**Scheme of work – Science Stage 8**

Cambridge Lower Secondary

**Introduction**

This document is a scheme of work created by Cambridge International as a suggested plan of delivery for Cambridge Lower Secondary Science Stage 8. Learning objectives for the stage have been grouped into topic areas or ‘units’. These have then been arranged in a recommended teaching order but you are free to teach objectives in any order within a stage as your local requirements and resources dictate.

The scheme for Science has assumed a term length of 10 weeks, with three terms per stage and three units per term. An overview of the sequence, number and title of each unit for Stage 8 can be seen in the table below. The scheme has been based on the minimum length of a school year to allow flexibility. You should be able to add in more teaching time as necessary, to suit the pace of your learners and to fit the work comfortably into your own term times.

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

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

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| --- | --- | --- |
| **Term 1** | **Term 2** | **Term 3** |
| Unit 8.1 Plant and animal nutrition | Unit 8.4 Transport in plants and animals  | Unit 8.7 Reproduction and growth |
| Unit 8.2 Elements, mixtures and compounds | Unit 8.5 Metals and non-metals | Unit 8.8 Chemical reactions  |
| Unit 8.3 Light | Unit 8.6 Sound | Unit 8.9 Forces and magnets |

**Unit 8.1 Plant and animal nutrition**

It is recommended that this unit takes approximately **33% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of the characteristics common to all living things to develop their knowledge of:

* the need of plants for carbon dioxide, water and light for photosynthesis and that this process makes biomass and oxygen
* the constituents of a balanced diet and the functions of various nutrients
* the effects of nutritional deficiencies
* the relationship between diet and fitness
* the organs and functions of the alimentary canal
* the function of enzymes.

Scientific enquiry work focuses on:

* discussing the importance of developing empirical questions which can be investigated, collecting evidence, developing explanations and using creative thinking
* making predictions using scientific knowledge and understanding
* testing predictions with reference to evidence gained
* taking appropriately accurate measurements
* using a range of equipment correctly
* presenting results as appropriate in tables and graphs
* identifying trends and patterns in results (correlations)
* comparing results with predictions
* discussing explanations for results using scientific knowledge and understanding and communicating these clearly to others
* making predictions using scientific knowledge and understanding
* discussing and controlling risks to themselves and others
* interpreting data from secondary sources.

Recommended vocabulary for this unit:

* photosynthesis, carbon dioxide, water, light, chloroplasts, biomass, oxygen, starch, adaptation
* nutrition, diet, deficiency, fitness, excretion, faeces, digestion, absorption
* protein, sugar, starch, fat, fibre, carbohydrate, vitamin, minerals, salt
* alimentary canal, mouth, stomach, small intestine, large intestine, rectum, anus, mastication, peristalsis, churning.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 8Bp1 | Explore how plants need carbon dioxide, water and light for photosynthesis in order to make biomass and oxygen | Plant nutritionRevise the seven life processes from Stage 7 (movement, reproduction, sensitivity, nutrition, respiration, excretion, growth). Ask: *Where do plants get their nutrition from?*Show learners a tree seed and a section of wood from the same type of tree. Ask: *Where did the particles which made the wood as the tree grew, come from*?Elicit from learners what is needed for the photosynthesis process to occur (carbon dioxide, water and sunlight) and what is produced (sugar and oxygen) during the process. Summarise with a word equation of this process: carbon dioxide + water $→$ biomass + oxygenShow learners a diagram of the basic structure of a leaf. Ask learners to discuss:* Which cells have chloroplasts?
* How does carbon dioxide get to these cells?
* How does water get to these cells?
* How does light get to these cells?

Learners then discuss which cells they think will do the most photosynthesis and how they are adapted for this process.Then learners discuss:* How does waste oxygen leave these cells?
* How does sugar travel from the leaves to other parts of the plant?
 | Seed and section of wood from the same kind of tree (e.g. acorn and oak wood, cherry stone and cherry wood, pine cone and conifer wood). Ideally this should be a tree type that is familiar to the learners.Diagram of the cross-section of a leaf. | Misconception alert: A very common misconception is that plants grow by ‘eating’ nutrients from the soil. Use initial activities to elicit this misconception so that it can be dealt with in the unit. |
| 8Bp18Ep68Eo18Eo28Eo48Ec28Ec38Ec6 | Explore how plants need carbon dioxide, water and light for photosynthesis in order to make biomass and oxygenMake predictions using scientific knowledge and understandingTake appropriately accurate measurementsUse a range of equipment correctlyPresent results as appropriate in tables and graphsIdentify trends and patterns in results (correlations)Compare results with predictionsDiscuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | Show learners the word equation for photosynthesis again: carbon dioxide + water $→$ biomass + oxygenAsk learners: *How could you prove that plants require water and light?*Note: learners will probably have conducted investigations on growing plants in light/dark and with/without water in earlier stages. These investigations can be referred to, but do not need to be repeated here.Oxygen productionAsk learners to suggest how they could demonstrate that plants produce oxygen when they photosynthesise. Elicit that it is normally difficult to see the oxygen being produced because it is a colourless gas.**Scientific Enquiry activity**Show learners a water plant which produces bubbles of oxygen when it photosynthesises (e.g. *Cabomba, Elodea).*Elicit the idea that the plant will produce bubbles of oxygen.Ask learners to suggest ways that they could:* demonstrate that the gas is oxygen
* measure the amount of gas produced.

For a demonstration, submerge the plant in water or in a 1% sodium hydrogen carbonate solution. Put the plant in a glass funnel with an inverted test tube on top. This allows the oxygen to be collected in the test tube and subsequently tested. Demonstrate ways for measuring the amount of gas produced (e.g. counting bubbles, measuring the volume of gas in a pipette or very small syringe). **Scientific Enquiry activity**Learners put a sprig of pond weed in a boiling tube. By putting the boiling tube at different distances from a light source, they can measure the effect of light intensity. As part of this scientific enquiry activity learners should:* predict the effect of changing the light intensity, using the word equation for photosynthesis to explain their prediction
* collect results in a table
* identify a trend in their results
* compare their results with their predictions
* explain their results using scientific knowledge.

Carbon dioxide use**Scientific Enquiry activity**An alternative to using pond weed is to immobilise algae in jelly (alginate) balls. These can be used for a variety of practical activities even if pond weed is unavailable.Algal balls can be placed in a hydrogen carbonate indicator. This goes purple when carbon dioxide is removed from it and yellow when carbon dioxide is added to it.Learners test the effect of placing the balls in different levels of light intensity and:* predict the effect of changing the light intensity, using the word equation for photosynthesis to explain their prediction
* collect results in a table
* identify a trend in their results
* compare their results with their predictions
* explain their results using scientific knowledge.
 | Pond weed (e.g. *Cabomba, Elodea*), water or 1% sodium hydrogen carbonate solution, large beaker, light source, glass funnel, test tube, boiling tubes.Suggested approaches for using pond weed can be found at: [www.saps.org.uk/secondary/teaching-resources/190](http://www.saps.org.uk/secondary/teaching-resources/190)Immobillised algal balls, hydrogen carbonate indicator, light source.Detailed instructions of how to make and use algal balls for a range of photosynthesis activities can be found at:[www.saps.org.uk/secondary/teaching-resources/235-student-sheet-23-photosynthesis-using-algae-wrapped-in-jelly-balls](http://www.saps.org.uk/secondary/teaching-resources/235-student-sheet-23-photosynthesis-using-algae-wrapped-in-jelly-balls) | Pond weeds can be obtained from aquarium suppliers. Follow local legislation on the use of non-native species and invasive plants.Algal balls kept in the dark will respire rather than photosynthesise. This can be a useful demonstration for later in the unit. |
| 8Bp18Ep68Eo28Eo38Ec38Ec6 | Explore how plants need carbon dioxide, water and light for photosynthesis in order to make biomass and oxygenMake predictions using scientific knowledge and understandingUse a range of equipment correctlyDiscuss and control risks to themselves and othersCompare results with predictionsDiscuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | Again, elicit the word equation for photosynthesis:carbon dioxide + water $→$ biomass + oxygenThe leaf starch test**Scientific Enquiry activity**The leaf starch test is a multi-stage process which allows learners to demonstrate that there is starch in the leaf. In order to understand the investigation, explain that starch is one of the main examples of ‘biomass’ produced in photosynthesis.Before conducting any investigations teach learners the leaf starch test and allow them to practise.Several methods are available. In brief, the waxy coating on the leaf is removed by boiling in water. Next the green pigment is removed from the leaf by immersing it in ethanol. Then it is possible to test the leaf for starch using iodine solution. Predicting patterns of starch productionOnce learners have learned how to do the leaf starch test, they can do both of these investigations.**Scientific Enquiry activity*** Give learners a variegated leaf from a plant that has been kept in bright light for at least 24 hours before the investigation.
* Learners predict which parts of the leaf will contain starch. They draw a picture to show their prediction and explain it using the word equation for photosynthesis.
* Learners the conduct the starch leaf test and compare their results with their predictions.

Conclude that only the green parts of a leaf do photosynthesis.**Scientific Enquiry activity*** Learners use black paper or aluminium foil to cover an area of a green leaf (still attached to the plant). The plant is then grown in bright light for at least 24 hours.
* Learners predict which parts of the leaf will contain starch. They draw a picture to show their prediction and explain it using the word equation for photosynthesis.
* Learners conduct the starch leaf test and compare their results with their predictions.

Conclude that photosynthesis only occurs when light can reach the green parts of a leaf. | Method for activity:[www.saps.org.uk/secondary/teaching-resources/1222-photosynthesis-testing-a-variegated-leaf-for-starch](http://www.saps.org.uk/secondary/teaching-resources/1222-photosynthesis-testing-a-variegated-leaf-for-starch)(for this first attempt, do not use a variegated leaf).Variegated leaf (*Pelargoniums* work well).*Pelargonium* plants, paper clips and black paper/aluminum foil. | This investigation is a classic of secondary school biology. However, it involves many stages and it can be complicated for learners to understand and interpret the results. Keep referring back to the word equation for photosynthesis to provide a scaffold for understanding the investigation.It is better to investigate light/dark and variegated leaves as two separate investigations rather than one combined investigation.Health and safety:It is important that there are no flames present when the ethanol is used. |
| 8Bh18Bh6 | Identify the constituents of a balanced diet and the functions of various nutrients. Secondary sources can be usedUnderstand the relationship between diet and fitness | Human nutritionAsk learners: *How are plant and animal nutrition similar? How are they different?* Learners identify as many similarities and differences as they can between plant and animal nutrition. Elicit the idea that plants make their food from carbon dioxide and water in the presence of light, but that animals must break down food to obtain chemical energy.Ask learners questions about the food they eat such as:*What is your favourite meal?**Which foods do you like or dislike?*Ask learners to define the word ‘diet’. Explain that the scientific term ‘diet’ means the food that an organism regularly eats (rather than a way to lose weight).Learners collect and study food labels from packaging to discover how foodstuffs are divided into carbohydrates, proteins, fats, vitamins and minerals.* They compare the protein, sugar, fat, fibre and salt content of foods with the recommended daily intake for adults. (It is difficult to find recommended daily intake values for adolescents.)
* *What combinations of food would give you the recommended daily intake of protein and fibre?*
* *What is the maximum number of snacks you could eat before you had more than the recommended daily intake of sugar and fat?*
* Learners identify the foods with the highest energy content (for growth, movement and keeping warm). Discuss *Are these ‘healthy’ food*s?

Demonstrate each of the food tests for protein, sugar, starch and fat using control samples to ensure a positive result.**Scientific Enquiry activity**Give learners a range of foods to test.Learners should design a table to present the results in a logical manner. They can compare their results with the nutritional information on the food packaging.In conclusion to the activity, learners should comment on the foods they have tested and discuss the idea of a balanced diet.  | Food labels showing nutritional information from common food items.A range of foods to test (e.g. fruit, starchy vegetable, dairy products, boiled egg, oil).Starch test: iodine solution.Protein test: biuret solution. (made of sodium hydroxide, hydrated copper(II) sulfate and potassium sodium tartrate), test tubes or spotting tileSugar test: Benedict’s solution, test tubes, heating bath. Fat test: filter paper. | This is an opportunity to identify learners’ prior knowledge, understanding and misconceptions.Several methods for these tests are available online.Health and safety:* Avoid potassium hydroxide solution on the skin.
* Copper sulfate is poisonous.
* Safety goggles should be worn.

Learners often confuse the Biuret test with the Benedict’s test |
| 8Bh18Bh28Bh68Ec58Bh7 | Identify the constituents of a balanced diet and the functions of various nutrients. Secondary sources can be usedUnderstand the effects of nutritional deficienciesUnderstand the relationship between diet and fitnessInterpret data from secondary sourcesDiscuss how conception, growth, development, behaviour and health can be affected by diet, drugs and disease | Describe the main functions of each of the main nutrients:* protein is used for growth and repair
* fats store energy
* carbohydrates (sugar and starch) provide an energy source.

Ask learners to suggest other components of a healthy diet.Give groups of learners a part of the diet to research using secondary sources. They should find out about its function and the problems that occur when there is not enough of it in the diet. These problems can include changes in growth, behaviour and health.Suggested topics include:* vitamin A
* vitamin C
* vitamin D
* iron
* calcium
* fibre
* water.

