vector maths & science

International Lower Secondary

SCIENCE

samplepagescatalogue

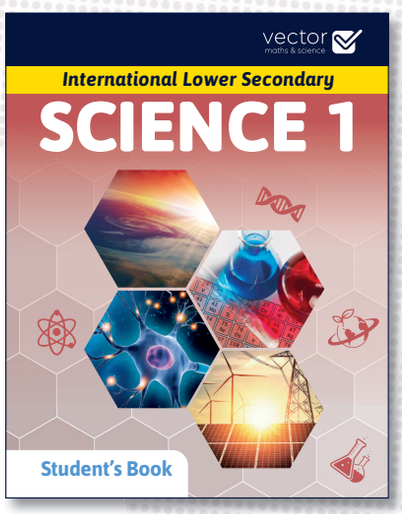
International Lower Secondary

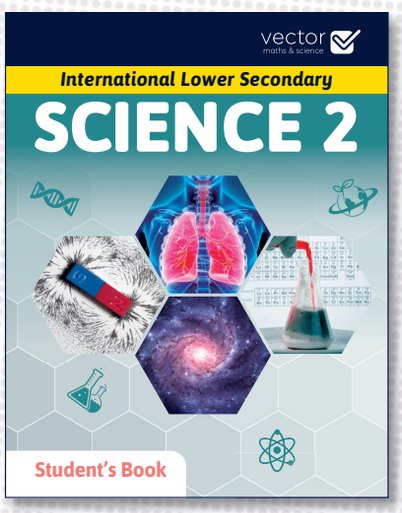
SCIENCE

Levels 1-3

VECTOR M&S International Lower Secondary Science series is a complete three-level course aligned to international standards of education, designed to meet the needs of secondary school students. This series aims to promote a deep understanding of scientific concepts in a friendly environment. A number of practical and scientific skills are developed through lessons that stimulate the interest of students and make connections between science and real life.

This series will provide students with an in-depth understanding of scientific concepts and theories, preparing them for success in their future studies by achieving a set of learning objectives in the scientific domains of Biology, Chemistry, Physics as well as Earth and Space.





Biology Chemistry Earth and Space Physics

Key features

FOR STUDENTS:

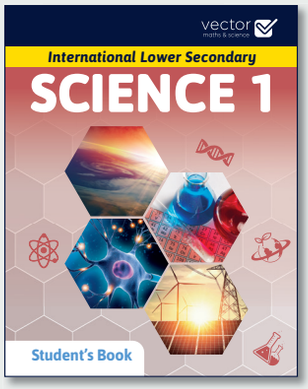
- cover pages with information on real-life situations, learning objectives of the unit and questions on prior knowledge
- high-quality illustrations and photographs
- a wide variety of discussion topics that promote interactive learning
- numerous activities to practise what was learnt in the theory sections, develop scientific enquiry skills through exploration and also challenge the learners with extra information on the topic taught
- review activities that allow the assessment of students' progress
- a section with the highlights at the end of each unit
- an extensive glossary to facilitate the development of students' vocabulary as well as a list with pictures of the laboratory apparatus for learners to become more familiar with the experiment procedure
- a section with information on methods learners should use as scientists
- a list of the keywords and an overview of the lesson at the end which help learners summarise what they have covered in the corresponding lesson

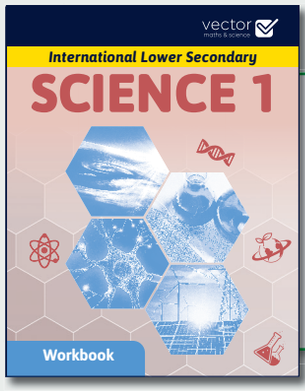
FOR TEACHERS:

- a detailed map of the Student's Book, Workbook and Teacher's Book that helps the teacher understand the structure of each book
- an extensive section with extra theory on the concepts taught in the unit and the corresponding keywords along with keyword information points for the teacher's reference
- step-by-step lesson plans for each unit
- digital resources such as Worksheets and Resource Sheets to support comprehension and extension of knowledge
- optional activities for further practice
- safety warnings and guidelines
- keys for all the questions and activities in the Student's Book, the Workbook and the resources as well as detailed steps for the implementation of the experiments

Components

FOR STUDENTS





Student's Digital Resources

FOR TEACHERS

Teacher's Digital Resources

Science 1

Lessons	Learning objectives
Unit 1: Energy	
1.1 Energy stores and transfers 1.2 Energy transformations 1.3 Energy is conserved 1.4 Reducing wasted energy	• Identify the ways in which energy can be stored. • Describe how energy can be transferred. • Describe energy transformations. • State the principle of conservation of energy and apply it in everyday situations. • Identify that during energy transformations some of the energy will be useful and the rest will be wasted. • Compare the energy that is being wasted by different devices.
Unit 2: Properties of matter	
2.1 The states of matter (particle model) 2.2 How matter changes states 2.3 The water cycle 2.4 Mixtures 2.5 Elements and compounds 2.6 Atoms and molecules 2.7 Chemical symbols and formulae	• Identify and describe how particles are arranged and move in the three states of matter. • Relate the different properties of matter to the particle model. • Identify the lack of particles as a vacuum. • Describe the changes of state using the particle model. • Identify the stages of the water cycle and explain how water is recycled. • Identify that air is a mixture of different gases. • Classify mixtures as heterogeneous or homogeneous according to their properties, and explore ways to separate them. • Describe what a compound is and how it differs from an element and from a mixture. • Define atoms and molecules, and identify molecules of compounds and elements. • Describe the Periodic Table as a way to sort elements. • Identify and write the chemical symbols of the first twenty elements of the Periodic Table. • Write the formulae of simple compounds, name the compounds and determine the elements and the number of atoms in compounds.

