment |

# Unit 6.5 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
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| **6Cc.04** Understand that chemical reactions involve substances, called reactants, interacting to form new substances, called products. | **6TWSp.01** Ask scientific questions and select appropriate scientific enquiries to use.  **6TWSc.06** Carry out practical work safely. | **Chemical reactions**  Show learners a candle and explain that you are going to light it.  *What do you think will happen when the candle is lit?*  *What questions do we have about burning candle?*  *How could we answer your questions? What scientific enquiry could we use?*  There are many questions that the learners might suggest (e.g. why does the wax melt? what is the smoke? where does the wax go?) Discuss the scientific enquiry types we could use and support learners in identify observing over time is the most practical one to use as it will give us information using first hand observations with no need to manage variables.  Light the candle with a match and let it burn at the front of the class.  *What is happening as the candle burns?*  *What evidence can you see?*  Explain that as the candle burns, there is a both a physical change to the wax (i.e. it melts) and a chemical reaction of the wax with oxygen (i.e. it burns in the air). In this chemical reaction there are two reactants (i.e. wax and oxygen) and two products are formed (i.e. carbon dioxide and water); the water is in the gas phase (i.e. water vapour) due to the heat from the candle).  This can be written as a simple word equation:  Wax + Oxygen 🡪 Carbon Dioxide + Water  Show learners a piece of paper and then scrunch it up into a ball. Ask them:  *What has happened to the piece of paper?*  *Is this a chemical reaction?*  Explain that the piece of paper has changed shape due to a physical force acting on it; this is a physical change. It is not a chemical reaction as no new products have been made (i.e. the paper is still paper).  As a demonstration, go into an open outdoor area, roll the paper into a tube and set fire to it using a match. Ensure the learners remain at a safe distance, use fireproof gloves and have a bucket of sand (or soil) to place the burning paper into. Always ensure you carry out a full risk assessment and meet the health and safety requirements of your school.  *How do you know a chemical reaction has occurred?*  As the paper burns, smoke is produced and the paper goes black. Once the flame is put out you can show that the black remains are very brittle and break off easily. The production of smoke and the fact that the paper has changed irreversibly prove that a chemical reaction has taken place.  *What chemical reactions do you encounter daily?*  Discuss with learners everyday examples of chemical reactions (e.g. cooking and baking; burning; combustion within a car engine; reactions inside the catalytic converter to reduce the polluting gasses produced by a car engine).  **Resources:** Candle, paper, matches |
| **6Cc.05** Observe and describe the evidence that a chemical reaction has taken place (limited to a gas being produced, colour change and change in temperature). | **6TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry.  **6TWSp.05** Describe risks when planning practical work and consider how to minimise them.  **6TWSc.06** Carry out practical work safely. | **The evidence of chemical reaction**  Show learners a video of a chemical reaction taking place.  *What do you notice about what is happening?*  *How do we know a chemical reaction is taking place?*  Show several videos to ensure learners have the opportunity to observe examples of the following indicators that a chemical reaction has taken place:   * change in temperature * change in color * change in odour * formation of bubbles as a gas is produced.   Ensure learners understand these four indicators do not all occur at the same time. Also explain that these indicators can sometimes be seen when a chemical reaction is not taking place (i.e. no new products are being formed). For example, a fizzy drink has gas bubbles in it but the gas is not a product of a chemical reaction; gas was added, during production, and has dissolved in the drink. When paints are mixed the colour changes but no chemical reaction has occurred; the colour change due to a difference in the light absorbed by the paint mixture compared to the individual paints.  Explain to learners that they will carry out their own chemical reaction which they will observe to see if there is any evidence that a chemical reaction is taking place. Learners must wear safety glasses in case there are any splashes from the reaction.  *What are the potential risks from doing a chemical reaction?*  *What steps do we have to take to be safe carrying out a chemical reaction?*  Demonstrate to learners how to smell chemical reactions in a safe way (i.e. by wafting the smell towards the nose with a hand rather than smelling the reaction by moving towards the container).  Working in pairs, learners put one teaspoon of sodium bicarbonate (i.e. baking powder) into a container (e.g. a plastic bottle, beaker or yogurt pot). Ensure the container is in a tray in case the reaction overflows. The learners then add 10 cm3 of vinegar (i.e. acetic acid) and observe what happens.  *What can you observe happening?*  *Are there any signs that a chemical reaction is happening?*  *What is causing the bubbles?*  As the sodium bicarbonate and vinegar mix, learners will observe bubbles being produced and a distinct change in the odour. If they hold the container in their hands, they will also feel that it is cold.  These are signs that a chemical reaction is happening, the bubbles are caused by the formation of gas which rises through the liquid.  Learners can write the equation for the reaction:  Sodium Bicarbonate + Acetic Acid 🡪 Carbon Dioxide + Sodium Acetate  The general equation for a chemical reaction is: Reactant A + Reactant B 🡪 Product C + Product D  Give learners a wide range of household chemicals, such as:   * water * baking powder (i.e. sodium bicarbonate) * lemon juice (i.e. liquid citric acid) * solid citric acid (if available) * vinegar (i.e. acetic acid) * flour (i.e. starch) * effervescent tablets.   