Learners present their findings to each other. All learners should make a table that summarises the main point on each topic.Working in pairs, learners take it in turns to describe the symptoms they would have if they had a nutritional deficiency. Their partner needs to identify the nutritional deficiency they have. | Secondary sources |  |
| 8Bh48Ep18Ep28Ep68Eo28Ec3 | Understand the function of enzymes as biological catalysts in breaking down food to simple chemicalsDiscuss the importance of developing empirical questions which can be investigated, collecting evidence, developing explanations and using creative thinkingTest predictions with reference to evidence gained.Make predictions using scientific knowledge and understandingUse a range of equipment correctlyCompare results with predictions | Ask learners to chew a piece of bread for a few minutes and notice the changes that take place. Ask: *Why does food need to be chewed? What gets added to the bread as it is chewed? What do you notice about the taste of the bread between the start and end of chewing?*Explain to learners that a chemical change is occurring in the mouth as well as the food being broken up by the teeth and the chewing process. Use diagrams to show that large molecules of starch are broken into small molecules of sugar.**Scientific Enquiry activity**Investigate the effect of the enzyme amylase on starch solution. Have learners discuss the questions they could investigate.Show learners dialysis tubing and explain that the surface of the tube has lots of holes that are too small to see.* Provide groups of learners with a mixture of starch and amylase. They place the mixture inside a piece of dialysis tubing tied at one end. They then place the tubing inside a beaker of water, held in place with an elastic band and leave for 20 minutes.
* Learners predict the results they expect if they test the water around the dialysis tubing.
* Learners test the water for starch (using iodine solution) and glucose (using Benedict’s solution or glucose test strip).
* Learners compare their observations with their prediction.
* Learners explain the results using ideas about large polymers such as starch not being soluble but being broken down into smaller soluble molecules. Only the smaller molecules can pass through the dialysis tubing into the water.
 | Small piece of bread for each learner. Link to a similar activity:[www.nuffieldfoundation.org/practical-biology/evaluating-visking-tubing-model-gut](http://www.nuffieldfoundation.org/practical-biology/evaluating-visking-tubing-model-gut)Helpful video: [www.youtube.com/watch?v=lgWE5m7xUJs](https://www.youtube.com/watch?v=lgWE5m7xUJs)Beaker, dialysis tubing, elastic band, starch suspension, glucose solution, teat pipette, white spotting tile.Starch test: iodine solutionSugar (glucose) test: Benedict’s solution, test tubes, heating bath.  | Health and safety:Be aware of allergies and intolerances. |
| 8Bh38Bh4 | Recognise the organs of the alimentary canal and know their functions. Secondary sources can be usedUnderstand the function of enzymes as biological catalysts in breaking down food to simple chemicals | Learners may have previously seen a model of the functions of the organs in the alimentary canal. Progression is achieved by using a wider variety of scientific vocabulary and identifying the role of enzymes in many organs.* Grind up some cereal and pieces of white bread with some water using a pestle and mortar to form a paste. This represents chewing or *mastication*. Elicit the idea that there are enzymes in the saliva.
* Pour the mixture through a funnel attached to a tube that leads to a clear plastic bag containing malt vinegar. Show *peristalsis* by squeezing the food down the tube.
* Squeeze the bag to show the action of the stomach *churning* the food with the stomach acid (represented by the malt vinegar). Explain that the chemicals in the food are being *digested*. Explain that there are enzymes in the stomach as well as acid.
* Use a nylon stocking (or tights) with string tied around it about half-way down to stop the food. Pour the mixed up food into the stocking. Do this over a tray or lots of newspaper to collect the liquid containing the digested food that is being *absorbed* into the body. (There are more digestive enzymes in the small intestine.)
* Cut the string. Move the mixture of food by *peristalsis* into the lower parts at the bottom of the stocking. Squeeze as much of the liquid out of the stocking as possible. This shows the water being *absorbed* in the large intestine. By wrapping the tights in a tea towel, more water can be *absorbed*.
* Cut the end of the tights to create an *anus.* Squeeze the solid waste onto the tray or newspaper to represent *defecation* (removal of faeces) and *egestion* (removing undigested waste) from the body.

Ask learners: *Does this model show excretion?* Identify that there are no waste products in the ‘faeces’ in this model.Learners summarise their understanding of the functions of the parts of the digestive system as a summary paragraph or in an annotated diagram (which includes the liver and pancreas). | Cereal/white bread, water, pestle and mortar/bowl and spoon, funnel, tube, clear plastic bag, malt vinegar, nylon stocking/tights, string, tray/newspaper, scissors, tea towel.Secondary sources. |  |

**Unit 8.2 Elements, mixtures and compounds**

It is recommended that this unit takes approximately **33% of the teaching time for this term**.

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

* changes of state, gas pressure and diffusion.
* the chemical symbols for the first twenty elements of the Periodic Table
* elements, compounds and mixtures.

Scientific enquiry work focuses on:

* discussing the importance of developing empirical questions which can be investigated, collecting evidence, developing explanations and using creative thinking
* planning investigations to test ideas
* using a range of equipment correctly
* discussing and controlling risks to themselves and others
* comparing results with predictions
* discussing explanations for results using scientific knowledge and understanding and communicating these clearly to others.

Recommended vocabulary for this unit:

* particles, diffusion
* element, atom, mixtures, compounds, chemical bond, reaction, word equation
* chemical symbol, Periodic Table
* hydrogen, helium, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, neon, sodium, magnesium, aluminimum, silicon, phosphorous, sulfur, chlorine, argon, potassium, calcium.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 8Cs18Ep18Ec38Ec6 | Show how the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of state, gas pressure and diffusionDiscuss the importance of developing empirical questions which can be investigated, collecting evidence, developing explanations and using creative thinkingCompare results with predictionsDiscuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | Review the motion and particle arrangement in a solid, liquid and gas from stage 7.Review the changes of state from stage 7 to describe how the motion and particle arrangement changes during melting, freezing, boiling, condensing and evaporating.**Scientific Enquiry activity**Observe ice floating in water.Learners try and explain these observations using the particle theory of matter.Lead the learners to the conclusion that ice must be less dense than water, despite the fact that it is a solid. This means that there must be fewer particles per unit volume than in liquid water.**Scientific Enquiry activity**Investigating compressibility. Have learners discuss the questions they could be asking and what evidence they will/could collect to answer their questions. Give learners syringes filled with sand, water and air and ask them to depress the plunger. *How easy is it to depress the plunger? How can we explain these observations?*Conclude that gases can be compressed easily because their particles are far apart but that liquids and solids cannot be compressed.Related to this it can be seen why liquids and gases flow easily yet solids cannot. Discuss, using the particle theory of matter, why liquids and gases can flow easily but solids cannot.Furthermore, gases and liquids take the shape of their containers but solids do not – learners should be able to explain these facts in terms of the particle theory of matter.Conclude that solids, liquids and gases have different properties because of the different arrangement and motion of particles.Explain why gases have a pressure. Explain why it is possible to blow up a balloon. **Scientific Enquiry activity**Inflate a balloon and ask learners to share ideas about why it is possible to do so. *What will happen if you keep blowing it up? Why?*Ask learners to predict what would happen if the inflated balloon is placed into hot water and into an ice bath. Demonstrate and discuss results.Link gas pressure with the number of particles hitting the inner surfaces of their containers.Discuss why the pressure inside a gas cylinder increases as temperature increases.Conclude that gases have a pressure as a result of particles hitting the walls of a container. | Water can be frozen in an upright measuring cylinder and/ or in a sealed plastic soda bottle.<http://home.d47.org/grnelson/files/2016/03/04-MSS-Gr8_U1.1-Act4-Making-Inferences-about-Particles.pdf>Sets of three syringes filled with sand, water and air. The syringes should be sealed so the contents cannot come out. This can be done by melting the end of the syringe or sealing it with a hot glue gun. Syringes should be tested in advance and learners warned not to press too hard.Useful teacher reference:[www.abc.net.au/science/surfingscientist/pdf/teachdemo\_8.pdf](http://www.abc.net.au/science/surfingscientist/pdf/teachdemo_8.pdf)Filled balloon (not too fully to allow for expansion), hot water bath, ice bath. |  |
| 8Cs1 | Show how the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of state, gas pressure and diffusion | Diffusion in liquids and gases 1. Diffusion in air: can be demonstrated by releasing a strong perfume at the front of the classroom and asking learners to put their hands up when they can first detect the smell.*What is happening to the particles of the perfume? Who can smell the perfume first? Why does it take time for everyone in the room to be able to smell the perfume?*Conclude that the particles of the perfume diffuse through the air and that mixing with the air particles continues until the concentration of perfume particles is equal throughout the room.2. Diffusion in liquids: Take a 250ml beaker and fill it with water. Place a wide drinking straw at the bottom of the beaker trying to disturb the water as little as possible. Carefully, with forceps place one crystal of potassium manganate (VII) into the top of the straw and let it fall to the bottom of the beaker. Very carefully, remove the straw and observe how the strong purple colour diffuses throughout the water.Learners explain diffusion in terms of particles spreading out and mixing. | Perfume or air freshenerpotassium manganate (VII) crystals, water, beakers, wide drinking straw | Health and safety:Be aware of allergies and intolerances.Emphasise to learners that any strongly-coloured substance could be used and the exact nature of the potassium manganate (VII) is not important to the activity. |
| 8Cp3 | Understand that elements are made of atoms | Discuss with learners what ‘stuff’ is made of: *The chair is made of…* For the examples they give e.g. steel, wood, talk about how they are materials but they are also made of ‘stuff’ – *What is the absolute smallest thing we can break all matter down into?* If you kept cutting and cutting, and could zoom in enough you would get to an atom. *Is there one atom? Is all matter made of one atom?* No we have lots of variety around us and there are many atoms, but there are only a set number of different types of atoms arranged in uncountable patterns – those basic building blocks are ‘elements’ and are represented in the Periodic Table. Ask learners to try to draw a ‘particles-in-a-box’ representation for gold [expect them to draw a regular arrangement of atoms touching each other].Next ask them to do similar diagrams for iron and carbon. [Most probably learners will draw similar diagrams but tell them not to worry that they are similar].Discuss: ‘*Even if all three of your diagrams look similar, why must there be some differences between them?* [elicit that they are different elements]*.*Also ask: *How might they be different?* [elicit that the particles might be different sizes from each other]Explain that each diagram they drew shows a specific element, which is composed of only one kind of atom, which are different from one another. |  |  |
| 8Cp2 | Give chemical symbols for the first twenty elements of the Periodic Table | Provide sealed containers or photographs of the first 20 elements of the Periodic Table. Learners describe each element in a sentence, e.g. ‘Hydrogen is a colourless gas’ and write the chemical symbol for it.Learners should ensure that the first letter of a chemical symbol is a capital and if there is a second letter in the symbol, it must be written in lower case.In the first twenty chemical symbols, two do not match with their standard name:* Potassium is represented with ‘K’, not a P or Po. Highlight that ‘P’ couldn’t be used because it was already used for phosphorus (discovered in 1669), and discuss the history of Potassium. ‘K’ comes from kalium, the medieval latin for potash (a potassium salt). In 1807, Humphry Davy exposed moist potash to an electric current and derived the metal he called potassium. It was called potassium (from potash) and kept the K symbol from kalium.
* Sodium is represented with ‘Na’, not S or So. In the same series of experiments in 1807, Humphry Davy exposed caustic soda (sodium hydroxide), which was mainly obtained from the Natron Valley in Egypt, to an electric current and derived the metal in it. It was called sodium (from soda) and kept the Na symbol to relate to natrium, the latin name, and the connection to Natron Valley.

The first twenty symbols must be learnt; learners can test each other as a team game. For example:* ‘my symbol is the end of my footwear’

Answer: ‘sock’ = K = potassium* ‘my symbol is a lot of water and a note’

Answer: ‘sea’ = C and ‘a’ = calciumAlternatively, learners can make up words using just the chemical symbols e.g. SOCK or CaN.Alternatively, they can make up crosswords orword searches. | Sealed samples or photographs of the first 20 elements of the Periodic Table.[www.rsc.org/periodic-table](http://www.rsc.org/periodic-table) | All the colourless gases can be sealed containers of air, but treated as if they contain the intended element. Elements not available or too dangerous to be included can be provided as a photograph instead.Hydrogen gas is a molecule made of two hydrogen atoms. Some elements exist as molecules and have different properties to a single atom of the element. At this stage that isn’t an issue and describing the properties of the molecules is acceptable.  |
| 8Cp68Eo28Eo3 | Distinguish between elements, compounds and mixturesUse a range of equipment correctlyDiscuss and control risks to themselves and others | **Scientific Enquiry activity**Distinguish between an element, a mixture and a compound. The reaction between iron and sulfurStart by examining samples of iron and sulfur. *What type of elements are iron and sulfur? Where in the Periodic Table are they found? What properties would you expect iron and sulfur to have?* * Test iron filings and sulfur with a magnet to show that iron filings are magnetic and sulfur is not.
* Mix iron filings and sulfur together. Examine the mixture. *What can you tell about its appearance?* *What would you expect the properties to be like? How could you separate iron from sulfur?* Demonstrate using a magnet how to separate some of the iron filings from the mixture.
* Heat the mixture strongly until it begins to react.
* Let the product cool and examine it. Compare the properties of an iron/sulfur mix with the product of the chemical combination between the elements.

Learners draw diagrams to show the arrangement of particles in iron, sulfur, mixture of iron and sulfur and in iron sulfide. They describe what has happened in the reaction. They should use the term ‘chemical bond’ in their explanations.Learners can write a word equation for the process.Conclude that the properties of a compound are different from the properties of the constituent elements, while the mixture retains the properties of the elements.**Scientific Enquiry activity**Provide a circus of elements, compounds and mixtures with associated information e.g. name of substance, formula, whether it can be separated, whether it can be broken down into elements.Learners move round the items in the circus. For each they need to identify whether the substance is an element, compound or mixture and explain their answer by selecting the best evidence provided. | Iron filings, sulfur powder, heat-proof test-tubes, heating apparatus, a magnet.Method:[www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/791/CFNS%20Experiment%2032%20-%20Iron%20and%20sulfur%20reaction.pdf](http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/791/CFNS%20Experiment%2032%20-%20Iron%20and%20sulfur%20reaction.pdf)Video:[www.youtube.com/watch?v=cL6I1O1YHH0](https://www.youtube.com/watch?v=cL6I1O1YHH0)Various samples of elements, mixtures and compounds with their chemical names. The substances can be in sealed containers or photographs with a card with some information e.g. bottle of copper chloride could have label ‘Copper chloride is a blue solid with a formula of CuC*l*2. Copper chloride cannot be separated into other substances.’ | Present learners with definitions of elements, mixtures and compounds which they can refer to throughout this unit.Do as a demonstration or give a reminder of safety measures.Health and safety:Safety goggles must be worn. |
| 8Cp68Cc1 | Distinguish between elements, compounds and mixturesUse a word equation to describe a common reaction. Secondary sources can be used. | Recap on the differences between elements, mixtures and compounds from previous activities.Start by burning a sparkler. *Can you explain what is happening? What is burning? What type of change is burning?*Demonstrate the formation of simple compounds. Show simple combinations of elements, e.g. burning magnesium or steel wool in air/oxygen. Alternatively, show videos.*What happened in each reaction?* Discuss that magnesium combined with oxygen to give magnesium oxide. Demonstrate how to draw particle diagrams of one of the reactions using different colours to represent atoms of different elements. Learners use the same approach for several reactions.Learners write word equations for the reactions that were observed.Conclude that compounds are substances that contain two or more different types of atoms. | Sparkler.Magnesium ribbon, matches, tongs.<https://youtu.be/m2i9jLPXprQ> – burning magnesium (0:20 – 1:30)<https://youtu.be/TkE1uVjrY0w>– iron and oxygen<https://youtu.be/IzkfNIG5LvE>– phosphorus and oxygen<https://youtu.be/tbPxwDiX1NU>– sodium and chlorine | Health and safety:* Safety goggles must be worn.
* The sparkler must be safely extinguished by plunging into cold water.
* Make sure that the sparkler is used safely to avoid burns or fires.
* Eye protection must be worn.
* Warn learners not to look directly at the bright light of magnesium burning.
 |
| 8Cp68Ep48Eo28Eo3 | Distinguish between elements, compounds and mixturesPlan investigations to test ideasUse a range of equipment correctlyDiscuss and control risks to themselves and others | **Scientific Enquiry activity**Plan and carry out the preparation of clean dry samples of one or both constituents from a mixture, e.g. sand and sugar, sand and salt, powdered chalk and copper sulfate, sugar and broken china.Before starting their plan learners should assess the risks to themselves and to other learners in the class and suggest appropriate safety procedures.Conclude that mixtures can be easily separated into pure substances. The constituents of a mixture are not held together by chemical bonds. | Mixtures to separate (e.g. sand and sugar, broken china and sugar, soil and water, sugar and water, salt and sand, salt and water, powdered chalk and copper sulfate), water, beakers, conical flask, stirring rods, filter funnels, filter paper.For a sand and salt mixture:[www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/455/CCE-1-SeparatingASandAndSaltMixture.pdf](http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/455/CCE-1-SeparatingASandAndSaltMixture.pdf) | It is possible that learners may have considered the separation of some of these substances before. Nevertheless, good planning and practical technique should be concentrated on. |

**Unit 8.3 Light**

It is recommended that this unit takes approximately **34% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of different types of energy and energy transfers to develop their knowledge of:

* how light travels and the formation of shadows
* how non-luminous objects are seen
* reflection at a plane surface and using the law of reflection
* refraction at the boundary between air and glass or air and water
* the dispersion of white light
* colour addition and subtraction, and the absorption and reflection of coloured light.