Science 1

Unit 3: Cells	
3.1 All living things are made of cells 3.2 Observing cells 3.3 Plant and animal cells 3.4 Specialised cells	• Describe how an organism is made up of organs, organs are made from tissues and tissues from cells. • Describe how a group of organs works together to form an organ system. • Recognise that all living organisms are made of cells. • Use a microscope to observe cells. • Name the basic parts of a cell and describe their functions. • Name the parts that only plant cells contain and describe their functions. • Distinguish between a plant cell and an animal cell. • Name some specialised cells and describe how these specialised cells are adapted to perform their functions.
Unit 4: Solar system	
4.1 Gravity 4.2 Our solar system 4.3 Formation of the solar system 4.4 The Sun, the Earth and the Moon 4.5 Tides	• Define the force of gravity as the force of attraction between any two objects. • Describe how the force of gravity depends on the masses of interacting objects and the distance between them. • Distinguish between mass and weight. • Recognise that gravity is the force that causes planets to orbit stars and moons to orbit planets. • Identify that no air resistance acts on celestial bodies to affect their movement. • Describe how the solar system formed from a nebula. • Identify the phases of the Moon and explain the positioning of the Earth, the Moon and the Sun in each phase. • Describe how solar and lunar eclipses occur and model them. • Identify the causes of tides and explain why sea levels change between high and low tide.
Unit 5: Metals and non-metals	
5.1 Metals 5.2 Non-metals 5.3 Alloys	• List the physical properties of metals. • List the physical properties of non-metals. • Compare metals and non-metals based on their physical properties. • Define alloys as mixtures of two or more different elements, at least one of which is a metal. • Compare the properties of different alloys to each other and to the metals they are made of. • Explain why metals and their alloys have different properties using the particle theory.
Unit 6: Acids and alkalis	
6.1 Acids and bases 6.2 Detecting acids and alkalis 6.3 How acids and alkalis affect our everyday life	• Name some properties of acids and bases. • Use indicators to identify whether a solution is acidic, alkaline or neutral. • Describe how the strength of acids and bases can be measured using the pH scale. • Describe everyday situations where acids and bases are involved.
Unit 7: Classification of living things	
7.1 The seven life processes 7.2 Classifying living things 7.3 Classifying animals 7.4 Species 7.5 Using keys to identify living things	• Identify living, once alive and never alive things based on the seven life processes. • Classify organisms into plants and animals and these into smaller groups. • Classify organisms into vertebrates and invertebrates and these into smaller groups. • Define the term species. • Identify variation within species. • Use and create simple dichotomous keys to identify organisms.

Science 1

Unit 8: Sound waves	
8.1 How sound travels 8.2 Reflection of sound 8.3 Speed of sound	• Describe how sound is transmitted by waves, and explain why sound does not travel through a vacuum. • Describe how sound reflects off a surface creating an echo. • Begin to realise the meaning and usefulness of the law of reflection. • Identify and explain how the medium affects the speed of sound using the particle model. • Calculate the speed of sound using reflected sound waves (echoes).
Unit 9: The Earth	
9.1 Types of rocks 9.2 Dating rocks 9.3 Earth structure 9.4 How Earth changes	• Describe how igneous, sedimentary and metamorphic rocks are formed. • Describe how fossils form. • Explain how fossils are used to compare the age of rocks but cannot be used to show the age of the Earth. • Describe the model of the structure of the Earth. • Identify that the Earth's surface changes over time due to the movement of tectonic plates. • Describe how the movement of tectonic plates creates three types of plate boundaries. • Identify that the movement of tectonic plates causes earthquakes, volcanoes and the formation of fold mountains at the boundaries of the plates.
Unit 10: The role of microorganisms in feeding relationships	
10.1 Feeding relationships 10.2 Microorganisms and viruses 10.3 Microorganisms affect food 10.4 Decomposers and their role	• Use food chains and food webs to describe feeding relationships and the flow of energy in an ecosystem. • Describe different types of microorganisms. • Explain how viruses are different from microorganisms. • Identify that microorganisms have an important role in decay. • Investigate how temperature and moisture affect decomposition. • Describe why decomposers are important to the environment.
Unit 11: Electricity	
11.1 Electrical circuits 11.2 Electric current 11.3 Measuring the size of an electric current 11.4 Changing the number of cells in a circuit 11.5 Changing the number of bulbs in a series circuit 11.6 Electrical conductors and insulators	• Relate the components of a circuit to their symbols. • Construct circuit diagrams from circuits and vice versa. • Use a model to show that an electric current is electrons flowing in one direction around a circuit. • Measure electric current in a series circuit with an ammeter. • Investigate how adding cells in series to a circuit affects the electric current. • Investigate how adding bulbs in series to a circuit affects the electric current. • Describe what electrical conductors and insulators are. • Test materials to classify them as electrical conductors or insulators. • Give examples of uses of electrical conductors and insulators in everyday life.

Unit 12: Chemical reactions	
12.1 Introduction to chemical reactions 12.2 Ways to represent a chemical reaction 12.3 Neutralisation reactions 12.4 Reactions that produce gases 12.5 Precipitation reactions	• Distinguish between physical and chemical changes. • Understand that new substances are formed by chemical reactions. • Recognise that changes in temperature and colour are indicators of chemical reactions taking place. • Use word equations to describe chemical reactions. • Use the particle model to show how atoms rearrange themselves during a chemical reaction. • Describe a neutralisation reaction using a general word equation. • Describe how the pH changes during the neutralisation reaction. • Give examples of uses of neutralisation in everyday life. • Recognise that the formation of a gas is an indicator of a chemical reaction taking place. • Use different methods to identify the gases hydrogen, oxygen and carbon dioxide when given off in reactions. • Describe a precipitation reaction as a chemical reaction between solutions that forms an insoluble product. • Recognise that the formation of a precipitate is an indicator of a chemical reaction taking place.