Do not use any chemicals which will pose a risk to yourself or others e.g. do not use household cleaning products such as bleach.  Explain to learners that they can choose two chemicals to mix together to see if a chemical reaction occurs.  Discuss with learners the need to be safe during all experimental work. Ask learners to consider the risks and what can be done to reduce the risks.  Learners mix a small amount of the two chemicals they have chosen and observe what happens. If there is a chemical reaction, they make a note of the evidence and try writing an equation for it. If there is no chemical reaction between the chemicals, they can choose two other chemicals to try.  Once learners have completed their experiments, collate their results as a class and identify what combinations of chemicals result in a mixture. From the class data learners create a dot plot (evidence of a chemical reaction and dots for each observation) and identify which feature of a chemical reaction was most common in the reactions they observed and which the least.  **Resources:** Containers, sodium bicarbonate, vinegar, teaspoons, safety glasses, a range of household chemicals to be tested |
| **6Cc.02** Describe how temperature affects solids dissolving in liquids and relate it to the particle model. | **6TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts.  **6TWSp.04** Plan fair test investigations, identifying the independent, dependent and control variables.  **6TWSc.05** Take appropriately accurate measurements.  **6TWSp.05** Describe risks when planning practical work and consider how to minimise them**.**  **6TWSa.05** Present and interpret results using tables, bar charts, dot plots, line graphs and scatter graphs  **6TWSc.06** Carry out practical work safely. | **Rates of dissolving**  Discuss with learners how there isn’t always a chemical reaction when adding chemicals together; sometimes a mixture forms. Demonstrate the dissolving of a sugar cube (i.e. the solute) in water (i.e. the solvent) at room temperature. If a sugar cube if not available a teaspoon of sugar can be used.  *What is dissolving?*  *What factors do you think might affect how quickly a solid dissolves in a liquid?*  *How could you investigate the effect of temperature on a solid dissolving?*  ‘Dissolving’ is the process by which a solute is added to a solvent and their particles mix together. Clearly explain that no reaction is taking place although, as the solute is ‘disappearing’, it can look like there is a chemical change.  Learners plan a fair test enquiry to investigate how the temperature of water affects the amount of sugar that will dissolve in it.  *What variables are you going to keep constant (control) in the investigation?*  *What is the independent variable going to be?*  *How are you going to measure the amount of solid that dissolves? What is the dependent variable?*  Ask learners to predict the effect the temperature might have on the amount of solid that will dissolve; encourage learners to use the particle model to help explain their predictions.  Provide learners with three different temperatures of water (i.e. cold water from the fridge, water at room temperature, and warm water from the hot tap)  Learners keep the volume of water and the amount of stirring the same; they add sugar cubes, one at a time, to the water at different temperatures and see if it dissolves. They need to ensure each sugar cube is fully dissolved before adding the next one.  It is important that they work quickly as the water will change temperature quite quickly. If thermometers are available, they can monitor the temperature themselves.  Learners judge when they think no more sugar is dissolving in the water. They record the number of sugar cubes that fully dissolved at each temperature of water; they plot a graph of the number of sugar cubes that dissolved against water temperature.  Learners can now investigate if temperature affects how quickly a solute dissolves in a solvent. This time learners add one sugar cube to each water sample and time how long it takes for one sugar cube to dissolve. They record their data in a table and then create a dot-to-dot graph, line graph (or scatter graph through which they can draw a line of best fit). .  *What have you found from your investigations?*  *Was your original hypothesis correct?*  Help learners to draw conclusions based on the graphs of their results (e.g. significantly more sugar dissolves in hot water than in cold water; sugar dissolves quicker in hot water than cold water).  *Why do you think more sugar dissolves in hot water than in cold water?*  *Why do you think sugar dissolves quicker in hot water than in cold water?*  *Can you explain it in terms of the particle model?*  Explain that the liquid particles in a warm solvent move faster than in a cold solvent; they are more able to break up the solid particles of the solute into the body of the liquid. Learners can draw a series of diagrams showing the particles of the solute and solvent during the process of dissolving; they can also take part in a role play where learners act as solvent and solute particles colliding under different temperatures.  **Resources:** Sugar cubes, water at different temperatures, heatproof containers, stirrers, stopwatches, graph paper, thermometers |