Scientific enquiry work focuses on:

* testing predictions with reference to evidence gained
* taking appropriately accurate measurements
* using a range of equipment correctly
* presenting results as appropriate in tables and graphs
* identifying trends and patterns in results (correlations)
* comparing results with predictions
* discussing explanations for results using scientific knowledge and understanding and communicating these clearly to others.

Recommended vocabulary for this unit:

* colour, red, blue, green, magneta, cyan, yellow, white
* luminous, non-luminous, shadow
* light ray, ray diagram, upright, inverted
* reflection, refraction, absorption, dispersion
* prism, filter, mirror, plane mirror, boundary, normal line, angle of incidence, angle of reflection, angle of refraction
* primary colour, secondary colour, colour addition, colour subtraction.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 8Pl18 Pl28Ec6 | Use light travelling in a straight line to explain the formation of shadows and other phenomenaDescribe how non-luminous objects are seenDiscuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | Ask learners to answer these two questions using their scientific knowledge. They should draw a diagram as part of their answer for each question.*How do we see the moon? Can cats really see in the dark?*Discuss common misconceptions including:* the moon is a light source
* light rays come out of an eye
* it is possible to see even when there is no light.

Distribute or show pictures of luminous and non-luminous objects. Ask pairs of learners to put them into groups. Each pair then explains how they grouped the objects.If learners have not already done so, ask them to group the items by how we see them.Learners may have previously used ‘black boxes’ to investigate the requirement of light to see objects in stage 5. This learning can be revised here, if necessary by using the boxes again.Show learners some luminous sources of light, e.g. lit candle or torch. *How is it possible to see them?* Show learners some non-luminous objects *How do we see objects which are not luminous?*Learners draw diagrams showing rays of light coming out of a luminous object. They also show that light reflects from non-luminous objects.Conclude that luminous sources give out or emit their own light. We see non-luminous objects when they reflect light to our eyes. Non-luminous objects cannot be seen in the dark. | Pictures of luminous and non-luminous objects (e.g. the sun, car headlight, human face, reflective road sign, Earth as seen from space, lit candle, moon, fire, shiny surface, pond, mirror, white building, black (or dark) building, fluorescent safety vest, luminous object).Black boxes made from shoe boxes (or similar). Put two small holes eye-width apart on one side of the box and cut a hole for a torch in the top of the box. Finally, paint the inside of the box black.Luminous sources of light (e.g. candle, match, torch, luminous sign or watch).Non-luminous objects (e.g. paper, clothing, ball, chair, mirror). | Learners have previously studied light and shadows in Stage 5 and Stage 7. It is important to identify whether any misconceptions persist and to respond to these.These diagrams can be sketches using arrows to represent the light rays. Learners will learn to draw ray diagrams later in the unit. |
| 8Pl1 | Use light travelling in a straight line to explain the formation of shadows and other phenomena | Introduce shadows, perhaps by showing a video of a theatre group (e.g. the Attraction Shadow Theatre Group). Discuss how they make shadows of different sizes.Introduce conventions for ray diagrams (continuous rays as straight lines from emitter to object, usually with arrow head indicating direction)With assistance, learners draw ray diagrams that show how shadows are formed. They also use ray diagrams to explain the different sizes of shadows formed when objects are different distances from a light source or screen.  | <https://youtu.be/FXowj1BHojs> | Note: learners have previously studied shadow formation in Stage 5. |
| 8Pl18Eo28Ec6 | Use light travelling in a straight line to explain the formation of shadows and other phenomenaUse a range of equipment correctlyDiscuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | Learners make and use a pinhole camera. A simple box can be made light-tight and have a pinhole in the centre of a sheet of black paper at one end and a greaseproof paper screen at the other.Learners point the hole towards a fairly bright light source and observe the image produced (size, colour, and orientation). With assistance, learners draw a ray diagram to explain their observations. Introduce the terms ‘inverted’ and ‘upright’.Conclude that pinhole cameras create an upside down (inverted) image. Ray diagrams can be used to explain why this happens. | A cardboard box, e.g. a shoe box, black paper, greaseproof paper, pin, light source (such as a candle).Optional: film.<http://drhsphotography.weebly.com/uploads/1/4/9/7/14971336/4090764_orig.gif>[www.instructables.com/id/Shoebox-Camera/](http://www.instructables.com/id/Shoebox-Camera/) | Diagrams with light rays should be used to show why the image is inverted.It is possible to take pictures with such a simple device. The screen is replaced with a piece of film which can be developed to give a negative. A trial run is necessary to estimate time of exposure. |
| 8Pl38Eo18Eo28Ec28Ec6 | Describe reflection at a plane surface and use the law of reflectionTake appropriately accurate measurementsUse a range of equipment correctlyIdentify trends and patterns in results (correlations)Discuss explanations for results using scientific knowledge and understanding Communicate these clearly to others | Discuss under which circumstances you are able to see reflections clearly and from which surfaces.**Scientific Enquiry activity**Demonstrate how to accurately record the path of a ray of light as it reflects from a plane mirror using pins. Introduce the idea of the ‘normal line’. Then show how to use a protractor to measure the angle of incidence and the angle of reflection.Learners, in groups, measure the angle of incidence and the angle of reflection for a wide variety of angles. They should record their results in a table and they may also plot a graph.If done accurately, these results should demonstrate the law of reflection.Conclusion – formally explain the law of reflection as:angle of incidence = angle of reflection.Demonstrate that when you throw (or kick) a ball against a flat wall it is easy to predict the direction it will take afterwards. Ask for a volunteer to help you demonstrate this by standing in the correct place to catch the ball. Elicit the idea that this is essentially the law of reflection.Show a photograph of Pepper’s ghost.Learners discuss and suggest ideas about how Pepper’s ghost is done.Demonstrate a version of Pepper’s ghost using two candles and a vertical piece of glass. Try activities such as:* blowing out one of the candles and relighting
* placing the unlit candle in a glass and filling the glass with water.

Use ray diagrams to explain the effect. Learners should annotate the diagrams to show the angle of incidence, angle of reflection and virtual image.Show a ray diagram of how Pepper’s ghost can be used in a theatre. In pairs, learners explain to each other how the effect is achieved. | Plane mirror, thick cardboard or corkboard, white paper, optical pins, protractor, ruler. The method is explained at: [www.youtube.com/watch?v=PF4\_liKm-WQ](https://www.youtube.com/watch?v=PF4_liKm-WQ)Alternatively, ray boxes can be used if available.This explains the theory clearly:[www.bbc.co.uk/schools/gcsebitesize/science/ocr\_gateway/home\_energy/introduction\_to\_wavesrev4.shtml](http://www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway/home_energy/introduction_to_wavesrev4.shtml)Football, flat wall.Suggested link: <http://entertainmentdesigner.com/history-of-theme-parks/the-enduring-illusion-of-peppers-ghost>Candles, glass.[www.thenakedscientists.com/HTML/experiments/exp/peppers-ghost/](http://www.thenakedscientists.com/HTML/experiments/exp/peppers-ghost/)[www.theatrecrafts.com/glossary/pages/peppersghost.html](http://www.theatrecrafts.com/glossary/pages/peppersghost.html) |  |
| 8Pl48Eo18Eo28Ec28Ec6 | Investigate refraction at the boundary between air and glass or air and waterTake appropriately accurate measurementsUse a range of equipment correctlyIdentify trends and patterns in results (correlations)Discuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | Show the effect of refraction using one of more of these demonstrations.The bending pencil.Fill three identical glasses with different amounts of water. Then put a pencil in each glass of water and learners make careful observations, drawing what they see. The pencils can be moved from one side of glass to another.The disappearing coin trick.Put a coin into the bottom of an empty glass. Slowly add water and watch the apparent position of the coin as the water level rises.Investigating the law of refraction**Scientific Enquiry activity*** Demonstrate how to accurately record the path of a ray of light as it enters and exits a rectangular block. This can be done with optical pins (as in the reflection investigations). Show how to find the normal line for the point of entry and exit. Then show how to use a protractor to measure the angle of incidence and the angle of refraction at the entry and exit point.
* Learners, in groups, draw the path of the light as it enters and exits a block. They should do this for several angles of incidence. It may help to darken the room.
* They measure the angle of incidence and the angle of refraction for a ray of light as it enters and leaves a block.
* They should record their results in a table and draw a graph of their results.

If done accurately, these results should demonstrate that the angle of refraction is less than the angle of incidence when the ray of light enters the block. The angle of refraction is greater than the angle of incidence when the ray of light leaves the block.Alternatively, a simulation can be used to investigate refraction. Again results should be recorded in a table and a graph drawn.**Extension activity**An application of refraction: spear fishing.Use a ray diagram to show the refraction of light. Ask: *What would happen if the fisherman speared the place where the fish appears to be? Does the fisherman need to stab above or below the image of the fish?* | Three clear identical drinking glasses, three pencils or straws, water.Coin, glass, water.Plane mirror, thick cardboard or corkboard, white paper, optical pins, protractor, ruler, graph paper.The method is explained at: [www.youtube.com/watch?v=KuCUaE6e1Oo](https://www.youtube.com/watch?v=KuCUaE6e1Oo)Alternatively, ray boxes can be used if available.Simulation:<https://phet.colorado.edu/en/simulation/bending-light> <http://physicsed.buffalostate.edu/SeatExpts/EandM/refract/img/refrsol1.gif> | Emphasise that light travels in straight lines, but the rays may change direction. The phrase ‘bending light’ can cause some learners to think that the rays of light are curved.Diagrams should be used to show the directions of the rays of light. |
| 8Pl58Eo48Ec28Ec6 | Explain the dispersion of white lightPresent results as appropriate in tables and graphsIdentify trends and patterns in results (correlations)Discuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | Learners use a prism and shine a ray of light towards it. They describe what they see. They should observe that the white light (after refraction) causes a spectrum of colours: red, orange, yellow, green, blue, indigo and violet. This is called ‘dispersion’.Ask learners to explain what this shows about white light.Conclude that white light is a mixture of colours. A prism can refract white light and disperse it into its constituent colours. The spectrum of colours produced by dispersion is: red, orange, yellow, green, blue, indigo and violet. | Triangular glass or Perspex® prisms, light ray boxes, white paper.This video shows the process of dispersion (learners do not need to understand the full scientific explanation given):[www.youtube.com/watch?v=Aggi0g67uXM](https://www.youtube.com/watch?v=Aggi0g67uXM) | Diagrams should be used to show the directions of the rays of light through the prism. |
| 8Pl68Ec6 | Explain colour addition and subtraction, and the absorption and reflection of coloured lightDiscuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | The primary and secondary colours of light and colour additionShow video clip of a laser light show. Ask learners to write down a list of all the colours they see.Ask learners to write down the primary colours. *How are other colours made?*Explain that only three colours of lights were used. *What colours do you think were used? Where do you think the others colours come from?*Use a magnifying glass to show the pixels on a television or computer screen. Elicit that these are red, blue and green instead of red, blue and yellow.**Scientific Enquiry activity**Learners investigate practically what happens when red, green and blue lights are mixed. They can make a Venn diagram to record their results. Explain that this is called ‘colour addition’.Alternatively, learners can mix colours of light with a simulation.Learners compare their results with those in a textbook or online. Ensure learners know the names of all the primary and secondary colours of light.Conclude that the primary colours of light can be combined to produce the secondary colours of light. Green and red light make yellow; blue and red light make magenta; and blue and green light make cyan. Blue, red and green light make white light. This is called colour addition. | <https://youtu.be/wFdmNom9xmE> (00:06–00:55 is sufficient.)Note: it is likely that learners will give the primary colours of paint. Different coloured filters (red, green and blue), light ray boxes or pencil torches, white paper.<https://phet.colorado.edu/sims/html/color-vision/latest/color-vision_en.html>(Use ‘RGB bulbs’)This link shows the expected Venn diagram:[www.bbc.co.uk/education/guides/zq7thyc/revision/6](http://www.bbc.co.uk/education/guides/zq7thyc/revision/6) | Use the first activities to elicit prior knowledge about the primary colours of paint. Health and safety:Care must be taken when working in a darkened room. Laser pointers must not be used as a light source.Care is needed to make the distinction between colour addition (i.e. a light effect) as opposed to mixing paints (a complex effect of the material involving colour absorption and reflection). |
| 8Pl68Ep28Ec38Ec6 | Explain colour addition and subtraction, and the absorption and reflection of coloured lightTest predictions with reference to evidence gainedCompare results with predictionsDiscuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | Filters and colour subtractionLearners investigate the effects of passing white light through red, green and blue filters. For each filter, learners draw a diagram. It is helpful if they annotate the white light to remind themselves that it contains all the colours in the spectrum. They should identify the colours that each filter absorbs and transmits.Introduce the term ‘colour subtraction’. Explain that objects (such as filters) subtract all the colours that they do not transmit. This means that the transmitted light is dimmer than the light without a filter.Ask: *What colours of light would pass through a magenta filter?* Ask learners to draw a diagram that explains this result.Ask learners to predict what happens if two filters of different colours are used at the same time. Demonstrate that no light passes through the second filter.Learners can summarise colour subtraction by observing some demonstrations and creating a Venn diagram.Learners draw a diagram that explains this effect using annotations. | Different coloured filters (red, green and blue), light ray boxes or pencil torches, white paper.This simulation can be used<https://phet.colorado.edu/sims/html/color-vision/latest/color-vision_en.html>(Use ‘single bulb’ with the filter on.)Useful supporting references:<http://maggiesscienceconnection.weebly.com/visible-light--color.html><http://hyperphysics.phy-astr.gsu.edu/hbase/vision/filter.html>Possible examples of colour subtraction:[www.youtube.com/watch?v=SUNj3q8CEY0](https://www.youtube.com/watch?v=SUNj3q8CEY0)[www.youtube.com/watch?v=zWS4-OvbpR0](https://www.youtube.com/watch?v=zWS4-OvbpR0) (especially 0:50–0:56) | Health and safety:Care must be taken when working in a darkened room. Laser pointers must not be used as a light source. |
| 8Pl28Pl68Ep28Ec38Ec6 | Describe how non-luminous objects are seenExplain colour addition and subtraction, and the absorption and reflection of coloured lightTest predictions with reference to evidence gainedCompare results with predictionsDiscuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others | Absorption and reflection**Scientific Enquiry activity**Learners investigate shining different-coloured lights onto different-coloured objects or pieces of paper (use white, red, green and blue).* Learners shine white light onto the different-coloured objects and observe the effect.
* They shine red, green and blue light onto the different coloured objects and observe the effect.
* They shine secondary colours of light (made by colour addition) onto the different coloured objects and observe the effect. In a well-darkened room, the shapes light up or disappear.
* Learners draw annotated diagrams to explain the results. Ensure learners use the terms ‘absorb’ and ‘reflect’ in their explanations.