Science 2

Lessons	Learning objectives
Unit 1: Forces and motion	
1.1 Variables and measurements in experiments 1.2 Speed 1.3 Moving at constant speed 1.4 The effects of forces on motion 1.5 The turning effect of forces	• Use appropriate equipment for the task to measure length and time and take those measurements with precision. • Repeat measurements, calculate their mean and identify that this is more accurate than using just one result. • Define speed as a measure of the distance moved by an object in a unit of time and identify metres per second (m/s) and kilometres per hour (km/h) as units for speed. • Use the speed equation (speed = $\frac{\text{distance}}{\text{time}}$) to calculate one of the quantities, in the correct units, given the other two. • Draw distance–time graphs for objects that move at a constant speed, and use them to calculate speed from the gradient and to compare the speed of objects. • Analyse a distance–time graph for an object that changes speed. • Use force diagrams to identify whether forces are balanced or unbalanced and describe how balanced or unbalanced forces affect the movement of objects. • Recognise that the moment of force is the turning effect of a force about a specific point, calculate the moment of a force about a point and identify its units. • Describe how an object is balanced when the moments acting clockwise are equal to the moments acting anti-clockwise.

Science 2

Unit 2: Mixtures and solutions	
2.1 Mixtures 2.2 Solutions 2.3 Solubility 2.4 Factors that affect solubility 2.5 Chromatography	• Distinguish between homogeneous and heterogeneous mixtures. • Define the terms solvent, solute and solution. • Explore how mass is conserved during dissolving. • Explain the difference between dissolving and melting. • Explain what happens during dissolving using the particle model. • Give examples of solvents other than water. • Explain how the concentration of a solution is determined. • Define the solubility of a solvent and explain when the solution becomes saturated. • Compare the solubility of different solutes in water. • List factors that affect solubility. • Explore how temperature affects solubility. • Describe the process of paper chromatography. • Analyse simple chromatograms.
Unit 3: Pressure	
3.1 Diffusion 3.2 Pressure on a surface 3.3 Pressure in liquids 3.4 Pressure in gases 3.5 Upthrust – Sink or float	• Use the particle theory to explain how diffusion happens in liquids and gases. • Explore how temperature affects the rate of diffusion. • Calculate pressure by dividing the force exerted on an area by the size of the area. • Identify newtons per metre squared (N/m^2) as a unit of measuring pressure. • Relate pressure to force and area to describe everyday examples of high and low pressure. • Describe what causes pressure in a liquid. • Explore how depth affects the pressure in a liquid. • Explain how hydraulic systems transmit forces. • Describe what causes pressure in gases. • Explain how the temperature and the concentration of a gas affect the pressure. • Describe how atmospheric pressure varies with altitude. • Explain how liquid pressure causes upthrust.
Unit 4: The respiratory system	
4.1 The human respiratory system 4.2 Inhaling and exhaling 4.3 Gas exchange in the lungs 4.4 Blood 4.5 Respiration in cells 4.6 Health and smoking	• Identify the parts of the respiratory system and describe their functions. • Describe how the diaphragm and the ribs move when you breathe in and out. • Describe the structure of the alveoli and outline the process of gas exchange in them. • Name the main components of blood as being red blood cells, white blood cells, plasma, and platelets, and describe their functions. • Explain how red and white blood cells are adapted to perform their functions. • State that aerobic respiration occurs in the mitochondria of the cells and energy is released. • Describe the process of aerobic respiration using a word equation. • Distinguish between respiration and breathing. • Highlight the harms of smoking on human health.
Unit 5: Atoms	
5.1 Developing models of the atom 5.2 The structure of the atom 5.3 Pure substances	• Explain how the atomic model has changed over time by describing different models of the atom. • Name the subatomic particles that make up the atom. • Describe the structure of the atom. • Describe the subatomic particles that make up the atom. • Identify that the electrostatic attraction between the positive charges of protons and the negative charges of electrons holds the atom together. • Explain why atoms are electrically neutral. • Explain what a pure substance is, and state the difference between its everyday meaning and its meaning in chemistry. • Describe what an impurity is and give examples of common impurities found within substances. • Calculate the percentage purity of a substance. • Describe how the purity of a substance can be determined by its physical properties. • Identify methods of separating and obtaining a pure substance.

Science 2

Unit 6: Earth's climate

6.1 The layers of the atmosphere
6.2 Weather
6.3 Climate
6.4 Climate change
6.5 Global warming

- Describe how the Earth's atmosphere has changed since the formation of the Earth until now.
- Name the layers of the atmosphere in order.
- Identify the main gases that make up the atmosphere.
- Identify different types of weather.
- Use different equipment to record and describe the weather.
- Distinguish between weather and climate.
- Describe how the climate in an area is affected by its latitude, altitude, and distance from the sea.
- Name the main climate zones on Earth and describe their climate conditions.
- Evaluate data and evidence for climate change in the past.
- Describe some natural factors that cause climate change.
- Describe the greenhouse effect and the human activities that enhance it.
- Indicate the effects of climate change.
- List ways to reduce climate change.
- Identify the advantages and disadvantages of using different renewable and non-renewable resources.

Unit 7: Ecosystems and habitats

7.1 Ecosystem
7.2 Different habitats
7.3 Changes to ecosystems

- Define what an ecosystem is, and name some of the ecosystems on Earth.
- Define biotic and abiotic factors.
- Describe the interactions between biotic factors and those between biotic and abiotic factors of an ecosystem.
- Explain the difference between a habitat and an ecosystem.
- Identify different habitats in an ecosystem.
- Describe how living things are adapted to their habitat.
- Use sampling to collect information about the organisms that live in a habitat.
- Identify changes in an ecosystem and their causes.
- Describe the effect of toxic substances, such as DDT, being present in an ecosystem.
- Describe how invasive species have a negative effect on an ecosystem.