| **6ESp.03** Know that there are different types of soils and they can be classified based on their clay, sand and organic content. | **6TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry.  **6TWSc.06** Carry out practical work safely. | **Soils**  Show learners some soil samples in the classroom (or collect samples together from the school grounds).  *What is soil?*  *Why is soil important?*  *What do you know about soil?*  Soil can be defined as the top 1.2 metres of the Earth’s crust (although this definition is flexible depending on where you are in the world). It is loose geological material, such as rocks, and organic material and it has huge importance as it is where crops grow. Soil is often classified by how much clay, sand and organic content a sample contains. Soil is therefore a mixture made of distinct components.  Give pairs of learners’ samples of different types of soil from the local area: they will investigate the samples by looking closely with a magnifying glass or hand lens (or a microscope) and touching them. Each learner should make a table and use it to record their observations and compare the types of soil they have.  If learners are touching them ensure you complete a risk assessment and follow your school’s health and safety guidance. It may be appropriate for learners to wear gloves when handling soil. Encourage them to use scientific vocabulary when describing the soil samples:  Consistency   * Loose - soil breaks apart easily when held. * Friable - soil breaks apart with a small amount of pressure. * Firm - soil breaks apart with a lot of pressure.   Texture   * Grainy - soil consists of large pieces and feels gritty. * Silky - soil consists of medium pieces and feels powdery. * Sticky - soil consists of small pieces and feels gummy.   Learners can also describe the colour of the soil sample and which materials (e.g. pieces of organic material, decaying leaves) are present in the sample.  Provide learners with containers of water. Learners add some water to a small portion of each soil sample and try to mould it into a ball. They discuss the differences between the samples.  *Do they feel sticky?*  *Can you make a ball?*  *Does the ball break easily?*  Learners put a small amount of each soil sample into a clear container with a lid (such as a plastic bottle or jar). They add water and shake the container; they leave the contents to settle until the following lesson. Distinct layers will form: the bottom layer will consist of pebbles and sand and the top layer will be silt, clay and water (discoloured by soluble organic material) and there will be floating organic material on the top. Learners measure the heights of the layers using a ruler and use this to inform is the soil is mostly clay, sand or organic material.  Support learners in classifying soils based on their observations and by considering the clay, sand and organic material content.  **Resources:** Magnifying glasses or hand lenses, soil samples from the local area, containers |
| **6ESp.04** Know that soil composition can change, which can support, or hinder, plant growth. | **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas.  **6TWSp.04** Plan fair test investigations, identifying the independent, dependent and control variables. | **Soil composition and plant growth**  Discuss the differences in appearance and texture of the soils from the local area.  *In what ways are soils different?*  *Why do you think soils are different?*  *What different components make up different soils?*  Explain that soil composition varies hugely in terms of its mineral content and the amount of organic materials. Environmental conditions (e.g. the weather) affect soil formation and therefore soil composition. The use of the soil also changes soil composition (e.g. repeated growth of the same crops can quickly use up organic material and minerals within the soil).  *What is the main way humans use soil?*  *Why is soil composition so important to humans?*  *Can the composition of soil be altered?*  Explain that soil is very important to humans all over the world as it is what crops are grown in to provide food for humans directly (i.e. plants) or indirectly by feeding animals. The composition of some soils is not so good at supporting healthy plant growth; it can be improved by adding fertiliser (i.e. organic materials or specific minerals) or by rotating the crops that are grown.  Show learners two different types of soil: a soil rich in organic content (e.g. a topsoil full of nutrients and organic material) and a very sandy soil (or a very clay-based soil). If necessary, these samples can be created by adding components (e.g. sand) to the soil that is available.  Tell learners they are going to carry out an investigation to find out which soil sample is best for plant growth. Have a class discussion about planning the investigation.  *What enquiry type will we need to use to get an accurate answer?*  *How will we set up the investigation?*  *What variables will we need to control?*  *What will our independent variable be?*  *How will we collect data from our experiment?*  Explain to learners that they will need to set up a fair test investigation to accurately compare plant growth in two soil samples. They will need to keep many things constant (e.g. the amount of soil, the temperature and amount of water, the seeds, the depth at which the seeds are planted, the placement of the containers). The variable will be the type of soil used. Data will be collected by daily observations and, when the shoot appears, measuring the height of the shoot.  Working in groups, learners put soil rich in organic material in one container and the same amount of sandy soil in another; they label the containers with the soil type. They plant one seed in each container, pushing it down to the same depth in both soil samples. (Note: Use any seed that grows reasonably fast so it can be observed within this unit of teaching such as tomato. Learners give each seed the same amount of water and place the containers side by side.  They monitor the growth of their plants over the course of two weeks, recording observations and taking measurements of shoot height when they appear above the soil. If the plants need watering both containers should have the same amount of water added.  *Which soil type was best for plant growth?*  *Why do you think that was?*  *What implications does this have for people growing crops for food?*  Explain that, the organic rich topsoil should be the best for plant growth as it is rich in minerals and organic material and it is good at holding the water for the plant to use. Sandy soils contain very little organic material; they dry out very quickly as water runs through them. It is hard for roots and shoots to push through heavy and sticky clay-based soils and this can limit plant growth.  Reinforce to learners that fertiliser can be added to a soil that is low in organic material; this can make the soil more suitable for growing crops.  Discuss how changing the composition of the soil can make growing crops easier or harder.  **Resources:** Soil samples, seeds, containers |