By using a combination of coloured pens and coloured lights, learners can write a message which has a different meaning depending on the colour of light falling on it.Conclude that white surfaces reflect all colours. Primary- coloured surfaces absorb other colours but reflect their primary colour. Secondary-coloured surfaces (e.g. yellow) reflect their primary colours (e.g. green and red).**Extension activity**Learners who require more challenge use colour subtraction, the absorption and reflection of light to explain the effects of mixing paints. | Different-coloured filters (red, green and blue), light ray boxes or pencil torches, white paper.Coloured pens, different coloured filters (red, green and blue), light ray boxes or pencil torches, white paper. | Health and safety:* Care must be taken when working in a darkened room.
* Laser pointers must not be used as a light source.
 |

**Unit 8.4 Transport in plants and animals**

It is recommended that this unit takes approximately **33% of the teaching time for this term**.

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

* how water and mineral salts are absorbed and transported in flowering plants.

They also develop their knowledge of transporting chemicals in humans by finding out about:

* the basic components of the circulatory system and their functions
* the basic components of the respiratory system and their functions
* gaseous exchange
* the effects of smoking
* aerobic respiration.

Scientific enquiry work focuses on:

* selecting ideas and turning them into a form that can be tested
* planning investigations to test ideas
* identifying important variables; choosing which variables to change, control and measure
* taking appropriately accurate measurements
* using a range of equipment correctly
* interpreting data from secondary sources
* identifying trends and patterns in results (correlations)
* identifying anomalous results and suggesting improvements to investigations.

Recommended vocabulary for this unit:

* absorption, transport, root hair, root hair cell, xylem, phloem, photosynthesis
* circulatory system, heart, ventricle, atrium, wall, valve, coronary circulation, artery, vein, capillary
* heart rate, pulse, blood, red blood cells, white blood cells, platelets, plasma
* trachea, lungs, alveoli, rib cage, diaphragm, intercostal muscles
* breathing, ventilation, inspire, expire, respiration, aerobic respiration, recovery time
* smoking, nicotine, tar, carbon monoxide, carcinogens, cilia, mucus.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 8Bp28Eo2 | Describe the absorption and transport of water and mineral salts in flowering plantsUse a range of equipment correctly | Transport systems in plantsAsk learners to write the word equation for photosynthesis. Elicit the idea that plant cells require water for photosynthesis. Ask learners to suggest the pathway of water to the cells in a leaf.**Scientific Enquiry activity**Provide groups of learners with newly germinated seedlings with root hairs. * Learners examine the seedlings with a hand lens to observe the root hairs.
* They examine slides of root hair cells using a microscope.
* They draw diagrams of what they see and discuss how the structure of the root hair cell makes it suited to its function.

Conclude that root hair cells are adapted to their function by having a large surface area in contact with the soil for better absorption. They take up water and mineral salts. | A plant sample with obvious root hairs (e.g. an onion or garlic bulb suspended over water in a transparent jar to see the branching formation),hand lens, microscope, prepared slides showing root hair cells.  |  |
| 8Bp28Eo2 | Describe the absorption and transport of water and mineral salts in flowering plantsUse a range of equipment correctly | Ask learners: *How can water absorbed through the roots of a plant reach the leaves?* Then demonstrate what happens when thin (capillary tubes) are placed in coloured water to show that water will rise up very thin tubes.**Scientific Enquiry activity**Explain to learners that they are going to try to find thin tubes in plant stems for the water to travel in.Learners, in groups, cut transverse sections through a celery stem that has been previously left in water containing a dye. Learners can try pulling the vessels from the length of the stalk.Discuss the idea that there are special, hollow vessels, called ‘xylem’ that carry water and dissolved minerals from roots to leaves. These form the woody part of a plant. The mineral salts travel in the water.Examine slides of the cross-section through a stem to show the phloem and xylem.Learners draw an annotated diagram showing the transport of water from the soil to the leaves. | Open glass (capillary) tubes of different diameters.Stalks of celery or some other light-coloured stem, water- soluble dye (e.g. eosin or food colouring), white tiles, scalpels and hand lenses.Suitable slides, microscope. | Capillary action is enough to move water small distances up a stem. However, the liquid water is also drawn up the stem when water vapour exits the leaves.Health and safety:Learners should take appropriate care using scalpels. |
| 8Bh5 | Recognise and model the basic components of the circulatory system and know their functions | Transport systems in animalsAsk learners some simple questions about blood and the heart to assess their current understanding.Provide learners with information sources (printed or online material). Learners research different types of circulatory systems and prepare a presentation that covers the following main points:* Why is a circulatory system important?
* Give examples of substances transported in blood.
* What is an open circulatory system?
* What is a single circulatory system?
* What is a double circulatory system?
* Give examples of animals with different types of circulatory systems.

Conclude that a circulatory system transports substances around an organism. Humans have a double circulatory system. This means that blood passes through the heart twice on one complete circuit of the body. | Information sources for learners.The presentation could be electronic or on paper. | This is an opportunity to identify learners’ prior knowledge, understanding and misconceptions about the circulatory system.  |
| 8Bh5 | Recognise and model the basic components of the circulatory system and know their functions | Use either dissection or diagrams to explain the anatomy of the mammalian heart.Demonstrate the dissection of a heart (sheep or cow). The key stages of the dissection are:* Show the coronary circulation.
* Show the vessels entering and leaving the heart. Compare their thicknesses.
* Cut off the base of the heart to reveal the different thicknesses of the walls of the left and right ventricles.
* Cut through the left ventricle and atrium and show the valves.
* Repeat the same process on the right side and identify similarities and differences.

Make sure that learners can identify the left and the right side of the heart in a real structure and on diagrams.Alternatively, if a dissection is not possible then this activity could be replaced with one in which learners cut out different parts of the organ and then paste them into the correct place on an outline of the organ.Learners label a diagram of the heart, including the main internal features and the blood vessels that enter and leave the heart. | Animal heart e.g. sheep or cow,dissecting board or plate/tray, scalpel, dissecting scissors, disposable gloves, 15 cm ruler that can be disinfected after use,access to warm water and soap for handwashing.A fuller method on demonstrating a heart dissection is available at: [www.nuffieldfoundation.org/practical-biology/looking-heart](http://www.nuffieldfoundation.org/practical-biology/looking-heart)Worksheets with organ outline and different key parts of the organ to cut out and paste into position on the organ outline,scissors, glue/paste. | Health and safety:When dissecting a heart, be aware of hygiene regulations.Some learners may not want to watch a dissection or may feel faint or uncomfortable. Provide an alternative for these learners (for example answering questions from a textbook). |
| 8Bh5 | Recognise and model the basic components of the circulatory system and know their functions | Recap learning from previous activities. Identify the blood vessels that carry blood **to** the heart and **away from** the heart.Learners look more closely at the different types of blood vessels and draw annotated diagrams of the three main types of blood vessels (arteries, veins, capillaries). They can use prepared microscope slides if available or images.Learners produce a table comparing the structure and function of the different blood vessels.**Extension activity**Learners who require more challenge predict what would happen if someone cut a capillary, artery or vein.Use a diagram to explain the double circulation system. Link with the reasons for the structures of artery, capillary and vein.See veins in your wrist or crook of your elbow.**Extension activity**Investigate how scientists developed their knowledge of the circulatory system from ancient times to the present day. | Prepared microscope slides (if available) or images.Secondary sources. |  |
| 8Bh58Ep38Ep48Ep5 | Recognise and model the basic components of the circulatory system and know their functionsSelect ideas and turn them into a form that can be testedPlan investigations to test ideasIdentify important variables; choose which variables to change, control and measure | **Scientific Enquiry activity**Ask learners to find out how fast their heart is beating.*Can you find your pulse? How? How would you explain to someone how to find their pulse? Can you only find your pulse on your neck and your wrist?*Learners, in pairs or groups of three, plan an investigation to discover the effect of exercise on heart rate. They should decide on their independent, dependent and control variables and write a method for the investigation. As part of their plans, learners should identify activity-related risks and hazards. They should decide the safety measures that they will take.Learners peer assess their methods with a different group. There are several ways that this investigation could be completed. Learners should give each other feedback on whether the method is clear:* What is the independent variable?
* How will the independent variable be changed?
* What is the dependent variable?
* How will the dependent variable be measured?
* What are the control variables?
* How will these variables be controlled?
* What are the risks and how will they do the investigation safely?

Once the plan has been checked, learners perform these activities and collect and analyse the data.Conclude that exercise increases heart rate. The more exercise is done the faster the heart beats. | This website is interactive and could provide learners with information on taking pulse at rest and during exercise:[www.getinthezone.org.uk/schools/ages-4-11/ages-9-11/game-the-pulse/](http://www.getinthezone.org.uk/schools/ages-4-11/ages-9-11/game-the-pulse/)Information on the following website might help with planning this activity.[www.tes.com/teaching-resource/the-effects-of-exercise-on-our-pulse-6324043](https://www.tes.com/teaching-resource/the-effects-of-exercise-on-our-pulse-6324043)Learners should exercise at a reasonable pace for at least two minutes. | Health and safety:* The type of exercise the learners choose to do should be safe to do in the space available (e.g. running on the spot, sit ups, star jumps).
* Check that learners are fit and healthy. Do not ask learners who have health issues to do the exercise activity.
* If the learners follow their own method in the next lesson then it must be checked by the teacher in advance.
 |
| 8Bh5 | Recognise and model the basic components of the circulatory system and know their functions | Provide learners with sources of information (printed or online). Learners research the functions of red blood cells and white blood cells. If time allows, learners can also find out about platelets and plasma.Learners use annotated diagrams to explain how blood transports a range of substances around the body.**Scientific Enquiry activity**Using prepared slides of human blood, learners work in pairs to try to identify the differences between red and white blood cells. They write down what they see and/or draw the differences.Relate the structure of red blood cells and white blood cells to their functions. | Secondary sources.Prepared slides,microscopes. | Link to Stage 7; the relationship between the structure of a cell and its function. |
| 8Bh58Ec5 | Recognise and model the basic components of the circulatory system and know their functionsInterpret data from secondary sources | **Extension activity**Learners research disorders of the circulatory system using secondary sources such as locally available health education material.They use this information to produce advice posters or presentations on topics such as:* What is angina?
* What are varicose veins?
* What is anaemia?
* What is haemophilia?
 | Secondary resources. |  |
| 8Bh88Bh10 | Recognise the basic components of the respiratory system and know their functionsExplain gaseous exchange | Use a diagram to show learners the main components of the respiratory system and the lungs, trachea and the necessary muscles.Show learners a picture of a cast of the lung. One side shows the air vessels. The other side also shows the blood vessels. *What are the names of the parts of the lung? Does the lung only contain air? What else is in the lung?* Elicit the idea that the blood supply is very close to the air in the alveoli.Conclude that parts of the respiratory system are adapted to get the oxygen in the air into the alveoli where it can get into the blood.Demonstrate a model of a lung using a balloon in a bell jar. Identify features of the model lung (e.g. diaphragm, lung, trachea, rib cage).Demonstrate that the air is drawn into the lung because the volume around the lung increases (i.e. the air is **not** *pushed into* the lung). Learners can try to explain this using their understanding of pressure in gases.Ask learners to evaluate the model: *What parts of the human respiratory system does it model well? What does it not model well?*Define *breathing* as the contraction and relaxation of muscles (the intercostal muscles and diaphragm).Compare this with *ventilation* (the movement of air into and out of the lungs – *inspiration* and *expiration*).Note: respiration is one of the characteristics of all living things. Ensure that learners understand that this is not the same as breathing.Learners summarise their understanding of breathing and ventilation using text and annotated diagrams. They should make reference to gas pressure.**Extension activity**Learners who require more challenge can compare and contrast methods of artificial ventilation (e.g. negative pressure and positive pressure ventilators). | For example:<https://goo.gl/cESLCU> (the full url for this website is: [www1.imperial.ac.uk/resources/3285AD1D-B374-4D98-8050-4F3E4B8CB618/a3lunghumancastisamacroscopicviewofaplasticcastoftheairwaysyellowthepulmonaryarteriesredandveinsblueofahumanlung](https://www1.imperial.ac.uk/resources/3285AD1D-B374-4D98-8050-4F3E4B8CB618/a3lunghumancastisamacroscopicviewofaplasticcastoftheairwaysyellowthepulmonaryarteriesredandveinsblueofahumanlung))An empty 500ml drink bottle (clear, without sport cap), drinking straw, balloon, scissors, tape, small piece of adhesive tack or modelling putty.Instructions of how to make a simple model lung:<https://youtu.be/MCEUW8moLeI>  | Make learners aware of the movement of the ribs and the diaphragm when you inhale and exhale. |
| 8Bh88Bh108Ep48Eo18Ec28Ec4 | Recognise the basic components of the respiratory system and know their functionsExplain gaseous exchangePlan investigations to test ideasTake appropriately accurate measurementsIdentify trends and patterns in results (correlations)Identify anomalous results and suggest improvements to investigations | Measuring the volume of a breath**Scientific Enquiry activity**Learners, in pairs or small groups, measure and record the volume of air they exhale in a standard breath.Using a spirometer:The spirometer needs to be filled with water and inverted into a bowl of water. One end of the aquarium tubing is placed into the open end of the bottle. The learner holds the bottle with one hand and the other end of the tubing with the other hand. They exhale into the tubing. Another learner records the volume of air expelled in each breath.Using a balloon:Alternatively, lung volume can be estimated with a round balloon (with the volume calculated from: V = $\frac{4}{3} πr^{3}$).Investigating the effect of exercise on breathing rate**Scientific Enquiry activity**Ask learners to count how many times they inspire (breathe in) during one minute. Discuss the difficulty of counting your own breathing rate (because it is possible to consciously change the breathing rate).In small groups, learners design a simple method that can be used to answer these questions:* What is the difference in breathing rate between someone who is resting and someone doing exercise?
* How long does it take after exercise for the breathing rate to return to normal?

Learners predict the results for their investigation and design a results table with space for repeated readings.* Learners collect and interpret their results.
* They compare their results with those from other groups and with their predictions.
* Ask learners: *Do you see any patterns (similarities) in the results from different groups?*
* Learners should identify whether they have any anomalous results from repeated readings. If there are anomalous results, then they should take another repeated reading (if there is time).
* Learners make simple conclusions. They should explain their results in terms of the requirement for oxygen during exercise.
* Learners evaluate their investigation and suggest improvements to the method that they used.

Conclude that during exercise the breathing rate (and volume of inhaled air) both increase. This allows more oxygen to be supplied to the muscles. When exercise stops, there is a ‘recovery time’. During this period the breathing rate returns to normal. | A spirometer can be made from: a 2-litre plastic soda bottle, masking tape, waterproof marker, large beaker with measurement lines, deep bowl or basin, plastic aquarium tubing (50-60 cm).Before the lesson, put a scale on the bottle:* Stick a piece of masking tape vertically along the side of the bottle.
* Add 50 cm3 of water to the bottle (using a measuring cylinder or beaker). Mark the volume on the masking tape.
* Repeat, making marks at every 50 cm3 to make a scale.