Unit 8: Light

8.1 Light travels in a straight line
8.2 Reflection of light
8.3 Refraction of light
8.4 Dispersion of light
8.5 Colours

- Demonstrate that light travels in straight lines using ray diagrams.
- Distinguish between transparent and opaque materials.
- Explain why shadows are formed.
- Describe how light is reflected off a flat surface.
- State the law of reflection.
- Draw and interpret ray diagrams of reflections of the light off flat surfaces.
- Distinguish between regular reflection off flat surfaces and diffuse reflection off irregular surfaces.
- Explore how light is refracted when it passes from one transparent medium to another.
- Explain that refraction happens because light travels at different speeds in different media.
- Draw and interpret ray diagrams of refraction of light when travelling from one medium to another.
- Explore how white light is separated into different colours using a prism and name the seven colours of the visible spectrum in order.
- Classify coloured light into primary and secondary colours.
- Explain how filters work by subtracting light.
- Describe how the selective absorption and/or reflection of light affects the observed colour of an object.

Science 2

Unit 9: The universe	
9.1 Asteroids 9.2 Galaxies 9.3 Exploring the universe	• Identify what asteroids are and describe how they are formed. • Explore how the size of the asteroid and its speed affect the size of the crater it forms. • Describe what a galaxy contains. • Identify that our solar system is part of a spiral galaxy called the Milky Way. • Classify galaxies as spiral, elliptical or irregular. • Identify that a light year is a unit used to measure astronomical distances and define the light year as the distance travelled by a beam of light in one year. • Calculate the length of a light year in kilometres. • Describe how the universe began and how it changes over time.
Unit 10: Reactions	
10.1 Reactions between metals and acids 10.2 Reactions between metals and oxygen 10.3 Reactions between metals and water 10.4 Endothermic reactions and processes 10.5 Exothermic reactions and processes	• Describe the reactions between metals and acids, and recognise that some metals do not react with acids. • Compare the reactivity of some metals with acids. • Describe the reactions between metals and oxygen. • Compare the reactivity of some metals with oxygen. • Describe the reactions between metals and water, and identify some inert metals. • Compare the reactivity of some metals with water. • Define what endothermic reactions are. • Distinguish between endothermic reactions and processes. • Give examples of how endothermic reactions and processes are used in everyday life. • Define what exothermic reactions are. • Destinguish between exothermic reactions and processes. • Give examples of how exothermic reactions are used in everyday life. • Determine whether a reaction is exothermic or endothermic by measuring the temperature change.
Unit 11: Nutrition and health	
11.1 Human growth and development 11.2 Nutrients 11.3 Energy needs 11.4 Effects of a poor diet 11.5 How the body moves	• Describe how fertilisation creates a zygote that develops into an embryo. • Distinguish between growth and development and describe their stages in the human life cycle. • Define nutrients and highlight the importance of water and fibre for our bodies. • Identify carbohydrates, proteins, fats, vitamins, and minerals as nutrients, give examples of foods that contain them and explain how they help our bodies. • Use food labels to identify the ingredients and energy in foods. • Explain that having a balanced diet means eating food containing all nutrients in the right amounts. • Explain that organisms require energy for essential processes in an amount depending on their activity, and state that food is a store of energy measured in kilojoules (kJ) or kilocalories (kcal). • Describe health problems and deficiency diseases caused by having an unbalanced diet, and highlight the importance of exercise for human health. • Describe how antagonistic muscle pairs work together. • Describe the movement in hinge, and ball-and-socket joints.

Unit 12: Magnetism	
12.1 Properties of magnets 12.2 Magnetic fields 12.3 Electromagnets 12.4 Uses of electromagnets	• Describe the properties of magnets. • Classify materials as magnetic or non-magnetic. • Explain how a magnetic object will become a magnet if we stroke it with a magnet. • Identify that the Earth's magnetic south pole is near the geographic North Pole, which is why the north pole of a compass needle always points towards it. • Define a magnetic field. • Draw and interpret magnetic field lines around a magnet and between two magnets. • Identify that the Earth's magnetic field is similar to the field produced by a large bar magnet. • Describe how the Earth's magnetic field is produced by the movement of Earth's liquid outer core. • Identify the components of an electromagnet. • Explore how the number of turns in the coils, the electric current in the coil and the material of the core affect the strength of the electromagnet. • Identify some applications of electromagnets.

Science 3

Lessons	Learning objectives
Unit 1: Energy transfer	
1.1 Density of solids, liquids and gases 1.2 Temperature and heat 1.3 Explaining temperature and heat with the particle model 1.4 Heat and changes of state 1.5 Methods of heat transfer	• Define density as the mass per unit volume of a substance. • Calculate the density of an object by dividing the mass of the object by its volume. • Identify the kg/m^3 and the g/cm^3 as density units. • Predict whether a substance will float or sink when placed in water using the value of density. • Define heat as the dissipation of energy from a hotter object or place to a cooler one. • Describe energy transformations using the law of conservation of energy. • Differentiate temperature from heat. • Explore how the change in temperature is affected by the mass of the object being heated. • Relate temperature to the average kinetic energy of particles and thermal energy to the total kinetic energy of all the particles. • Describe changes of state in terms of the arrangement, movement and energy of particles. • Explain how evaporation causes a liquid to cool. • Explore the factors that affect the rate of evaporation.