# Unit 6.6 Ecosystems

| Unit 6.6 Ecosystems |
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| Outline of unit: |
| In this unit, learners will extend their understanding of food chains into more complex food webs. They will explore different food webs that are found in different ecosystems and how each food web is made up of interacting food chains.  They will explore how energy moves through a food web and how producers are able to make their own food by using energy from the Sun.  Finally, learners will understand how some substances are toxic and can effect a whole food web. They will be introduced to the concept of bioaccumulation and how some toxic substances may not affect organisms high in a food web until it builds up to a toxic level. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * understanding what a food chain is * identifying and describing animals and plants as producers, consumers, predators and prey * being able to describe some different ecosystems * knowing that energy comes from the sun (in the form of heat and light) and plants use this energy to survive and grow. |
| Suggested examples for teaching Science in Context: |
| ***6SIC.03*** *Use science to support points when discussing issues, situations or actions.*  An understanding of food webs and food chains is important for considering the balance of ecosystems and how human intervention, however well intentioned, often upsets that balance. Thinking about their local area, learners can consider if there are examples of humans interacting with ecosystems that produce positive and/or negative effects, such as the introduction of a new species to an area, the reintroduction of a species to an area or the hunting of a species.  ***6SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science.*  Considering the interaction of animals and plants and how an ecosystem functions is part of many peoples’ jobs; if possible, invite in a local professional (e.g. ecologist, professional gardener, forestry worker to talk to learners about ecosystems.  ***6SIC.05*** *Discuss how the use of science and technology can have positive and negative environmental effects on their local area.*  The waste produced by humans can often have an impact on the environment. Learners can investigate if any waste produced in their local areas impacts on the local ecosystem(s) and if there are any current (or historic) instances of bioaccumulation in their local area (e.g. the use of DDT as a pesticide). |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
| --- | --- | --- | --- |
| **6Be.01** Interpret food webs and identify food chains within them. | food chain, food web, producer, primary consumer, secondary consumer, tertiary consumer, predator, prey, herbivore, carnivore, omnivore | Food chains/webs are models and representations of the feeding relationships between organisms. By analysing food chains/webs learners are interacting with a scientific model.  Learners can participate in a role play as a physical model to demonstrate their understanding of feeding relationships between organisms. Learners are allocated roles as different plants and animals; ensure more learners represent plants and animals lower down the food chain/web. Provide plants with balls to represent energy. Learners representing herbivores ‘eat’ the plants by taking their energy, learners representing carnivores then ‘eat’ the herbivores and carnivores higher up the food chain/web ‘eat’ herbivores or lower tier carnivores, as appropriate. | Some learners may think that the arrow in a food web simply points from one organism to another.  It is important that learners understand that, within a food chain/web, the arrow represents energy being transferred from one organism to another; the arrow points from the organism that is eaten to the organism that has eaten it. |
| **6Be.03** Identify the energy source of a food chain/web, and describe how energy is transferred through a food chain/web. | energy source, Sun, producer, consumer, energy flow | Learners can use (or draw) diagrams of food chains/webs and add in arrows showing the energy flow. This creates an energy flow diagram.  Learners can participate in a role play as a physical model to demonstrate their understanding that the Sun is the energy source of a food chain/web. They can repeat the role-play above except this time a learner, representing the Sun, starts with all the balls which they give to the learners representing plants. | Some learners may think that plants get their food from the soil that they grow in.  It is important that learners understand that plants are the food producers (i.e. they make their own food using energy from light). Soils contain substances that a plant requires e.g. a source of water, a mixture to anchor in (so they remain upright or will not be blown away) and a source of minerals and nutrients. Learners can be shown videos of hydroponics to prove soil is not required for plant growth but light and air is essential. |
| **6Be.02** Know that some substances can be toxic and damage living things, and that these substances can move through a food chain/web. | bioaccumulation, toxic, concentration, ingestion, substance, food chain, food web | Learners can participate in a role play as a physical model to demonstrate the impact of toxic substances on a food chain. Blocks can be used to represent a toxic pesticide; this provides clear differentiation from the balls that were used to represent energy in previous role plays. Some learners are given blocks to model plants being sprayed with toxic pesticides. Other learners, representing herbivores (e.g. insects), take the blocks and then sit on the floor to model ‘eating’ the plant now containing the toxic substance and ‘dying’. Finally, other learners, representing animals and plants, take the blocks and also sit on the floor to model ‘eating’ the dead herbivores containing the toxic substance and ‘dying’. | Learners may think that toxic substances only affect the plants and animals lower in the food chain as the toxic substance will not reach the top (e.g. humans). It is important learners recognise that most living things have some resistance to toxicity and small levels of toxic substances can be tolerated, or even required.  There are many examples of toxic substances that are required in small doses for plants and animals (including humans) to be healthy. One example includes arsenic.  There are some substances which are toxic regardless of dosage and these include mercury and cadmium. |