Balloons (round).Diagrams of the approaches can be seen at: <https://stjohns.digication.com/natalia_boscodoss/Lab_2_Measuring_Lung_Capacity>Stopwatches. | Sensitivity may be required if learners have asthma or other respiratory conditions. Health and safety:Any objects being placed into learners’ mouths must be clean and disinfected.Sensitivity and caution may be required if learners have asthma or other respiratory conditions. |
| 8Bh118Bh7 | Describe the effects of smoking. Secondary sources can be usedDiscuss how conception, growth, development, behaviour and health can be affected by diet, drugs and disease | Show learners some images of people and organs that have been damaged by smoking. These could include lungs affected by cancer, amputations, effects of mouth cancer, etc.Ask learners to list the problems that result from smoking. If the equipment is available, then demonstrate the use of a ‘smoking machine’ which collects the products of a burning cigarette. The products are drawn through cotton wool and universal indicator solution and their temperature is taken. Alternatively show a video of this demonstration.Ask learners to suggest the advantages and disadvantages of smoking. Debate the topics and identify that the long-term disadvantages of smoking are very serious. Locally available health education material can be used.Conclude that cigarettes produce harmful waste products that include tar, carcinogens and carbon monoxide. These waste products contribute to disease.Discuss reasons why it is important that the airways are kept clean. Explain the essential role of the cilia and mucus in effectively cleaning the incoming air. Relate the structure of the ciliated epithelial cells to their function. Learners can then explain what happens when chemicals in cigarette smoke paralyse the cilia.Learners design a poster/leaflet warning about the risks of smoking, including on foetal development.  | Cotton wool, universal indicator solution, thermometer, U-tube apparatus, syringe (to draw smoke through apparatus), rubber tubing.Health education material on smoking. | Although selected images should be shocking, be sensitive as some learners may have relatives who have smoking-related diseases. Some learners may find some images make them feel faint or uncomfortable.Health and safety:The ‘smoking machine’ demonstration should only be done in a fume cupboard.Nicotine is an addictive drug and tar can cause cancer. Chemicals in cigarettes paralyse the cilia so that the airways cannot be cleaned effectively. |
| 8Bh9 | Define and describe aerobic respiration, and use the word equation | Revise previous learning by asking learners to identify the differences between breathing, ventilation and respiration. Ask learners to name the chemicals that the blood carries to each cell. Use these to write the reactants in the word equation for aerobic respiration.Ask learners if they know either of the products of this reaction. Prompt learners for the full word equation for respiration.**Extension activity**Learners who require more challenge can compare photosynthesis and aerobic respiration. |  | Make sure that learners know that aerobic respiration requires oxygen. |

**Unit 8.5 Metals and non-metals**

It is recommended that this unit takes approximately **34% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of the Periodic Table and properties of materials and develop their ideas on:

* the differences between metals and non-metals
* chemical reactions
* word equations.

In this unit, the reactions of metals can be confined to: sodium, magnesium, zinc, iron, copper, silver and gold.

Scientific enquiry work focuses on:

* testing predictions with reference to evidence gained
* planning investigations to test ideas
* identifying important variables; choosing which variables to change, control and measure
* making predictions using scientific knowledge and understanding
* using a range of equipment correctly
* comparing results with predictions
* presenting conclusions to others in appropriate ways
* presenting results as appropriate in tables and graphs.

Recommended vocabulary for this unit:

* metal, non-metal, Periodic Table
* density, malleability, ductility, combustion
* word equation
* corrosion, rusting, oxidation, galvanising.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 8Cp1 | Describe and explain the differences between metals and non-metals | Show learners spoons made out of different materials (e.g. wood, metal and plastic). *When might you use each spoon? What property makes it suitable for this use?**What are the differences between metals and non-metals? What properties of metals have you learnt about in physics?* Compare properties of metals and non-metals.*Can you name some metals? Non-metals?* *Can you find them in the Periodic Table?**What do you notice about the position of metals and non-metals in the Periodic Table?* Discuss the relative position of metals and non-metals in the Periodic Table.Show learners the names and symbols of less-known metals (e.g. tungsten, molybdenum) and non-metals (e.g. selenium, arsenic). Ask them to predict whether each is a metal or a non-metal based on its position in the Periodic Table.Conclude that metals and non-metals have, generally, different properties. In the Periodic Table metals are found in the middle and to the left and non-metals are found to the right. | Spoons made of different materials, e.g. wood, plastic, metal.Periodic Table of elements.The Periodic Table app from the Royal Society of Chemistry might be useful and is available free for both Android and iOS: [www.rsc.org/periodic-table](http://www.rsc.org/periodic-table) | Link to Stage 8 Unit 8.2.Learners may have used a variety of tests to distinguish between metals and non-metals in Stage 7, Unit 7.7. Some of these may be used for revision. |
| 8Cc28Eo28Ec38Ec7 | Describe chemical reactions which are not useful, e.g. rustingUse a range of equipment correctlyCompare results with predictionsPresent conclusions to others in appropriate ways | Before we explore chemical reactions which are not useful (not beneficial for human activity) we need to explore chemical reactions in general.**Scientific Enquiry activity**Learners investigate the reaction of some metals with dilute acids.* Learners add a small volume of dilute acid to the metal sample in a test tube.

*How can you tell there is a chemical reaction happening?** They carry out a test for hydrogen on the gas given off. (Suggest to learners that they choose the most vigorous reaction on which to conduct the test.)
* Learners write word equations for the metals which react.

Give learners a general equation: metal + acid → salt + hydrogen | Small pieces of zinc, iron, magnesium and copper, test tubes, dilute acid (for example dilute hydrochloric acid), wooden splints.There are several ways to test the gas. This method involves collecting hydrogen in an inverted test tube:[www.youtube.com/watch?v=hJtHEP3QiNU](https://www.youtube.com/watch?v=hJtHEP3QiNU) | Health and safety:This demonstration should only be done in a fume cupboard.Safety goggles must be worn.Learners may need help with writing the name of the salt. |
| 8Cc28Eo2 | Describe chemical reactions which are not useful, e.g. rustingUse a range of equipment correctly | Start by showing photographs of some products of useful and not useful chemical reactions (e.g. burning, mouldy bread, rusting, effect of acid rain on buildings, plastic products, cleaning products). Learners identify each as ‘useful’ or ‘not useful’. They explain their choice.Show a picture of a rusty car or a bicycle. *What is rusting? What are differences between corrosion and rusting?*Introduce the terms ‘corrosion’ and ‘rusting’. Explain that rusting is an example of corrosion. Rusting is the name given to the corrosion of iron and alloys containing iron (e.g. steel).*Why does iron rust? What are the conditions necessary for the formation of rust?*Explain that rusting requires oxygen and water. What activities can be carried out to prove this?**Scientific Enquiry activity**Learners set up test tubes containing iron or steel nails under different conditions:* in dry air in a sealed test tube (add anhydrous copper sulfate, anhydrous calcium chloride or a bag of silica gel to the tube)
* in boiled, distilled water covered with a layer of oil
* dipped in water, then placed in an open test tube
* in salty water in an open test tube.

Learners write a prediction of what will happen to the nails in the four conditions.Conclude that rusting (corrosion of iron) is an example of a reaction that is not useful. | Pictures of useful and not useful chemical reactions.Picture of a rusty car/bicycle.Iron or steel nails, anhydrous copper sulfate (or anhydrous calcium chloride or a bag of silica gel), distilled water, oil, salt, test tubes, test tube racks, bungs. | Misconception alert: A chemical reaction is not inherently useful or not useful. What we (humans) want to achieve through chemistry, which defines a reaction’s use, is important but this doesn’t alter the nature of a reaction. It is important to make this clear to learners, so that they don’t believe there are ‘good’ and ‘bad’ reactions.If possible, keep the activity set up so that the results can be further discussed in the ‘preventing rust’ lesson below. |
| 8Cc28Ep28Ep48Ep58Ep68Eo28Ec38Ec78Eo4 | Describe chemical reactions which are not useful, e.g. rustingTest predictions with reference to evidence gainedPlan investigations to test ideasIdentify important variables; choose which variables to change, control and measureMake predictions using scientific knowledge and understandingUse a range of equipment correctlyCompare results with predictionsPresent conclusions to others in appropriate waysPresent results as appropriate in tables and graphs | Ask learners to remember the results of the investigation on rusting. *What effect did salt have on rusting?* Explain that adding salt makes rusting go faster. *What else might affect the speed of rusting? Do you think rusting is more of a problem in cold places or hot places?*Give learners data, from a secondary source, of the mass of an iron nail before and after an investigation into rusting carried out at different temperatures (include one unexpected result).Learners analyse and interpret these data: * They decide what the axes should be and plot the data on a line graph.
* They draw a line of best fit. *Are all results as expected?*

Explain that the unexpected, anomalous result should not be included in the line of best fit. Suggest possible reasons for the anomaly and ways of improvement. | Data on rusting at different temperatures (it does not have to be exact as long as it shows an increase in rate – greater mass loss – at different temperatures), graph paper. |  |
| 8Cc2 | Describe chemical reactions which are not useful, e.g. rusting. | Preventing rusting Examine the test tubes with iron/steel nails. Learners record observations and make simple conclusions.*How could we prevent rusting?* Show a picture of a bicycle. Learners suggest how different parts are protected from corrosion. Learners annotate their pictures.Summarise ways of preventing rust from forming e.g. painting, greasing, galvanising, plastic coating. Ask learners to suggest where they could be most appropriately used and why.**Extension activity**Learners identify and record ways that rust is prevented in the school grounds, in a car and at home. Learners could make a list or take photographs.Conclude that there are many different ways of preventing rust from forming. | Results of the investigation from previous lesson.Picture of a bicycle. |  |
| 8Ec5 | Interpret data from secondary sources | Provide learners with information sources (printed or online material). Learners need to find the answer to the questions:* How do other metals corrode (e.g. magnesium, aluminium, zinc, tin, silver and copper)?
* What is iron used for?
* Why is iron widely used even though it rusts?

Groups prepare presentations of their research. These can be electronic or non-electronic. Encourage learners to choose a creative approach to their presentation (e.g. stop frame animation, role play, news reel, movie trailer, video).Conclude that some metals corrode more easily than others. | Secondary sources. |  |

**Unit 8.6 Sound**

It is recommended that this unit takes approximately **33% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of the types of energy to develop their knowledge of:

* the properties of sound in terms of movement of air particles
* the link between loudness and amplitude, pitch and frequency.

Scientific enquiry work focuses on:

* selecting ideas and turning them into a form that can be tested
* planning investigations to test ideas
* identifying important variables; choosing which variables to change and measure
* discussing and controlling risks to themselves and others
* presenting results as appropriate in tables and graphs
* identifying trends and patterns in results (correlations)
* presenting conclusions to others in appropriate ways
* identifying anomalous results and suggesting improvements to investigations
* interpreting data from secondary sources.

Recommended vocabulary for this unit:

* vibration, wave, longitudinal wave, oscilloscope, trace
* sound source, sound receptor, sound detector
* amplitude, volume, pitch, frequency

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 8Ps18Ep48Ep58Eo48Ec28Ec7 | Explain the properties of sound in terms of movement of air particlesPlan investigations to test ideasIdentify important variables; choose which variables to change, control and measurePresent results as appropriate in tables and graphsIdentify trends and patterns in results (correlations)Present conclusions to others in appropriate ways | Ask learners: *How are sounds made?***Scientific Enquiry activity**Demonstrate that sounds are due to vibrations, using one or more demonstration. For each demonstration learners should observe the vibrations and explain that these are responsible for the sound.* Suspend a table tennis ball from nylon thread. Vibrate a tuning fork (or a bell) and touch the table tennis ball.
* Demonstrate how sounds are made on any string instrument. Identify the vibration of the strings.
* Learners hum and use their fingers to feel the vibrations at their lips and neck (pressing gently on the voice box).
* Place polystyrene balls on a loudspeaker. Play low and high sounds through the speaker.
* Show how water moves when placed on a loudspeaker.
* Show high-speed footage of different ways that sound can be made.

Ensure that learners can correctly use the terms ‘pitch’ and ‘volume’. For example, play sounds of different pitches and volumes and ask the learners to describe them.Show how notes with different pitches are made on a variety of instruments (e.g. string instruments or a piano). Compare the length of the strings when a low note and a high note are made.Look at the vibrations caused by notes of different pitches. Identify that the vibrations are faster for the higher notes. Introduce the term ‘frequency’ and explain frequency as a ‘rate’ i.e. number of times something happens/repeats in a second.Provide learners with information sources (printed or online material). Learners research the story of how we hear sounds:* Where do sound waves enter the ear?
* What parts of the ear vibrate?
* What do hair cells do?
* How are sounds of different pitch detected?

Learners research the parts of the ear and describe how the ear detects sound. Learners produce a flow chart to show how the ear detects sound.Demonstrate ear structure using a model ear.Conclude that vibrations cause sound. The vibrations from the sound source cause air particles to vibrate. These, in turn, cause parts of the ear to vibrate. When hair cells vibrate they send nervous signals to the brain. | Table tennis ball, nylon thread, tuning fork or bell.Any string instrument (e.g. a guitar, tambura, violin, viola, ‘cello, double bass, harp).* Loudspeaker and polystyrene balls: <https://youtu.be/ssrLJGbIBdI>
* Loudspeaker and water (select excerpts): <https://youtu.be/THUMdTohWkI>
* Sound using body parts: [archive.teachfind.com/ttv/www.teachers.tv/videos/sound-using-body-parts.html](http://archive.teachfind.com/ttv/www.teachers.tv/videos/sound-using-body-parts.html)
* Vibrations of guitar strings: <https://youtu.be/RwxIg7YkaLc>
* Animation of how a piano works: <https://youtu.be/gNNkhop45G8>

Secondary sources / model ear.Secondary sources / model ear. | This topic is an opportunity for cross-curricular links with music. Learners who play musical instruments can be asked to bring them to demonstrate how they make notes of different pitches and volumes.Emphasise the word ‘vibration’ of a source of sound. |
| 8Ps18Ps28Eo3 | Explain the properties of sound in terms of movement of air particlesRecognise the link between loudness and amplitude, pitch and frequency, using an oscilloscope.Discuss and control risks to themselves and others. | **Scientific Enquiry activity**Investigate how we detect the direction of sound. Blindfold a volunteer learner who sits in the middle of the room while the others form a circle around them.Point to one of the learners in the circle who then makes a sound (a squeak or a clap). The seated learner must then try to point in the direction of the noise. Try this activity with the seated person using both ears and then again with one ear covered.Ask learners to suggest how we identify the direction of sound. Elicit the idea that direction can be determined by the difference in time it takes the sound to reach the ear.Provide learners with information sources (printed or online material). Learners find the answer to the questions:* Where are the sound receptors in the ear? What do they look like?
* What happens when sound receptors respond to loud sounds?