Science 3

Unit 2: The Periodic Table	
2.1 The structure of the atom 2.2 Electron arrangement and the Periodic Table 2.3 Groups and periods in the Periodic Table 2.4 Ionic bonds 2.5 Covalent bonds	• Recognise and describe the structure of a neutral atom. • Define the atomic number and mass number of an atom. • Calculate the number of subatomic particles in different atoms and isotopes. • Relate the mass of an atom to the number of subatomic particles in its nucleus. • Describe how the elements are arranged in the Periodic Table. • Understand the link between the group number and the period number of an element and the arrangement of its electrons. • Describe trends in properties of elements within groups in the Periodic Table. • Describe how the properties of elements change within periods in the Periodic Table. • Relate the electron arrangement of elements within the same group to their properties. • Explain how positive and negative ions are formed and how they form ionic bonds. • Relate chemical reactivity to an atom's electron arrangement. • Relate the structure of ionic substances to their properties. • Describe how covalent bonds are formed using dot and cross diagrams. • Explain what a molecule is. • Relate the structure of covalent substances to their properties. • Describe the structures of diamond and graphite as two different forms of carbon. • Compare the physical properties of diamond and graphite in terms of their bonding and structure. • Compare the properties of ionic to covalent compounds.
Unit 3: Photosynthesis	
3.1 The process of photosynthesis 3.2 The structure of the leaf 3.3 How photosynthesis can be affected 3.4 Minerals for healthy growth	• Describe how plants use light energy to produce carbohydrates through the process of photosynthesis. • Write the word equation for photosynthesis. • Explain why photosynthesis is important for life on Earth. • Identify that photosynthesis happens in chloroplasts. • Describe how leaves are adapted to carry out photosynthesis. • Indicate the factors that affect the rate of photosynthesis. • Experiment on how light intensity affects the rate of photosynthesis. • Explain the importance of minerals for plant growth.
Unit 4: Climate change	
4.1 The recycling of carbon 4.2 Changes in the amount of carbon dioxide in the atmosphere 4.3 Effects of climate change	• Describe how carbon is recycled by passing through organisms and depict this in flow diagrams. • Explain the importance of carbon recycling for living organisms. • Describe how fossil fuels are formed and identify combustion as the process that releases carbon dioxide into the atmosphere. • Describe the key steps of the carbon cycle and depict them in diagrams of the carbon cycle. • Identify human activities and natural processes that affect the carbon cycle. • Describe how asteroid collisions with Earth cause climate change and mass extinction. • Outline the impacts of climate change on the environment.

Science 3

Unit 5: Transport and excretion	
5.1 Plants need water 5.2 Transpiration 5.3 Excretion in plants and humans 5.4 The urinary system	• Describe how water is transported in plants through the roots, up the stem and finally to the leaves. • Explain the importance of water in plants. • Describe the process of transpiration. • Explain the effect of temperature, humidity, wind and light intensity on the rate of transpiration. • Name excretory products of plants and the human body. • Identify the parts of plants and body organs responsible for excretion. • Differentiate solid wastes from excretory products. • Name the main parts of the urinary system and describe their function. • Describe ways to keep the urinary system healthy.
Unit 6: Reactions	
6.1 The reactivity series 6.2 Displacement reactions 6.3 Making salts 6.4 Conservation during chemical reactions	• Identify and explain how the reactivity series is constructed. • Predict the position of a metal in the reactivity series based on its reactivity with water, oxygen or an acid. • Describe displacement reactions, and write their word equations. • Predict the outcome of a displacement reaction based on the reactivity series. • Describe different methods of making salts and how to separate them from the other product(s) of the reaction. • Use symbol equations to describe chemical reactions. • Show how atoms are rearranged during chemical reactions. • State the law of conservation of mass and use it to calculate the masses of the products and reactants of simple chemical reactions. • Describe how the law of conservation of energy is applied during chemical reactions.
Unit 7: Human reproduction	
7.1 The human reproductive system 7.2 From fertilisation to birth 7.3 Being healthy during pregnancy	• Name the main components of the male and female reproductive systems and describe their functions. • Identify puberty as the stage in the life cycle of humans when the reproductive system of males and females becomes mature. • Describe how the process of fertilisation occurs. • Outline the development of a foetus during pregnancy. • Indicate factors that affect the growth of the foetus.
Unit 8: Sound waves	
8.1 Loudness of sound 8.2 Pitch of sound 8.3 Interference	• Define amplitude of a sound wave and recognise it on a waveform. • Relate the loudness of a sound to the amplitude of the sound wave. • Define the frequency of a sound wave. • Compare the frequency of different sound waves by their waveforms. • Relate the pitch of a sound to the frequency of the sound wave. • Describe the effects of wave interference and interpret waveforms of waves reinforcing or cancelling each other.
Unit 9: Stars, the Moon and the Earth	
9.1 The formation of stars 9.2 The origin of the Moon 9.3 Plate tectonics	• Identify that a nebula is a cloud of dust and gas, mainly hydrogen, in space. • Describe how stars are formed in nebulae. • Describe different theories about how the Moon formed and state the evidence that supports or contradicts them. • Recognise that the giant impact hypothesis is the most prevalent theory for the formation of the Moon. • State the evidence that supports there being tectonic plates and their movement on Earth. • Describe how convection currents cause the movement of the tectonic plates.

Science 3

Unit 10: Electricity

10.1 Electric current and voltage 10.2 Electrical resistance 10.3 Series circuits 10.4 Parallel circuits 10.5 Everyday circuits	• Recognise current as the flow of electrons and relate voltage to energy from the power supply. • Identify the volt (V) as the unit of voltage and measure it with a voltmeter. • Explore how adding cells affects current. • Define electrical resistance and explain its effect on charge flow in a circuit. • Calculate resistance by dividing voltage by current. • Identify the ohm (Ω) as the unit of resistance. • Apply Ohm's law to calculate current, voltage, and resistance. • Measure current and voltage in series circuits and investigate how current is the same all around a series circuit, and how voltage across components in a series circuit adds up to the supply voltage. • Explore how adding bulbs in series affects current, and give an explanation using resistance. • Measure current and voltage in parallel circuits and investigate how voltage across the branches of a parallel circuit is the same and how current is shared between the branches. • Explore how adding branches to a parallel circuit affects the current passing through the power supply and give an explanation using resistance. • Interpret, draw and construct circuit diagrams of everyday circuits. • Compare series and parallel circuits.