# Unit 6.6 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
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| **6Be.01** Interpret food webs and identify food chains within them. | **6TWSm.01** Describe how a model can help us understand and describe scientific phenomena and ideas. | **Food webs**  Show learners a simple food chain (e.g. grass 🡪 rabbit 🡪 fox). Then, by asking questions, identify what they already know about food chains:  *What is a predator?*  *What is a prey?*  *What is a producer?*  *What is a consumer?*  *What is a primary consumer?*  *What is a secondary consumer?*  *What is a herbivore?*  *What is a carnivore?*  *What is a omnivore?*  Clarify any terms that learners seem unfamiliar with or confused by.  Explain that food chains are part of much more complex ‘food webs’ that exist in every ecosystem.  Select a food chain with a common plant (e.g. grass) and animals that the learners are familiar with. Designate one group of learners as the common plant and other learners as the animals in the food chain. Learners could be given animal masks (or name labels) to help them remember which animal they are.  Connect the producer (on one side) to the final consumer (on the other side) by each holding one end of a piece of string. Other consumers find their appropriate place along the food chain and hold the string there.  The following process can be used to extend this food chain into a food web using organisms that the learners are familiar with:   * Explain how many creatures eat the same food. Ask learners to name another animal that eats the producer. * Designate a learner as that animal and place them off the food chain as a new ‘branch’. * Ask learners to name an animal that eats the newly-placed animal. If learners suggest an animal that is already in the model, then use string to connect the two food chains together. Alternatively, add a new learner representing the new animal. * Keep adding animals and connections until the learners cannot provide any further suggestions. * Discuss how this added complexity leads to a food web rather than a simple food chain. This is a scientific model which shows all the known, interconnecting feeding relationships between the plants and animals included.   Give learners some printed examples of food webs from different ecosystems; ask them to circle the food chains they can see.  *How do food chains and food webs help you understand the interactions in an ecosystem?*  **Resources:** String, printed food webs |
| **6Be.03** Identify the energy source of a food chain/web, and describe how energy is transferred through a food chain/web. | **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Energy flow**  Ask questions to start a conversation with learners about where living things get the energy they need to survive:  *Where do plants get their energy from?*  *Where do animals get their energy from?*  *Where does energy within food chain come from originally?*  Most of the energy within living things comes from the Sun. Explain how the class will participate in a physical model of the energy transfer within a food chain/web.  Designate a learner as the Sun who gives energy (represented by balls) to other plants (represented by other learners). Explain that the ‘plant learners’ holding the balls use the energy to make food, and the energy is then contained in the food.  When a consumer (i.e. a herbivore) eats the plant they consume the food and therefore get the energy which they need to live. Designate some learners as herbivores that eat plants; ask them to ‘eat the plants’ by taking the balls from the ‘plant learners’.  Designate another group of learners to act as predators who eat the ‘herbivores’ and get the energy they hold. As the consumers prey on each other, the energy can be passed up through the food chain.  Explain how the role-play of the energy transfer acts as a model which shows our understanding of how energy is transferred through a food chain/web.  Learners record their understanding by creating a comic strip. Ensure they cover the key points (e.g. the energy comes from the Sun, producers transfer that energy into food, consumers eat producers and transfer the energy from the producer to themselves, consumers eat consumers).  This activity can be extended by asking learners to create a ‘What If’ story based on the question:  *What will happen if the energy from the Sun could not reach the surface of the Earth?*  **Resources:** balls, printed food webs/chains |
| **6Be.02** Know that some substances can be toxic and damage living things, and that these substances can move through a food chain/web. | **6TWSc.07** Use a range of secondary information sources to research and select relevant evidence to answer questions. | **Toxic substances in food chains**  Introduce the word ‘toxic’ to the learners.  *What does the word ‘toxic’ mean?*  *If a substance is ‘toxic’ what does that substance do?*  Focus the discussion with learners on how toxic substances can damage living things leading to illness and even death.  Show learners some images of toxic substances (e.g. mercury, arsenic and lead). Discuss how each example is toxic. Using secondary information sources, learners research one or more of the named toxic substances to create ‘toxic substance profiles’; they identify the sources of a toxic substance, the impact the toxic substance has on living things (including, but not limited to, humans). They may also find out the history of how humans have used toxic substances in the past and how scientific discovery has, over time, changed our understanding of which substances are toxic. Learners then share their toxic substance profile with the class.  Explain that energy is not the only thing that can flow through a food web; sometimes toxic substances that are introduced to an ecosystem can be passed through the food web and build up in consumers higher up. Learners who research mercury and microplastics (in aquatic food chains) or DDT (an insecticide which affects the shells of bird eggs) can explain how these toxic substances move through the food chain/web. This is because toxic substances often stay in the organism that has eaten them meaning the toxic substance is passed onto other organisms that eat them.  Learners can produce a comic strip to show how toxic substances move through a food chain/web.  **Resources:** Secondary information sources |

# Unit 6.7 Puberty

| Unit 6.7 Puberty |
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| Outline of unit: |
| This unit introduces the organs of the human reproductive system and the physical changes that occur during puberty. It does not cover human reproduction, pregnancy or child birth.  The aim of this unit is to give learners scientific information about the changes that will happen to their bodies. Ideally this should be before they start puberty so it may be helpful to schedule this unit earlier in the stage to better align to the needs of your learners. You may also wish to teach this content in separate groups for boys and girls, although all learners should have the opportunity to fully meet all the learning objectives.  When teaching this unit, it is recommended that:   * the use of scientific terms for the organs of the reproductive system (rather than colloquial terms) is modelled * diagrams (rather than photographs) are used to show the organs * ground rules for asking questions are set at the beginning of the unit (e.g. do not ask anyone about their individual experiences).   Learners often have many questions about this topic, and this is a good opportunity for them to get reliable information based on scientific understanding. |
| Recommended prior knowledge or previous learning required for the unit: |
| Learners will benefit from previous experience of:   * knowing humans are living things * identifying humans as part of the animal kingdom * knowing humans have offspring * understanding male and female humans have some key physical differences * understanding the reproductive system of flowering plants. |
| Suggested examples for teaching Science in Context: |
| ***6SIC.04*** *Identify people who use science, including professionally, in their area and describe how they use science****.***  Learners can consider the important role that medical professionals (e.g. doctors, nurses and midwives) play in keeping them healthy. It may be beneficial to have a local doctor, nurse or midwife come in and talk about their job and its links to human reproduction with the learners. |

| Learning objective | Key vocabulary | Possible models and representations | Possible misconceptions |
| --- | --- | --- | --- |
| **6Bs.03** Name the parts of the human reproductive system. | reproductive system, penis, testes, sperm, vagina, uterus, oviduct, ovary, egg | Learners can label diagrams of male and female reproductive systems using key vocabulary. | Some learners may use colloquial terms for the reproductive parts, many of which are taboo, and this can lead to them being unwilling to talk scientifically about the human reproductive system.  Some learners may think that all the reproductive organs are external and visible. Ensure learners are aware that there are also internal reproductive organs, especially in the female system. |
| **6Bp.01** Describe the physical changes that take place during puberty in humans. | puberty, hair growth, voice breaks, oily skin, hips widen, menstruation, breasts, muscles, hormones | Learners can label diagrams showing where the main physical changes happen for males and females during puberty. | Some learners may think that all physical changes are restricted to either males or females.  It is important that learners understand that most physical changes during puberty happen to both males and females and only very specific changes are gender specific. This misconception will be addressed by coverage of the learning outcome. |