Learners make an information leaflet about the dangers of listening to loud music.Conclude that the ear contains sound receptors. These can be damaged by loud sounds. | Secondary sources. | Be very sensitive if any learners have a hearing condition.More sophisticated theories of auditory localisation also consider how sound waves are affected by the effect of the shape of the human head and outer ears. |
| 8Ps18Ps28Ec5 | Explain the properties of sound in terms of movement of air particles.Recognise the link between loudness and amplitude, pitch and frequency, using an oscilloscope.Interpret data from secondary sources. | Use a signal generator and a loudspeaker to investigate the class’ range of hearing. The additional use of a cathode ray oscilloscope (CRO) enables learners to ‘see’ that the sound is still being produced even when it is above the pitch they can hear.Alternatively, use a sound generator to produce sounds of different frequencies. Identify the highest-frequency sounds that learners in the class can hear. Compare this with the highest sounds that adults can hear.Give learners secondary data on the hearing thresholds of humans and a range of animals. Learners should plot a graph of the data. They summarise the differences between the frequencies that different species can hear.Conclude that pitch is determined by the frequency of vibrations. High frequency sounds are higher and low frequency sounds are lower. | Signal generator, loudspeaker, cathode ray, oscilloscope.Video of signal generator:[www.youtube.com/watch?v=pHS8zCdscTg](https://www.youtube.com/watch?v=pHS8zCdscTg)Sound generator:<http://onlinetonegenerator.com/hearingtest.html>Data on the hearing range of different species:[www.lsu.edu/deafness/HearingRange.html](http://www.lsu.edu/deafness/HearingRange.html) | Be very sensitive if any learners have a hearing condition. |
| 8Ps1 | Explain the properties of sound in terms of movement of air particles. | Recap the idea of ‘particles’.Ask learners to draw a picture of how they think air particles move between a sound source and a sound detector.Demonstrate that sound makes air particles between the source and the detector move. This can be shown using a lit candle or bubbles.Place a sound source in a closed box. Demonstrate that the sound can pass through the box even though the air molecules cannot.Alternatively, create a large film of detergent that is larger than a source of sound (e.g. a speaker). Demonstrate that the sound can pass through the film of detergent without breaking it. Ask: *How is the sound reaching our ears? Are the air particles moving from the source to the detector?*Use a role play to model the movement of sound. Learners stand in a line. The learner at one end is the ‘sound source’ and the learner at the other end is the ‘sound detector’. Show how the air particles each move backwards and forwards. Each air particle causes the next one to move. Explain that this happens in a sphere around a sound source.Use an animation to show the movement of air particles in a sound wave.Ask learners to identify the vibration of individual particles and also the direction that the sound travels.Learners themselves can form a line as in the video clip, each holding onto the shoulders of the learner in front. The teacher can start the sound off and each learner feels the vibration. Louder and higher pitched sounds can be modelled.Ask learners to compare their model with their understanding of particles and critique the model:*What does this model show well? What does this model not show well? Is it ‘good enough’ to explain the properties of sound?* Ask learners if they have ever noticed that they can hear a train through the rails, before they can hear it through the air. *Why do you think this is?*Alternatively, use the example of Native Americans and trackers hearing horses by putting an ear to the ground.Use a role play to demonstrate that it is easier for sound to cause particles to vibrate if the particles are nearer together.Discuss: *Can sound travel in a vacuum?*If available, demonstrate a bell ringing in a vacuum. Alternatively, show the video.Ask learners to evaluate their predictions using the evidence from the lesson.Conclude that sound makes air particles vibrate forward and backward. The vibrations cause the next particle to vibrate. In this way the sound is carried from the source to the detector. Sound cannot travel in a vacuum. | Loudspeaker, candle, bubbles:<http://archive.teachfind.com/ttv/www.teachers.tv/videos/sound-through-a-medium-wobbling-bubbles.html> <https://youtu.be/G5V-EWE9emI> Source of sound (e.g. a bell), box with lid.Loop (e.g. from a wire coathanger), detergent, loudspeaker:<https://youtu.be/aj9ZOzIXaYc> (0.16–0.23)The longitudinal wave animation on this page (with blue spheres representing the air particles) can be used: [www.acoustics.salford.ac.uk/feschools/waves/wavetypes2.php](http://www.acoustics.salford.ac.uk/feschools/waves/wavetypes2.php)An example of this model can be seen at:[www.bbc.co.uk/education/clips/ztwkjxs](http://www.bbc.co.uk/education/clips/ztwkjxs)This is a good opportunity to revise understanding of the particle model. It is likely that learners will predict that sound moves most quickly in gases.Simulation of sound waves in a solid and a gas:[www.acs.psu.edu/drussell/Demos/waves/wavemotion.html](http://www.acs.psu.edu/drussell/Demos/waves/wavemotion.html)Bell ringing in a vacuum: [www.youtube.com/watch?v=ce7AMJdq0Gw](https://www.youtube.com/watch?v=ce7AMJdq0Gw) | It is expected that learners will show individual sound particles moving from the source to the detector. Use a range of activities to show why this model is incorrect. |
| 8Ps18Ep38Ep48Ep58Eo48Ec28Ec4 | Explain the properties of sound in terms of movement of air particles.Select ideas and turn them into a form that can be tested.Plan investigations to test ideas.Identify important variables; choose which variables to change, control and measure.Present results as appropriate in tables and graphs.Identify trends and patterns in results (correlations).Identify anomalous results and suggest improvements to investigations. | Ask learners why lightning is seen before thunder is heard. Elicit the idea that sound waves travel more slowly than light.Remind learners that to calculate speed (e.g. km per hour) you need a distance (km) and a time (hours). Show the speed equation.Ask learners to discuss ways that they could measure the speed of sound. They should decide on their independent, dependent and control variables. As part of their plan they should identify how they will make their measurements as accurate as possible.Learners should write a detailed plan for their investigation. As part of their plan they should include information about how many times they will repeat their measurements.* Groups of learners carry out the investigation to measure the speed of sound waves. Circulate and provide support for groups.
* Learners collect and interpret their results. They should design a results table with space for repeated readings.
* Learners should compare their results with those from other groups. Ask learners: *Do you see any patterns (similarities) in the results from different groups?*
* Learners should identify whether they have any anomalous results from repeated readings. If there are anomalous results then they should take another repeated reading (if there is time).

Conclude that the speed of sound can be calculated from data on distance and time. | Equipment to measure distance (e.g. tape measure, trundle wheel) and time (e.g. stopwatch). | Alternatively, the echo received from a distant wall can be used but remind learners that the sound travels twice the distance.It is good practice for the class to average their measurements, discarding any which seem to be very inaccurate. |
| 8Ps2 | Recognise the link between loudness and amplitude, pitch and frequency, using an oscilloscope. | Revise that, in sound, the air particles move backwards and forwards. Show an animation of this process. Ask learners to describe what they see. Elicit the idea that there are waves across the screen. Explain that even though the individual air particles do not move very far, there are waves that travel from the source to the detector.Demonstrate sound waves using a slinky. A small piece of paper can be used to tag one part of the slinky. Learners can use this to identify that each part of the slinky moves backwards and forwards (like the air particles), but the wave moves in a particular direction.Ask learners to compare the slinky model with their understanding of sound and critique the model: *What does this model show well? What does this model not show well? Is it ‘good enough’ to explain the properties of sound?* Use a simulator to illustrate how waves look with different amplitudes and frequencies.Use a slinky, pen and a large piece of paper to model the action of an oscilloscope. Attach the pen to the slinky so that its tip is on a large piece of paper. One learner moves the paper at a constant speed (at right angles to the slinky). At the same time another learner uses the slinky to model sound waves.Repeat this demonstration with waves of different amplitudes and frequencies.Show learners an oscilloscope and compare the trace with the waves produced by the slinky and a pen. Demonstrate the difference in traces between high frequency, low frequency, high amplitude and low amplitude sounds.Learners draw the oscilloscope trace for sounds with different pitches and volumes. They annotate their diagrams with the terms ‘pitch’, ‘frequency’, ‘amplitude’ and ‘volume’.Conclude that sound travels as waves and oscilloscopes can be used to visualise the frequency and amplitude of the vibrations. | Slinky:<https://youtu.be/GIkeGBXqWW0>[www.supportingphysicsteaching.net/XBP/So\_DensityVibrations/index.html](http://www.supportingphysicsteaching.net/XBP/So_DensityVibrations/index.html) Virtual oscilloscope:<https://academo.org/demos/virtual-oscilloscope/> | If a CRO is available the CRO will give traces of the sounds produced by a signal generator, synthesizer or a microphone. Explain that the CRO responds to an electrical pulse and that a microphone transfers sound energy to electrical energy.Using musical instruments will show that different ones have different patterns associated with their sound. |
| 8Ps2 | Recognise the link between loudness and amplitude, pitch and frequency, using an oscilloscope. | Volume and amplitudeShow learners a video of a wine glass being broken by a tone. Ask: *Did the pitch of the tone change? Did the frequency change? What did change?* Elicit the idea that the volume changed. Show how vibrations change when a drum is hit loudly and quietly. Identify that the pitch (frequency) is the same but the vibrations are bigger. Introduce the term ‘amplitude’.Use a loudspeaker. Demonstrate the different vibrations when quiet and loud notes are made. Learners create a role play that models how air particles move as a result of loud and soft sounds. They then model the vibration of air particles for different combinations of pitch and frequency. Groups of learners can demonstrate these to each other. The audience have to decide the type of sound that is being represented.Learners write a summary of the movement of air particles in sounds of different pitch and volumes.Show learners a video of a speaker covered in paint. Learners identify examples of vibrations that cause sounds of different frequencies or amplitudes.Conclude that volume is determined by the amplitude of vibrations. High amplitude sounds are louder and low amplitude sounds are quieter. | <https://youtu.be/CdUoFIZSuX0> (0:34–1:14)Coffee cup on drum snare (1:24–1:28):<https://youtu.be/EeY5d966Td0>Loudspeaker and signal generator.Paint on a speaker (2:51–4:35):<https://youtu.be/5WKU7gG_ApU> |  |

**Unit 8.7 Reproduction and growth**

It is recommended that this unit takes approximately **34% of the teaching time for this term**.

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

* the human reproductive system, including the menstrual cycle, fertilisation and foetal development
* the physical and emotional changes that take place during adolescence
* how conception, growth, development, behaviour and health can be affected by diet, drugs and disease.

Scientific enquiry work focuses on:

* interpreting data from secondary sources.

Recommended vocabulary for this unit:

* egg, ovum, ovary, oviduct, uterus, vagina
* sperm, penis, testis, sperm duct
* puberty, adolescence, menstrual cycle, ovulation
* fertilisation, cell division, implantation,foetus, foetal development, placenta, umbilical cord, pregnancy
* conception, growth, development
* drugs, medicines, disease

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 8Bh138Bh12 | Describe the human reproductive system, including the menstrual cycle, fertilisation and foetal development.Discuss the physical and emotional changes that take place during adolescence. | Learners label diagrams of the reproductive organs of a male and female. They should annotate the diagrams to indicate the function of each part.Discuss with learners the functions of the different parts. Learners can then improve the annotations on their diagrams.Learners compare the reproductive system of humans and flowering plants and create a summary table.Revise the physical and emotional changes that occur in puberty. Learners sort cards into changes that happen to boys, girls or both. | Unlabelled diagrams of the reproductive organs of a male and female.Cards with changes that happen during puberty. | Note: care should be taken when introducing this sensitive topic. It is recommended that teachers agree with learners that no-one will ask about, or reveal, any personal sexual experiences. It can be helpful to have an anonymous question box.Many learners are concerned about their own development, so there is a need to be sensitive and reassuring. |
| 8Bh13 | Describe the human reproductive system, including the menstrual cycle, fertilisation and foetal development. | Show learners a diagram of the thickness of the uterus during the menstrual cycle. Ask learners to identify:* when the uterus wall is getting thicker.
* when the uterus wall is getting thinner.
* when menstruation takes place.

Explain that the menstrual cycle is numbered from the first day of menstruation.*What day is the egg released?* *What is the lining of the uterus like when the egg is released?**How long does the menstrual cycle on this diagram last?***Extension activity:** Explain that the menstrual cycle is controlled by hormones. Give learners the following information:* Hormone 1 controls ovulation from the ovary.
* Hormone 2 stops a thick uterus lining breaking down.
* Hormone 3 causes the uterus lining to get thicker. It also causes hormone 1 to be produced.

Also give learners a labelled diagram of the menstrual cycle with the levels of LH, progesterone and oestrogen.In pairs, learners need to work out the names of hormones 1, 2 and 3. | Diagram of the thickness of the uterus during the menstrual cycle.Labelled diagram of the menstrual cycle including the hormone levels. | Note: it is important to explain to learners that different women have menstrual cycles of different lengths (e.g. 24 to 35 days). During puberty it is common to have menstrual cycles of irregular lengths. Diagrams of menstrual cycles show 28 days as this is an average.Note: at this level, learners do not have to recall the names or functions of the hormones in the menstrual cycle. |
| 8Bh13 | Describe the human reproductive system, including the menstrual cycle, fertilisation and foetal development. | An effective way to explain fertilisation is to tell learners a story: *‘Let me read you a story – listen and imagine. Once upon a time there were two important cells ….*’ Tell the story of the journey of the sperm cell and egg cell. Describe fertilisation as the fusing of the sperm nucleus and the egg nucleus. Learners identify their adaptations and link them to their functions.Explain that the sperm is deposited in the vagina. They have to swim to the egg. The egg is moved down the oviduct.Learners create a flow chart that summarises their understanding of the journey of sperm cells to the egg. Their flow chart should end with fertilisation of the egg.Learners often ask about twins. Explain that identical twins are due to one fertilised egg dividing to form two foetuses. Non-identical twins are due to two eggs each being fertilised by different sperm. Learners use annotated diagrams to explain the development of identical and non-identical twins. |  |  |
| 8Bh13 | Describe the human reproductive system, including the menstrual cycle, fertilisation and foetal development. | Show learners a video clip that shows the development of a human embryo. Choose video clips that show the division of the fertilised egg and lead on to the further development. Check videos for suitability of content before showing them to learnersProvide learners with information sources (printed or online material) on foetal development. Learners draw and annotate a sequence of pictures or diagrams illustrating ovulation, fertilisation, cell division and implantation. Discuss the foetus’ need for nutrients and explain the role of the placenta in materials exchange. Learners label a diagram and use arrows to show movement of oxygen and nutrients from the mother to the foetus and the movement of carbon dioxide and other waste products from the foetus to the mother.  | Note: this video uses animations from 01:55–04:55 and then includes an augmented image of a real birth: [www.ted.com/talks/alexander\_tsiaras\_conception\_to\_birth\_visualized](http://www.ted.com/talks/alexander_tsiaras_conception_to_birth_visualized)Information sources for learners.Diagram of the placenta and umbilical cord. |  |
| 8Bh78Ec5 | Discuss how conception, growth, development, behaviour and health can be affected by diet, drugs and disease.Interpret data from secondary sources. | Ask learners to identify the substances that can pass from the mother to the foetus through the placenta.Show images of the effect of Foetal Alcohol Syndrome and point out the smooth philtrum and thin upper lip. Explain that this is due to alcohol passing into the foetus and damaging it.Provide learners with information sources (printed or online material) on things that can affect conception (fertilisation), growth or foetal development. Groups can research different topics and report to the class:* diet (e.g. lack of folic acid, iron or calcium)
* smoking
* drugs (e.g. cocaine or heroin)
* disease (e.g. diabetes, malaria or rubella).