Unit 11: Rates of reaction

11.1 Determine the rate of reaction 11.2 Rates and concentration 11.3 Rates and surface area 11.4 Rates and temperature	• Define the term rate of reaction and describe ways of measuring the rate of reaction through the amount of reactant used or the amount of product formed. • Draw and interpret graphs showing the production or consumption of a substance over time. • Explain why the rate of a reaction changes using the particle model. • Explore how the concentration of a reactant affects the rate of reaction. • Use the particle model to explain why the rate of reaction increases when the concentration of a reactant increases. • Explore how the surface area of a reactant affects the rate of reaction. • Use the particle model to explain why the rate of reaction increases when the surface area of a reactant increases. • Explore how the temperature of a reactant affects the rate of reaction. • Use the particle model to explain why the rate of reaction increases when the temperature of a reactant increases.

Unit 12: Genetics

12.1 Chromosomes 12.2 Inherited and environmental variation 12.3 Inheritance 12.4 Selective breeding 12.5 Natural selection and evolution	• Describe the structure of chromosomes, and identify the genes as part of it. • Recognise that genes control a certain characteristic of the organism. • State that a normal human cell contains 46 chromosomes. • Describe how we form a karyotype by arranging chromosomes in pairs. • Define within-species variation and distinguish between variation caused by genes and variation caused by the environment. • Recognise that mutations cause variation. • Recognise that the X and Y chromosomes in humans are the sex chromosomes and explain how sex is determined. • Use genetic diagrams to determine different characteristics and the sex of a human. • Describe the process of selective breeding. • Outline the advantages of selective breeding. • List the evidence that Darwin used to propose the theory of evolution by natural selection. • Describe the process of natural selection, and explain how natural selection benefits organisms and leads to their evolution. • Give examples of natural selection in action. • Explain how changes in the environment can cause species to become extinct if they cannot adapt to those changes.

Questions about prior knowledge related to the course material of this unit.

7 Classification of living things

Science around us

Some species show greater variation between individuals than other species. In some species, the individuals are very similar to each other. This can be caused by many different factors including human activity. The individuals of the European bison that live today are all offspring of 12 individuals that survived in the early 20th century. Because of extensive hunting, the European bison was almost extinct at that time. This means that the offspring which live today all have very similar characteristics to each other.

Another example of a species with individuals with very similar characteristics is the northern elephant seal. The northern elephant seal almost became extinct due to hunting and about 50 individuals survived in the early 19th century. All individuals of the northern elephant seal that live today are offspring of those 50 individuals and show a low variation between them. Low variation in a species can be dangerous for the survival of the species, since all individuals might not be able to adapt to environmental changes or diseases.

Revise your knowledge:
- What is adaptation?
- What is meant by the characteristics of an organism?
- What is a skeleton?
- What is the backbone?
- What is an exoskeleton?

Learning objectives:
- Identify living, once alive and never alive things based on the seven life processes.
- Classify organisms into plants and animals and these into smaller groups.
- Classify organisms into vertebrates and invertebrates and these into smaller groups.
- Define the term species.
- Identify variation within species.
- Use and create simple dichotomous keys to identify organisms.

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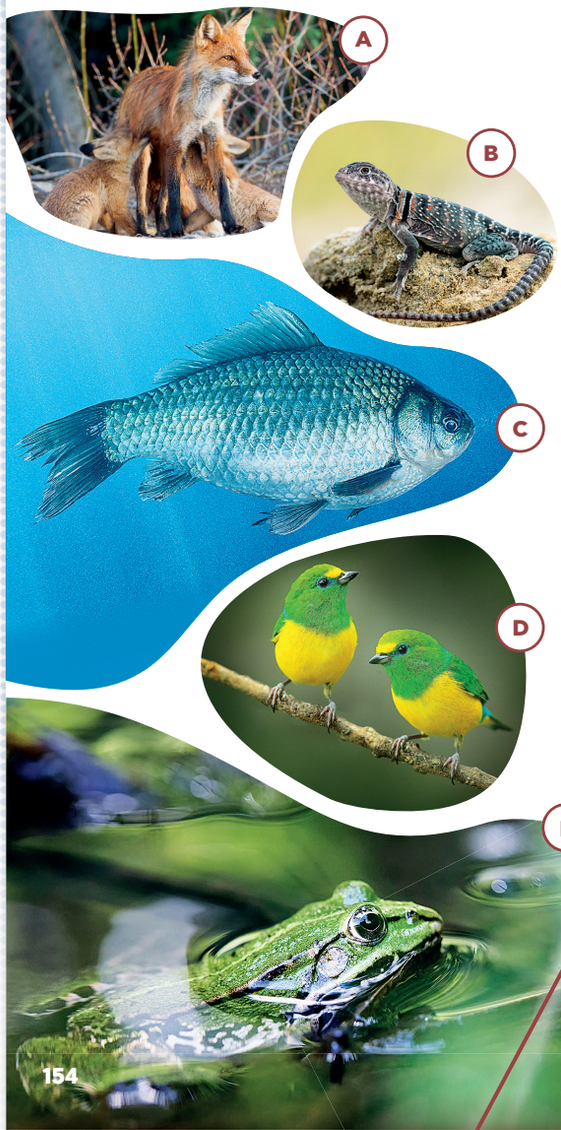
A brief text that links the course material with everyday life.

The key concepts students will learn in this unit.