# Unit 6.7 Suggested activities

| Learning objective | Thinking and Working Scientifically opportunities | Suggested teaching activities and resources |
| --- | --- | --- |
| **6Bs.03** Name the parts of the human reproductive system. | **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **The human reproductive system**  Recap the features of the organ systems covered so far in the Cambridge Primary Science Curriculum (i.e. respiratory system, circulatory system, nervous system, musculoskeletal system).  *Are there any differences between these organ systems in boys and girls?*  Elicit that these organ systems are the same for boys and girls. Explain that this is not the case for the reproductive system; the reproductive system of males and females are different and they have different organs.  Give learners an unlabelled diagram of the male reproductive system with arrows pointing to the penis and the testes.  *Do you know the scientific names of the two organs indicated?*  Tell learners that these parts are called the ‘testes’ and the ‘penis’. Learners label their blank diagrams.  It may be appropriate to give learners a simple explanation of the functions of these organs, such as:   * Sperm cells are made in the testes where sperm cells in humans are similar to pollen grains in plants. * The penis is used for the excretion of urine and it is also part of the male reproductive system.   Give learners an unlabelled diagram of the female reproductive system with arrows pointing to the ovaries, oviducts, uterus and vagina.  *Do you know the scientific names of the organs indicated?*  Tell learners the correct names for each of these organs and ask them to label their diagrams.  Again, it may be appropriate to give learners a simple explanation of the functions of these organs, such as:   * Egg cells mature in the ovaries; egg cells in humans have a similar function to egg cells in plants. * The Oviducts are tubes that carry the eggs from the ovaries to the uterus. * The uterus is where a baby develops in a pregnant woman. * The vagina is the opening to the female reproductive system.   Explain that the female reproductive system is mostly internal and therefore cannot be easily seen, unlike the male reproductive system.  **Resources:** Blank diagrams of the human reproductive systems (male and female) |
| **6Bp.01** Describe the physical changes that take place during puberty in humans. | **6TWSm.02** Use models, including diagrams, to represent and describe scientific phenomena and ideas. | **Puberty**  Explain that ‘puberty’ is the biological process which all humans go through to become biological adults with the ability to reproduce. The age puberty begins within humans varies from person to person; the typical age ranges are 8 – 14 years old with girls often starting puberty before boys.  Find out what the class already know about the physical changes that happen as a human grows up by asking questions:  *What physical differences are there between the appearance of a human baby, a child, a teenager and an adult?*  Make a note of their responses. Their answers may include: grow taller and heavier, skin becomes oily, spots appear on skin, hair grows on face, hair grows under arms, body produces hormones, body shape changes, voice becomes deeper, body sweats more, may become physically attracted to other people, start to think more about appearance.  Explain that, as we grow up, our bodies change because the level of hormones within our blood increase. Puberty happens to every human and also to many animals.  Give learners a blank diagram of the human bodies of a male and a female. Learners label the diagrams as you discuss the various physical changes that occur:  Happens to both males and females:   * Hair growth: hair develops under the armpits and around the pubic area (i.e. where the reproductive organs are). Males will develop substantial terminal hair on their arms, legs and chest. Hair change and growth happens very differently to different individuals. * Grow taller: Puberty often involves a period of rapid growth. * Oily skin: The skin secretes an oily substance that can cause unpleasant odours if not washed off regularly. It can also block skin pores and cause spots to develop.   Only happens in males (or most noticeable in males):   * Facial hair: Hair develops on the jaw and above the mouth; this is most noticeable in males. * Muscles develop all over the body and strength increases; this is most noticeable in males. * Shoulders broaden. * Voice changes (i.e. breaks): The larynx grows and the voice deepens; it can happen very suddenly or over a long period. (Note: Womens’ voices also deepen slightly, the process is much more gradual.) * Testes and penis: These organs become bigger; this is part of the way that boys become biological adults who could be fathers.   Only happens in females   * Hips widen. * Breasts develop: The breasts grow to be ready to provide milk for a baby. * Menstruation starts: This is part of the way that girls become adults who could become pregnant.   Learners may be nervous about going through the process of puberty themselves, so it can be useful for them to make a book about the changes. For example:   * Ask each learner to fold a piece of A4 paper in half to form a booklet. * They open the booklet and on the **inside front cover (page 2)** write the word ‘Me’ and their current age. Ask them to write down any words they think describe them as they are now, such as:   + What they look like   + Interests   + Personalities   + Friends   + Favourite music   + Favourite TV   + Hobbies/interests. * **Front Page (page 1)** Learners write ‘Me’ and add the age they were 1 year ago. Ask them to repeat the exercise and create a profile of themselves last year. * **Inside back cover (page 3)** Write the word ‘Me’ again and the age they will be in 1 year. They build a profile of how they think they will be different by this time next year.   *What physical and emotional changes might you have gone through?*  *How might your interests and lives change?*   * **Back Page (page 4)** – Write ‘Me’ again and aged 20. Ask the learners to imagine themselves aged 20 and write words to describe what they would like to be like as a young adult. Encourage them to be positive and include what they would like to be doing too. * Ask the group to reflect on what they learned from the exercise and to discuss, in pairs, what they need to do over the next few years to become the 20 year old they want to be.   *What changes might happen?*  *What are they most excited about?*  *What issues might they face along the way?*  Menstruation  Explain to the learners that they are going to find out about one of the changes that happens to a girl’s body during puberty which means they will be capable of becoming pregnant. Remind them of previous learning about the organs of the female reproductive system (i.e. ovaries, oviduct, uterus, egg, vagina).  Show learners an animation that explains the physical side of menstruation. Explain that everyone is different and reassure them that there is no need to worry if they do not start to menstruate at the same time as others.  Many girls are worried about the practicalities of menstruating and it might be useful to have a extra lesson for the girls led by a female teacher (or nurse) to address their questions (e.g. Does it hurt? When will it happen? What should I do when I start my period? Will everyone know that I have my period?).  Seek to address these questions in an open and positive way, encouraging girls to talk to their family if they are worried about anything.  **Resources:** Blank diagrams of human reproductive systems (male and female), an animation of menstruation |