**Extension activity:** Learners who require more challenge investigate the way that scientists collect data about factors that can affect foetal development (e.g. the zika virus).All learners create a summary of the ways that diet, smoking, alcohol, drugs and disease can affect the conception, growth and development of the foetus. This could be in the form of a leaflet with advice for pregnant women. | Images of people with Foetal Alcohol Syndrome.Information sources for learners. | Deal with the subject sensitively. |
| 8Bh78Ec5 | Discuss how conception, growth, development, behaviour and health can be affected by diet, drugs and disease.Interpret data from secondary sources. | Provide learners with growth charts (graphs) showing human growth. Ask them to interpret the graphs.Discuss at which periods in life there is rapid growth and how this growth can be measured.Learners, in pairs, investigate how growth can be affected by diet, drugs or disease. They present their chosen topic (diet, drugs, or disease) to the rest of the class.All learners create a summary of the main points from the presentations. | Growth chart which shows the average height of boys and girls at different ages.Secondary sources.Note: a wide variety of diseases could be selected as examples (e.g. parasitic worms, diet deficiency diseases, genetic conditions, coeliac disease, kidney diseases). | Explain the use of growth charts but point out that these are for an average person.Selection of example diseases will need sensitivity. |
| 8Bh7 | Discuss how conception, growth, development, behaviour and health can be affected by diet, drugs and disease. | Discuss what learners understand about drugs.Introduce the terms ‘illegal drugs’, ‘legal drugs’ or ‘pharmaceutical drugs’. Learners classify a range of drugs (e.g. penicillin, alcohol, nicotine, heroin, aspirin etc.)Learners use secondary sources to research into the effects of the different types of drugs on the health of an adolescent. | List of drugs.Secondary sources. | Deal with the subject sensitively. |
| 8Bh7 | Discuss how conception, growth, development, behaviour and health can be affected by diet, drugs and disease. | Learners will have encountered many parts of this learning objective throughout stage 8. To consolidate their learning, they create a summary (e.g. a mind map).Some teachers may also like learners to consider sexually-transmitted diseases in the context of this unit. |  |  |

**Unit 8.8 Chemical reactions**

It is recommended that this unit takes approximately **33% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of mixtures, compounds, metals and corrosion to develop their knowledge of:

* some common compounds including oxides, hydroxides, chlorides, sulfates and carbonates
* using word equations to describe a reaction.

Scientific enquiry work focuses on:

* using a range of equipment correctly
* discussing and controlling risks to themselves and others
* selecting ideas and turning them into a form that can be tested
* presenting results as appropriate in tables
* identifying trends and patterns.

Recommended vocabulary for this unit:

* reaction, word equation
* reactants, products, rate of reaction
* elements, compounds, oxides, hydroxides, sulfates, carbonates, salts, chlorides
* oxidation, combustion.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 8Cc18Cp58Eo3 | Use a word equation to describe a common reaction. Secondary sources can be used.Name some common compounds including oxides, hydroxides, chlorides, sulfates and carbonates.Discuss and control risks to themselves and others. | Preparation of chloridesStart by showing a formula for a compound e.g. NaC*l*. *Which elements make up this compound? Can you suggest the name of this compound? How could you make sodium chloride?*Show a video of a reaction between sodium and chlorine.Learners write the word equation and record observations. *How do you know that the new substance was made?*Explain that there are other ways of preparing chlorides.Demonstrate preparation of a chloride by the reaction between excess metal (magnesium, zinc, iron) and dilute hydrochloric acid.* For each reaction, learners write word equations, ensuring that they name the salt correctly.
* Learners make careful notes of the main steps involved, including relevant diagrams.

Learners suggest reactants that can be used to make a certain metal chloride. Alternatively, they predict what product will be formed from given starting materials.Conclude that compounds containing a metal and chlorine are called chlorides. | <https://youtu.be/tbPxwDiX1NU> Magnesium ribbon, zinc, iron filings, dilute hydrochloric acid, laboratory glassware, spatula.[www.syngentaperiodictable.co.uk/reaction-zone.php](http://www.syngentaperiodictable.co.uk/reaction-zone.php) – simulations and videos of a range of reactions. In the section ‘reactivity of metals’ there are videos showing the reaction between a selection of metals and chlorine. | Health and safety:Safety goggles must be worn. |
| 8Cc18Cp58Eo28Eo3 | Use a word equation to describe a common reaction. Secondary sources can be used.Name some common compounds including oxides, hydroxides, chlorides**,** sulfates and carbonates.Use a range of equipment correctly.Discuss and control risks to themselves and others. | Preparation of sulfatesGive learners sets of cards describing the main steps of the reaction between a metal and hydrochloric acid. Learners put the steps in the correct order.Demonstrate how to use the same procedure to prepare a metal sulfate using sulfuric acid. Learners, in groups, repeat the method to prepare either zinc sulfate or copper sulfate using one of these reactions:* zinc and sulfuric acid
* copper oxide and sulfuric acid
* copper carbonate and sulfuric acid.
* Before starting the practical activity each learner should assess the risks involved and agree the safety measures required.
* The reactants and products can be weighed to revise conservation of mass.
* If reagents are unavailable, the video can be watched.
* Learners practise writing word equations for each reaction.

Conclude that sulfates can be prepared by reacting metal or a metal compound with sulfuric acid. | Cards showing the main steps in preparing a metal chloride by reacting a metal and hydrochloric acid.Zinc, copper oxide or copper carbonate, dilute sulfuric acid (0.5 mol dm-3, irritant), laboratory glassware, spatula.The reaction of copper oxide with sulfuric acid involves clear colour changes. A full protocol can be found at:[www.rsc.org/learn-chemistry/resource/res00001917/reacting-copper-ii-oxide-with-sulfuric-acid?cmpid=CMP00006703](http://www.rsc.org/learn-chemistry/resource/res00001917/reacting-copper-ii-oxide-with-sulfuric-acid?cmpid=CMP00006703) Preparation of copper sulfate:[www.youtube.com/watch?v=PTa8tkJ8rv0](https://www.youtube.com/watch?v=PTa8tkJ8rv0) | Health and safety:Safety goggles must be worn. |
| 8Cc18Cp58Eo28Eo3 | Use a word equation to describe a common reaction. Secondary sources can be used.Name some common compounds including oxides, hydroxides, chlorides, sulfates and carbonates.Use a range of equipment correctly.Discuss and control risks to themselves and others. | Preparation of oxidesLearners write a word equation and identify the reactants and products from the sentence ‘Carbon burns in oxygen to produce carbon dioxide’.Learners prepare one or more oxides. Possible investigations include:* Burn charcoal. Collect the gas produced and use limewater to identify it as carbon dioxide.
* Burn magnesium in a crucible.
* Burn iron wool.

Before starting an investigation, learners discuss the risks and hazards and agree the safety measures.For each reaction learners:* identify the signs of a chemical reaction
* identify the reactants and products
* write a word equation.

**Extension activity**Learners measure the mass of reactants and products (where possible) and calculate the mass of the remaining reactants and products.Discuss that the simplest reaction is the combustion of elements to form oxides. Explain that this is an example of oxidation.Conclude that oxides are formed in reactions with oxygen. | Charcoal, magnesium ribbon, iron wool, copper powder, heating apparatus, crucible, mass balance.The following videos show the reactions but do not give the mass of the reactants and products.Burning magnesium (0:20 – 1:30): <https://youtu.be/m2i9jLPXprQ> Iron and oxygen:<https://youtu.be/TkE1uVjrY0w> – Iron and pure oxygen:<https://youtu.be/XhhJZ55JPxo> – Phosphorus and oxygen:<https://youtu.be/IzkfNIG5LvE> – Sulfur and oxygen:<https://youtu.be/V1sQO91UvFI> – Videos of several reactions; useful to show the reactions of Group 1 metals with oxygen:[www.syngentaperiodictable.co.uk/reaction-zone.php](http://www.syngentaperiodictable.co.uk/reaction-zone.php) | Health and safety:* Safety goggles must be worn.
* Burning magnesium in air should not be viewed directly due to its brightness. Link this to its use in flares and fireworks.
* Burning iron wool causes sparks.

Measuring the mass of magnesium oxide is not reliable due to loss of magnesium oxide. |
| 8Cc18Cp58Eo28Eo3 | Use a word equation to describe a common reaction. Secondary sources can be used.Name some common compounds including oxides, hydroxides, chlorides, sulfates and carbonates.Use a range of equipment correctly.Discuss and control risks to themselves and others. | Preparing metal hydroxidesLearners write sentences that describe this word equation: sodium hydroxide + zinc chloride → zinc hydroxide + sodium chlorideDemonstrate the reaction that the learners have described. Identify that zinc hydroxide forms a white precipitate.Learners investigate reactions of different metal ions with sodium hydroxide. They react a small volume of dilute sodium hydroxide solution (approximately 0.4 mol dm-3) with solutions containing ions of aluminium, zinc, calcium, copper, iron (II) or iron (III). This investigation is traditionally done in test tubes. However, drops of the reactants can be mixed on a laminated sheet. This requires smaller volumes of each solution.Before doing the investigations, learners should discuss the risks involved and agree the safety measures.For each reaction they:* describe the appearance of the reactants
* describe the appearance of the products
* identify the signs of a chemical reaction
* write a word equation.

If solutions of transition metals are unavailable, their reactions with sodium hydroxide can be shown using the simulation.Conclude that some metal hydroxides can be prepared by a reaction with sodium hydroxide. | Sodium hydroxide (0.4 mol dm-3, irritant), zinc chloride solution (0.2 mol dm-3), test tubes, dropper.Sodium hydroxide (0.4 mol dm-3, irritant), test tubes, dropper.Solutions (0.2 mol dm-3) containing ions of: aluminium, zinc, calcium, copper, iron (II) or iron (III).A method for this approach is available:[www.rsc.org/learn-chemistry/resource/res00000757/microscale-reactions-of-positive-ions-with-sodium-hydroxide?cmpid=CMP00005906](http://www.rsc.org/learn-chemistry/resource/res00000757/microscale-reactions-of-positive-ions-with-sodium-hydroxide?cmpid=CMP00005906)[www.chem.ox.ac.uk/vrchemistry/livechem/transitionmetals\_content.html](http://www.chem.ox.ac.uk/vrchemistry/livechem/transitionmetals_content.html) Note: Learners can investigate the reactions themselves and write down observations. However, detailed guidance on how to use the simulation will need to be given first. | Common names – caustic soda, slaked lime, limewater –should be given.Health and safety:Safety goggles must be worn. |
| 8Cc18Cp58Eo28Eo38Ep38Eo48Ec2 | Use a word equation to describe a common reaction. Secondary sources can be used.Name some common compounds including oxides, hydroxides, chlorides, sulfates and carbonates.Use a range of equipment correctly.Discuss and control risks to themselves and others.Select ideas and turn them into a form that can be tested.Present results as appropriate in tables and graphs.Identify trends and patterns in results (correlations). | Reactions of carbonatesPour some fizzy drink into a glass. *What makes the drink fizz? Where does this come from?*Some of the gas from a fizzy drink can be collected and tested with limewater.Explain that the carbon dioxide used in fizzy drinks can be produced when carbonates react with acids. Give an example word equation for the reaction of a carbonate with acid, e.g.: calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxideBefore starting the practical activity each learner should assess the risks involved and agree the safety measures required.Learners investigate the reaction of one or more carbonates with acid. For each reaction they:* describe the appearance of the reactants
* describe the appearance of the products
* identify the signs of a chemical reaction
* test the gas produced with limewater
* write a word equation.

Conclude that carbon dioxide is formed when carbonates react with acids. | Fizzy drink, glass.Calcium carbonate, sodium carbonate or sodium hydrogen carbonate.Dilute acid e.g. sulfuric acid (0.5 mol dm-3 irritant), hydrochloric acid (0.5 mol dm-3 irritant) or vinegar.Test tubes, dropping pipettes, limewater, delivery tubes. | Common names – sodium bicarbonate, limestone and chalk – should be given.Health and safety:* Eye protection must be worn.
* Learners must identify and follow the safety measures required for working with acids.

If using vinegar give learners a word equation to complete:calcium carbonate + ethanoic acid → calcium ethanoate + \_\_\_\_ + \_\_\_\_ |
| 8Cp4 | Explain the idea of compounds. | Start by revising the definition of a compound.Return to the video showing the formation of sodium chloride.Use play building bricks, or molecular modelling kits, to show that elements are made of one type of atom and a compound is when at least two atoms of different elements interact to form a chemical. For example, diamond is only made of carbon atoms so it isn’t a compound, but water is made of hydrogen and water so is. Learners build a range of compounds to model. Identifying elements in compounds*How can we tell which elements make up a compound? What proof do we have? Can we prove that sodium is part of the newly-formed compound?*Explain that chemists use different tests to identify elements in compounds. One of these tests is a flame test.Demonstrate or show learners a video that shows the different colours seen in a flame test.Learners identify the metal present in some compounds using a flame test. Before starting, they should discuss the risks and hazards and agree safety measures.* Learners observe flame colours for the following metals: potassium, lithium, calcium, copper and sodium.
* They present their findings in a table and use results to identify the unknown element.

If learners are unable to perform the practical:Use a simulation of flame tests. Learners observe the colours of different flames and identify the metal element in an unknown sample.Conclude that elements combine together to make new compounds. | <https://youtu.be/tbPxwDiX1NU> Flame test colours:<https://youtu.be/MGUPKA_pOEE> Labelled wooden splints pre-soaked (for at least 6–8 hours) in solutions of compounds of:* potassium
* lithium
* calcium
* copper
* sodium.

Flame test simulation such as [https://www.newpathonline.com/free-curriculum-resources/virtual\_lab/Chemistry\_Flame\_Test/9/12,13,14/1914](https://www.newpathonline.com/free-curriculum-resources/virtual_lab/Chemistry_Flame_Test/9/12%2C13%2C14/1914)  | One should be labelled as ‘unknown’.Health and safety:* Eye protection must be worn.
* Learners need to be taught how to use heat sources safely.
 |
| 8Cp18Cc18Cp5 | Describe and explain the differences between metals and non-metals.Use a word equation to describe a common reaction. Secondary sources can be used.Name some common compounds including oxides, hydroxides, chlorides, sulfates and carbonates. | Reactions with water.Learners write a word equation and identify the reactants and products from the sentence ‘Sodium hydroxide and hydrogen gas are produced when sodium reacts with water’.Learners react one or more elements with water or steam. Possible elements that could be reacted with water or steam are: magnesium, iron (needs to be observed after a day).For each reaction they:* identify the signs of a chemical reaction
* identify the reactants and products
* write a word equation.