7.3 Classifying animals

Vertebrates

Vertebrates belong to the animal kingdom, and they are all animals which have an inner skeleton with a backbone. There are different groups of vertebrates classified by their characteristics.



Mammals: They are animals with fur or hair on their bodies. They give birth to young, which feed from the milk their mother produces. Mammals have lungs to breathe.

Reptiles: They are animals with scales, and their skin is dry. They live on land and breathe with lungs. Sometimes we can also see them in the water, but they lay their eggs only on dry land. The shell of their eggs feels like leather.

Fish: They have scales and fins and they live in the water. They lay soft and jelly-like eggs in the water and they breathe with their gills.

Birds: They have feathers, wings and a beak. Most of them can fly and they breathe with their lungs. Birds lay eggs with a hard shell.

Amphibians: They have a wet, smooth skin through which they can breathe. They also have lungs to breathe, and they spend time both on land and in the water. However, they lay their eggs only in water and they live in the water when they are young. Their eggs are soft and jelly-like.

? In which group would you classify a crocodile?

All the theoretical background the student needs is written in a concise text that contains all the necessary knowledge including terminology and fine points.

Questions that promote active learning and accompany the theory section.

7.3

Invertebrates

Invertebrates are a group of animals of the animal kingdom. There are several groups of invertebrates with a variety of characteristics. However, all invertebrates do not have an inner skeleton or a backbone.

Molluscs: They are animals with soft bodies, but with strong muscles. Many of them have a shell which protects them. Sometimes this shell might be inside their body.

Jellyfish: They are animals that live in water. Their body is soft and jelly-like and they have long tentacles which have stinging cells. They use these tentacles to get their food in the water.

Annelids: They are worms, like the earthworm. Their bodies are soft and segmented.

Flatworms: They have soft flat bodies which are not segmented.

Nematodes: They are worms that have soft and thin bodies, which are not segmented.

Echinoderms: They are animals that live in the water, like the starfish. Their body is hard on the outside and covered with spines.

Arthropods: They are animals with a segmented body and legs with joints. They also have a hard exoskeleton. There are many animals in this group. Two smaller groups of arthropods are arachnids and insects. Arachnids, like spiders, do not have antennae and they have eight legs in total. Insects, like bees, have antennae, they have six legs and they might also have wings.

? In which group would you classify an octopus?

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Pictures designed to complement the theory section.

Section for students to expand their acquired knowledge in different contexts.

7.3 Classifying animals

Dive into Science

What is a *mus musculus*?

Mus musculus is the scientific name of what we know as the common mouse. Scientists have been trying to classify organisms into groups for many years. Today they use a classification system which was invented by Carl Linnaeus, a Swedish scientist, who lived in the 18th century. He gave each organism a name with two Latin words, like the mus musculus. This naming system is still used today.

Activities

1. Answer the questions.

a. Which five groups of vertebrates do you know?

_____

_____

b. Which seven groups of invertebrates do you know?

_____

_____

2. Complete the table, as in the example.

Vertebrate groups	Characteristics	Reproduction	Breathing
birds	*feathers, beak, wings*	*lay eggs*	*lungs*
		give birth	
fish			
	scales, dry skin		
	wet smooth skin		skin and lungs

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This section includes scientific enquiries, in which students have the opportunity to plan investigations, make predictions, observations and comparisons, use equipment to take measurements, record and display results, discuss and draw conclusions, construct models or do research about a topic. These investigations are usually carried out in groups or pairs. Teachers support students during these activities, but they do not transfer knowledge.

In this section, students consolidate their newly acquired terminology and knowledge of concepts and processes from each lesson and reinforce essential scientific skills through meaningful activities.

3. Draw lines to match.

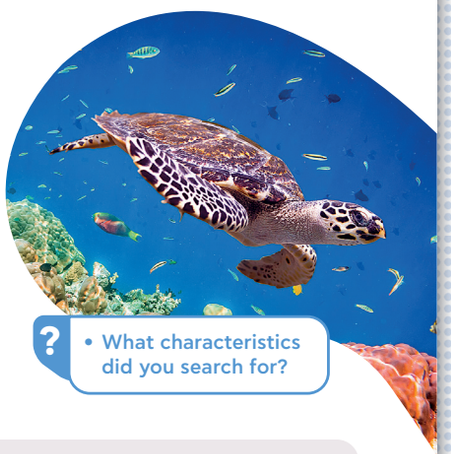
Flatworms	are soft and have long tentacles with stinging cells.
Jellyfish	have segmented bodies with legs with joints and a hard exoskeleton.
Arthropods	have hard bodies on the outside covered with spines.
Annelids	are worms with soft, thin and non-segmented bodies.
Molluscs	are worms with soft and flat non-segmented bodies.
Echinoderms	are worms with soft segmented bodies.
Nematodes	have soft bodies with strong muscles.

Explore Science

Investigating animal classification

1. Choose one group of animals out of: mammals, reptiles, birds, fish, amphibians, molluscs and arthropods.
2. Do some research on this group of animals.
3. Search for the characteristics of each group and describe if it is a vertebrate or invertebrate group.
4. Find two animals that belong to this group and describe them.

Make a presentation of your findings and discuss them with your class.



? • What characteristics did you search for?

Keywords

mollusc
jellyfish
tentacle
stinging cell
annelid
worm
flatworm
nematode
echinoderm
starfish
arthropod
arachnid

Overview

- Vertebrates are all animals which have an inner skeleton with a backbone.
- Invertebrates are all animals without an inner skeleton nor a backbone.
- Vertebrates are grouped into mammals, reptiles, fish, birds and amphibians.
- Invertebrates are grouped into molluscs, jellyfish, annelids, flatworms, nematodes, echinoderms, and arthropods.

The significant terminology and words which are needed for each lesson, which students are expected to learn. The keywords are highlighted once in the content of each lesson and listed in the Glossary.