# Sample Lesson 1

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| CLASS: | |
| DATE: | |
| **Learning objectives** | **6Cp.03** Understand that electrical conductivity and thermal conductivity are properties of a substance. (This lesson focuses on thermal conductivity)  **6TWSc.08** Collect and record observations and/or measurements in tables and diagrams appropriate to the type of scientific enquiry.  **6TWSc.03** Choose equipment to carry out an investigation and use it appropriately. |
| **Lesson focus /**  **success criteria** | I can identify the properties of substances including thermal conductivity  I can make observations over time and record my observations in a table  I can choose equipment giving reasons for my choice  I can use equipment appropriately in an investigation |
| **Prior knowledge /**  **Previous learning** | Learners will benefit from knowing some properties of substance and all substances have properties.  Learners will continue to develop their skills in carrying out an ‘observation over time’ investigation.  Learners should know that ice is the solid state of water and that ice melts to liquid water when it is heated up. |

**Plan**

| **Timing** | **Planned activities** | **Notes** |
| --- | --- | --- |
| **Introduction** | Have a saucepan in the room and fill it with boiling water; it will cool during the lesson.  Show learners a metal stirring spoon and a wooden spoon.  Place the spoons into the hot water, ensuring that the handle is not in the water. Leave the spoons in the water for 1 minute. While the spoons are in the water, ask learners:  *What is happening to the spoons?*  *Which spoon should I pick up?*  *Why that one?*  *Why not the other one?*  Explain that all materials are made of different substances and some of those substances are good at insulating against heat loss, and some materials are good at conducting heat.  Explain that a thermal insulator is something that inhibits heat moving through the substance from one place to another, a thermal conductor is something that enables/supports heat moving through the material from one place to another.  The metal spoon is a thermal conductor which is why it will be hot to pick up; the heat is moving easily through the metal. The wooden spoon is a thermal insulator which is why I can pick it up even through it has been in the hot water for a while. (Note: the wooden spoon may be warmer than when it started as insulators can still enable heat to move through them it just happens slowly if at all). | Ensure you write a risk assessment for this activity, follow your schools health and safety policies and ensure learners do not get to close to hot/boiling water.  Resources:  Saucepan, wooden spoon, metal spoon, boiling water |
| **Main activities** | Show learners a tray of ice cubes and explain that their challenge is to stop their ice cube from melting. Introduce the investigation: What substances are thermal insulators and what ones are thermal conductors?  *How can you stop an ice cube melting?*  *Will you need substances that easily allow heat to move or substances that inhibit heat moving? Why?*  Place learners into groups of three. Provide a range of substances/materials to the learners and give them time to select the substances/materials they want to test.  Learners then select from a range of substances/materials available, as many as possible, which can include newspaper, different fabrics, writing paper, wool, bubblewrap, plastic food wrap (film), metal foil, plastic wrapper, and other available ones.  Learners choose two materials to wrap their ice cube in it and secure the two layers with an elastic band.  *Which materials are the most appropriate?*  *Why are you making that choice?*  *What do you think is going to happen when the ice cube is wrapped up?*  *What difference will your material choices make?*  Ask learners to write down their choice of equipment with a reason based on their scientific understanding. Once learners have made a choice with a reason they can collect their ice cube.  Keep one ice cube back, and announce this to the class, that one ice-cube (you may want to name your ice-cube) will act as a control. If needed explain a control is where we have one sample where we are not making a change to compare our other samples against.  Learners measure the mass of their ice cube before they start as accurately as possible. Learners then work to insulate their ice cube.  Once insulated the learners observe their ice cube, and those of other groups, and discuss what is happening. Show the particle model of a solid to the learners and ask them what will happen if the ice cube gets heated up. Show how as the ice cube heats up the particles gain more energy and move more to the point they move out of their fixed positions and flow around each other as a liquid.  When the control ice cube has melted learners unwrap their ice cubes and measure the mass of them (ensure they drain off any excess water and do not measure any materials) to see how good their choices of insulating material were. | Resources:  A range of materials  ice cubes  scales  elastic bands |
| **End/Close/**  **Reflection/**  **Summary** | *What did you notice about your ice cube? How much of the ice cube has melted? Why?*  Collect the data in a class table (or graph) of ice cube mass against the material combinations used.  *What do you notice?*  *Which combinations worked well? Why?*  *Which materials are the most effective insulators?*  *Which materials are the most effective conductors?*  Some materials are better thermal insulators than others as they are better at limiting the thermal energy getting to the ice cube.  Thicker materials and materials with air trapped in them (e.g. bubble wrap) tend to be better thermal insulators. |  |