**Extension activity**Learners measure the mass of reactants and products (where possible) and calculate the mass of the remaining reactants and products.As demonstrations the learners could observe the reactions of sodium or lithium with water.Alternatively, learners use simulations and videos to research the reactions of metals and non-metals with water and/or steam. Give learners a list of reactions that they need to investigate. Learners complete a table of observations and results.Conclude that:* reactions of metals with water form metal hydroxide
* reactions with steam produce metal oxide
* reactions of non-metals with water produce acids.
 | Magnesium, iron, heating apparatus.Simulations and videos of a range of reactions. Learners can explore this resource on their own and write results and observations made:[www.syngentaperiodictable.co.uk/reaction-zone.php](http://www.syngentaperiodictable.co.uk/reaction-zone.php) This resource looks at the reactions of different metals with water and steam:<http://resources.hwb.wales.gov.uk/VTC/reactions_of_metals/eng/Introduction/pop.htm>This video can be used to show reactions of Group 1 metals with water:<https://youtu.be/eaChisV5uR0> | Health and safety:Eye protection must be worn.Health and safety:For demonstration only: sodium and lithium. Screens must be used for sodium and lithium. |

**Unit 8.9 Forces and magnets**

It is recommended that this unit takes approximately **33% of the teaching time for this term**.

In this unit, learners build on their previous knowledge of the effects of forces on movement to develop their knowledge of:

* speed including interpreting simple distance/time graphs
* magnets, electromagnets and magnetic fields.

Scientific enquiry work focuses on:

* planning investigations to test ideas
* identifying important variables; choosing which variables to change, control and measure
* making predictions using scientific knowledge and understanding
* taking appropriately accurate measurements
* using a range of equipment correctly
* discussing and controlling risks to themselves and others
* presenting results as appropriate in tables and graphs
* making simple calculations
* discussing explanations for results using scientific knowledge and understanding; communicating these clearly to others
* presenting conclusions to others in appropriate ways.

Recommended vocabulary for this unit:

* speed, time, distance, distance/time graph, gradient, timing gates
* magnet, electromagnet, magnetic poles, north pole, south pole, attraction, repulsion, force, field, magnetic field pattern, compass.

| **Framework Code** | **Learning Objective** | **Suggested activities to choose from** | **Resources**  | **Comments**  |
| --- | --- | --- | --- | --- |
| 8Pf18Ep58Ep68Eo18Eo28Eo38Eo48Ec1 | Calculate average speeds, including through the use of timing gates.Identify important variables; choose which variables to change, control and measure.Make predictions using scientific knowledge and understanding.Take appropriately accurate measurements.Use a range of equipment correctly.Discuss and control risks to themselves and others.Present results as appropriate in tables and graphs.Make simple calculations. | *How far can you move in 10 seconds?*Show a video of current 100 m world record holder (at the time of writing this is held by Usain Bolt and took 9.58 seconds). Discuss how the data only suggests a time and not a speed. *How do we know he was the fastest?***Scientific Enquiry activity**Explain to learners that they are going to investigate how far they can move in 10 seconds. Remind learners of the importance of collecting results in an organised way. Ask learners to design a table they could use for their results. If necessary, remind learners of how to draw a table and show an example.Take learners to a space where they can move reasonably long distances (e.g. outdoors in the school or in a hall). Learners can try different activities such as running, walking, skipping and hopping for 10 seconds. If skateboards or bicycles are available, then they can also be tested for 10 seconds.For each activity, learners need to measure the distance they have moved and record the results in their tables. They then calculate the mean distance they travelled in 10 seconds for each activity.Elicit that speed = $\frac{distance}{time}$Learners return to the classroom and discuss their results:* Was it a fair test?
* How accurate were the measurements?
* Were there any anomalous results?
* How could the investigation be improved?

Learners process and analyse the data they collected. They:* calculate average speeds for each activity
* draw bar charts to compare different activities.

The speeds from different learners can also be compared (e.g. by calculating the range of speeds for each activity):* Which activities were fastest?
* Which people were fastest?
 | Example of Usain Bolt’s 100 m world record run: <https://youtu.be/3nbjhpcZ9_g>(Audio is in German and can be muted.)Stopwatches or electronic timers, tape measures or trundle wheels, graph paper. | A suitable safe site must be chosen if learners are permitted to run at speed. |
| 8Pf18Eo18Eo28Eo48Ec1 | Calculate average speeds, including through the use of timing gates.Take appropriately accurate measurements.Use a range of equipment correctly.Present results as appropriate in tables and graphs.Make simple calculations. | Demonstrate how to use timing gates.**Scientific Enquiry activity**Learners investigate how the average speed of an object varies with the gradient of a slope that the object is rolled down.They:* plan and carry out the investigation
* record measurements in a table
* calculate the speed for each reading
* calculate the average speed for each gradient/height of slope
* draw a line graph of their results (‘gradient of slope’ against ‘average speed’)
* draw conclusions from their investigation.
 | Timing gates / data loggers,slopes, different objects e.g. toy car. | The height of the slope can be used instead of the gradient. |
| 8Pf28Eo18Eo28Eo48Ec1 | Interpret simple distance/time graphs.Take appropriately accurate measurements.Use a range of equipment correctly.Present results as appropriate in tables and graphs.Make simple calculations. | Ask learners to list the different ways they can present the results of an investigation. *Do you prefer tables or graphs? Why? What are their advantages and disadvantages?*Elicit the idea that tables are good for organising data. For analysis, graphs can make trends easier to see.Demonstrate how to draw a distance/time graph from example data. The graph should show two periods of movement with a stationary period in the middle.**Scientific Enquiry activity**Arrange most of the learners in a line. They should be 1 m apart and all should have stop watches.* Ask one learner to walk along the line, varying their speed as they go (including at least one stop).
* All learners in the line start their stopwatches when the teacher says ‘go’. They stop their stopwatches when the learner walks past them.
* Learners collect the data and use it to create a distance/time graph.

**Scientific Enquiry activity*** Tell learners that they will investigate the (slow) movement of wind-up toys, measuring their positions over time.
* Show learners the equipment that they will have available to them. Learners, in groups, discuss how they will collect the results.
* Take feedback from the groups. Agree a method to use for the investigation. Learners write down the method.
* Learners design a table for their results.
* Groups of learners carry out the investigation. They should take repeated results for each distance measurement.
* Learners calculate the mean results for each reading and draw a graph of distance (*y-*axis) against time (*x-*axis).
* Learners write a description of the movement described by the graph. For example: *‘*The toy started by moving 10 cm in 3 s. Then it stopped for 1 s. It then moved again and travelled 3 cm in 5 s. Then it stopped.’
 | Example data to draw a simple distance/time graph.Large space, stop watch (one for each learner), distance measurer.A selection of wind-up toys, stopwatches or electronic timers, rulers and large pieces of paper.Note: a possible method is to place the toy in the centre of a large sheet of paper (marked with an ‘X’). The position of the toy is marked every 10 seconds. Then the distances between the marks are measured with a ruler and recorded. | If available a motion sensor device could be used here.It is a very useful device for showing motion instantly on screen. The device emits ultrasound waves which reflect and return from an object ahead. The computer measures the time interval and plots the distance/time graph so that a learner moving towards the computer can see the shape immediately. |
| 8Pf2 | Interpret simple distance/time graphs. | Show learners some distance/time graphs (e.g. those created in the previous activities) from last lesson. *Which part shows the object stationary? Which part shows the object moving away? Which part shows the object moving quickly? Can you tell if an object is moving forwards or backwards on a distance/time graph?*Elicit the conclusions:* A horizontal line indicates that the object is stationary (zero speed).
* A smooth sloped line indicates a steady speed.
* The steeper the line the higher the speed.

Use simulations for learners to explore distance/time graphs.Provide examples of data for learners to draw and interpret distance/time graphs.Ask learners to write down the formula that links speed, distance and time.Ensure that learners identify speed = $\frac{distance}{time}$Show a simple distance/time graph. Ask: *What was the distance at zero seconds? What was the distance at 2 seconds? How far did the object move in 2 seconds? What was the average speed of the object between 0*–*2 seconds?*Similarly, model how to find the distance travelled and average speed between 2–4 seconds, 4–6 seconds etc.Provide examples of distance/time graphs for learners to interpret. Learners should practise:* identifying the distance travelled at different times
* calculating speeds from distance/time graphs.
 | Simulation:[www.absorblearning.com/advancedphysics/demo/units/fullscreen.html?src=media/010103Helicopter.swf&title=undefined&w=500&h=400](http://www.absorblearning.com/advancedphysics/demo/units/fullscreen.html?src=media/010103Helicopter.swf&title=undefined&w=500&h=400)Data for learners, graph paper.Possible data:[www.mathwarehouse.com/graphs/distance-time-graph-activity.php](http://www.mathwarehouse.com/graphs/distance-time-graph-activity.php)Examples of distance/time graphs. | Learners do not need to be able to calculate the gradient of a graph at this stage.It will help learners to not get confused between distance/time and speed/time graphs if they write down all of the working for their calculations. |
| 8Pm18Eo48Ec6 | Describe the properties of magnets.Present results as appropriate in tables and graphs.Discuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others. | MagnetismRevise previous learning on magnets by showing learners some examples of effects caused by magnets (e.g. a video). Assess whether learners can correctly use the term ‘magnet’, ‘magnetic’, ‘attract’ and ‘repel’. Attraction and repulsion can be seen very easily if magnets are suspended. This is also an opportunity to check which pole points to the north of the Earth.Elicit that magnets do not need to be touching to have an effect on each other i.e. they involve ‘non-contact’ forces. Clarify that this is another example of a ‘field’ (a region in which each point is affected by a force – in some ways similar to, but in many ways quite different to, a gravitational field).**Scientific Enquiry activity**Learners float a small magnet on a piece of polystyrene (or similar) on a dish of water. They should test the effect of the magnet on different samples (including both magnetic and non-magnetic metals). *What forces do you detect? What is attracted to magnets? What is repelled by magnets? Which materials are magnetic?* Introduce a model to explain the activity of magnets. In the ‘domain model’ materials contain lots of mini-magnets (‘domains’) each of which has a north and south pole. In most materials these are in random orientations. In a magnet, all the domains are lined up so that they form one big magnet. *What would happen if a magnet was cut in half? How many magnets could you get?***Scientific Enquiry activity**Learners magnetise a nail by stroking it with a permanent magnet. They demonstrate that it is magnetic by using it to pick up paper clips (or similar).Use an animation so learners can visualise the domains becoming arranged in the nail. *What would happen if you stroked the magnet in different directions?*If there is time, learners investigate whether their predictions are correct. | Possible video:<https://youtu.be/Seo8ZOjxn2M> 2 bar magnets, cotton.Small magnets, magnetic materials, non-magnetic metals and non-metals, a small dish of water and piece of lightweight object (e.g. polystyrene) to float the magnet on. If this is impractical then bar magnets can be suspended from thread.Animations explaining the domain/mini-magnet model. (Use the ‘by pane’ option to access the animations.)<http://supportingphysicsteaching.net/XBP/Em_MiniMagnets/index.html>Animations using the mini-magnet model to explain how a nail can be magnetised. (Use the ‘by pane’ option to access the animations.)<http://supportingphysicsteaching.net/XBP/Em_Stroking/index.html> |  |
| 8Pm2 | Recognise and reproduce the magnetic field pattern of a bar magnet. | Show learners an example of magnets exerting a force at a distance.In pairs, learners discuss what they think is happening. They share their ideas and feed back to the class.Remind learners that in physics, a field is a region in which a force acts on each point. Use a simulation to demonstrate how a magnetic field can be mapped. Start by showing the simulation without the field. Demonstrate that the compass experiences a force that is in different directions depending on where it is in the field. Demonstrate that the field has different strengths in different places:* the field is stronger near the poles (shown by the field lines being closer together)
* the field is weaker further away from the poles (shown by the field lines being further apart).

Show learners how to use a plotting compass to detect the field around a bar magnet.Learners, in pairs, draw the field around a bar magnet. Compare results.Use the simulation again with the magnetic field visible. Ask learners to compare the shape of this field with the one they have drawn.Ask learners to identify where the magnetic field is strongest. Ask them to predict which part of a bar magnet, iron filings would be most attracted to.Demonstrate placing a bar magnet beneath a piece of card. Sprinkle iron filings on the top. These will produce patterns. The filings will be concentrated around the poles.Concludethat magnetic field lines radiate out from magnets. They get weaker with distance and are concentrated around the poles. They have a direction of north pole to south pole. | <https://phet.colorado.edu/en/simulation/legacy/magnet-and-compass>For each pair of learners: bar magnet, compass, sheet of A3 paper, pencils.Bar magnet, card or acetate transparent sheet, iron filings in a ‘pepper-pot’ for sprinkling.  | Health and safety:eye protection should be used to make sure that no iron filings damage the eye. Iron filings should not be allowed to stick to the magnet. |
| 8Pm38Ep48Ep58Eo28Eo38Eo48Ec68Ec7 | Construct and use an electromagnet.Plan investigations to test ideas.Identify important variables; choose which variables to change, control and measure.Use a range of equipment correctly.Discuss and control risks to themselves and others.Present results as appropriate in tables and graphs.Discuss explanations for results using scientific knowledge and understanding. Communicate these clearly to others.Present conclusions to others in appropriate ways. | Show a video clip of a crane in a scrap yard. Learners discuss what they observe and how they think it works.Discuss ideas. Elicit the idea that the crane contains a magnet that can be turned on and off.Copper is non-magnetic but when it carries a current it creates a temporary magnetic field around it. An electromagnet is designed to use this idea. A simulation can help visualise what is happening in an electromagnet when there is, and is not, a current.Learners make their own electromagnet using a low voltage applied to an insulated copper wire wrapped around an iron nail. They test this with a compass to detect magnetism. *Is the shape of the field the same as with a permanent magnet? Is the magnetism permanent? Does the magnetism ‘disappear’ when the current stops? Does the magnetism ‘disappear’ when the nail is removed but current kept on?***Scientific Enquiry activity**Learners use their electromagnet to pick up small items like paper clips. By using the ‘number of paper clips picked up’ as their dependent variable, they design an investigation to find out:* How does the number of coils of copper wire affect the strength of the electromagnet?
* How does the current in the wire affect the strength of the electromagnet?

This is an opportunity for learners to demonstrate a wide range of scientific enquiry skills by planning, doing, interpreting and evaluating their own investigation.Learners summarise their learning by making a table that compares and contrasts permanent magnets and electromagnets.**Extension activity**Learners research the uses of magnets and electromagnets, for example in: medical contexts, route finding, security, sorting steel from other materials for recycling. | Possible video:<https://youtu.be/6yhNOXQkMpY>Use the animations with ‘show internal view’: <http://supportingphysicsteaching.net/XBP/Em_DirectCurrent/index.html> Low voltage power pack or batteries (rechargeable batteries are unsuitable and dangerous), insulated copper wire, crocodile clips, iron nail, plotting compass.Low voltage power pack or batteries (rechargeable batteries are unsuitable and dangerous), insulated copper wire, crocodile clips, iron nail, paper clips.Secondary sources. | Avoid/rectify misconceptions about copper itself being a magnetic material, even when it is used in an electromagnet. Explaining current as moving electrons is not required at this stage.Health and safety:Mainselectricity should never be used directly for any of these investigations. If it is not being used for power packs, then it should ideally be switched off. Clear safety measures must be explained and followed. Rechargeable batteries should not be used. |