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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

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| --- | --- |
| CLASS: | |
| DATE: | |
| **Learning objectives** | **6ESp.04** Know that soil composition can change, which can support, or hinder, plant growth.  **6TWSp.04** Plan fair test investigations identifying the independent, dependent and control variables. |
| **Lesson focus /**  **success criteria** | Learners will plan and carry out a fair test investigation to determine which type of soil is best at supporting plant growth. |
| **Prior knowledge /**  **Previous learning** | Learners will know what a plant needs to grow.  Learners will know the characteristics of different types of soil.  Learners will have previous experience of a fair test investigation. |

**Plan**

| **Timing** | **Planned activities** | **Notes** |
| --- | --- | --- |
| **Introduction** | Take learners outside and provide them with small containers. Ask them to identify and collect soil samples from around the school grounds.  *Can you find samples which look different?*  *How is the soil different?*  *What can you see in the soil?*  *Does it matter if the soil is different or not?*  Ask learners to sort the soil samples into groups based on criteria they choose. Learners share their criteria and how they have sorted their samples.  Recap that soils can contain organic material, clay, sand and debris (including large stones).  Soil is very important to humans all over the world as it is where crops are grown to provide food. The composition of the soil determines how good it is for growing plants in. Soil composition can be altered by adding fertiliser, or by rotating the crops that are grown. | Note this learning will need to take place over several lessons with time between lessons for other teaching and learning.  If you have no or limited outdoor space, samples of soils can be brought into the classroom, ensuring you follow your schools health and safety policies.  If required samples of different soils. |
| **Main activities** | *What is the main human use for soil? Why is soil composition so important for humans? Can soil composition be altered?*  Show learners an image of a plant.  *Why does the plant need the soil?*  Ensure learners talk about minerals, nutrients, water and for anchoring.  Present learners with some dry sand.  Tell learners they are going to carry out an investigation to find out how changing the soil affects the plant. Have a class discussion about planning the investigation.  *What enquiry type will we need to use to get an accurate answer?*  *How will we set up the investigation?*  *What will we need to keep constant?*  *What will our variable be?*  *How will we collect data from our experiment?*  Learners will need to set up a fair test investigation to accurately identify what happens to a plant when the composition of the soil it is in changes.  *What variable do we need to change?*  *What variables do we need to control?*  *What variable are we monitoring?*  The amount of soil, water will need to be kept the same, the seedlings used will need to be the same, and planted to the same depth, and the position of the containers will need to be the same. The variable will be the type of soil plants are planted in. Data will be collected by daily observations and then measuring the height of the shoot when it is possible to do so.  Groups of learners receive a planting containing, and a seedling. Set one up as the ‘teacher pot’ which can act as the control. Using only a set volume of sand learners plant their seedlings in the sand.  *Do you think your plants are going to grow in that soil? Why? Why not?*  All learners leave the seedlings until they begin to wilt. (Learners can undertake other lessons while regularly observing the plants).  *What is happening to the plant?*  *What can we do about this?*  Providing groups with fertiliser and clay soil, learners unpot their seedling and mix their sand, clay soil and fertiliser. Discuss how they are changing the composition. Instruct different groups to mix in different ratios, according to the table below, so a class set of data can be produced that shows how changing the composition affects plant growth.  Learners give each seedling the same amount of water over the investigation and place the containers side by side, so the conditions are the same.  Continue to observe the seedlings over time, recording observations at least twice a day (ideally at the same time each day). After several days, learners repot the seedlings again with different ratios.  If possible, try to get the using different soil compositions set up with seedlings planted in them:   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Group | 1st repotting | | | 2nd repotting | | | | % organic material | % clay soil | % sand | % organic material | % clay soil | % sand | | 1 | 20 | 20 | 60 | 60 | 20 | 20 | | 2 | 60 | 20 | 20 | 20 | 60 | 20 | | 3 | 20 | 60 | 20 | 40 | 30 | 30 | | 4 | 100 |  |  |  | 100 |  | | 5 |  | 100 |  | 100 |  |  | | Teacher |  |  | 100 |  |  | 100 |   If there are more than five groups, ensure you consider the soil composition changes you want each group to investigate.  Continue to observe the seedlings and start to identify the impact changing the soil composition has on plant health. | Resources:  Containers with holes in the bottom  Sand  Plant fertiliser  Clay soil  Seedlings  Water |
| **End/Close/**  **Reflection/**  **Summary** | Draw together all the class data and discuss what the data shows.  *What happened when you changed the soil composition?*  *Which composition made the biggest difference to the plant? Which one was best? Which one was worst?*  The organic rich topsoil should be the best for plant growth as it is rich in minerals and organic material and it hold the water well for the plant to use. Sandy soils contain very little organic material and they dry out very quickly as water runs through them. Clay-based soils are heavy and sticky and can limit plant growth as it’s hard for the roots and shoots to push through them. |  |

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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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