These points summarise the scientific concepts that students have learnt in each lesson.

7 Unit Highlights

7

Dead organisms
- They were once alive but not any more

Seven life processes
- Only living organisms carry out all the seven life processes

- Nutrition
- Growth
- Movement
- Respiration
- Reproduction
- Excretion
- Sensitivity

Classification
- All organisms are classified into kingdoms
- Kingdoms are then divided into smaller groups depending on the characteristics of organisms

Animal kingdom
- Vertebrates: mammals, reptiles, fish, birds, amphibians
- Invertebrates: molluscs, jellyfish, annelids, flatworms, nematodes, echinoderms, arthropods (insects and arachnids)

Plant kingdom
- Ferns
- Mosses
- Conifers
- Flowering plants

Species
- Has individuals with similar characteristics that can have fertile offspring
- A fertile offspring can have its own offspring

Extinction
- When a species does not exist any more
- When a species cannot adapt to a changing environment or loss of habitat
- Because of natural processes or human activities

Variation
- Individuals of a species are not identical, but similar
- There is variation within a species

Identification keys
- Used to identify organisms
- Are dichotomous with yes/no questions

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Unit Highlights are visual tools which organise and present the scientific concepts of each unit. These scientific concepts are presented in boxes.

Review activities cover ideas from the whole unit. These activities are designed to assist students' learning and to help teachers assess students' progress.

7 Review

7

1. Circle the correct answer.

a. A flying bird is a **living / non-living / dead** thing.
b. Something that was once alive but not any more is a **living / non-living / dead** thing.
c. Something that is alive is a **living / non-living / dead** thing.
d. A rock is a **living / non-living / dead** thing.
e. A wooden chair is a **living / non-living / dead** thing.

2. Complete the sentences with the words in the box.

nutrition reproduction growth movement sensitivity respiration excretion

a. The process of _____ happens when a human is sweating.
b. A plant becoming bigger and bigger shows the process of _____.
c. The process of a mother elephant giving birth is _____.
d. The process of _____ happens when an animal is eating a plant.
e. A bird flying in the sky does the process of _____.
f. A process that gives energy to an organism and happens in all of its cells is _____.
g. An organism responding to a change in temperature does so because of the process of _____.

3. Match. Write 1 or 2 in the boxes. Then answer the question.

vertebrates	A
conifers	B
mosses	C
organisms that photosynthesise	D
organisms that move from place to place	E
invertebrates	F
flowering plants	G
organisms that eat plants or other animals	H
ferns	I

1. animal kingdom
2. plant kingdom

What is common to all organisms in the plant and animal kingdom?

_____

4. Draw lines to match.

Mosses	have flowers and roots, and they reproduce mainly with seeds.
Ferns	can grow on rocks, and they do not have real roots. They reproduce with spores.
Conifers	have leaves that look like needles and they reproduce with seeds which are inside a cone.
Flowering plants	do not have flowers, but they have roots. They reproduce with spores.

5. Read the sentences and write Yes or No.

a. An arthropod is a vertebrate. _____
b. A bird has feathers, and it lays eggs. _____
c. Fish breathe with gills and they have a backbone. _____
d. A starfish is an echinoderm. _____
e. Jellyfish have a backbone and legs. _____
f. Annelids are insects. _____
g. Amphibians lay eggs in water. _____
h. Reptiles lay eggs in water. _____
i. A spider is an arachnid not an insect. _____

6. Answer the questions.

a. What is a species?

_____

b. What happens when a species goes extinct?

_____

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Work like a scientist

Scientific method

In order to understand and explain the processes and things that happen around them, scientists base their thinking and research on the scientific method. Applying the scientific method as an investigation method ensures that scientists have a better chance of reaching reliable results to support or reject their hypotheses. The steps of the scientific method include:

1 Observe
The beginning of the scientific method is something you observe through your senses or even some background information you collect about a topic.

2 Ask a question
Ask a question based on what you observe and you want to learn about. The question must be testable and should be answerable through scientific investigation. The question also should be exact and accurate and not answerable through personal opinion.

3 Form a hypothesis
Research and gather information about the topic of your question and form a hypothesis that can be tested.

4 Test the hypothesis
Make a prediction based on your hypothesis. Then plan an investigation to test your prediction to see if your hypothesis is supported by evidence or not. After that, carry out the investigation you planned and collect your data.

5 Analyse your results and draw a conclusion
Analyse and interpret the obtained results from your investigation using the appropriate tool. Draw a conclusion based on your results that answers your initial question and determine if your results can be used as evidence to support or reject your hypothesis. If the hypothesis is rejected, you must form another hypothesis and repeat the process from step 3.

6 Share your results
Report the results of your investigation and communicate them to others.

A hypothesis can become a theory when a lot of evidence has been found to support it and it is repeatedly found to be accepted through different investigations from different groups. But even a theory does not always remain the same. A theory can evolve, adapt, be changed or be rejected and replaced by another theory.

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The Work like a scientist section provides students with information about the steps of the scientific method, how to plan and conduct scientific investigations, how to take measurements and how to record and present their results. You can refer students to this section at the beginning of the year as well as during the year, as advised in the Teacher's Book or when you consider it would be to students' benefit.

All the laboratory equipment and special materials used throughout the book are presented with pictures to help students visualise them.

The Glossary contains all the keywords with comprehensible and age-appropriate definitions to ensure a gradual development of scientific terminology and mastery of communication skills. Additional vocabulary items included from lessons are marked with an asterisk (*).

Laboratory equipment and materials

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Glossary

abbreviation*: a short way to write something
absorb (for sound): to take in and stop sound instead of reflecting it or allowing it to pass through
acid: a chemical substance that has a sour taste and pH value between 0 and 7
acid rain: the rain that is more acidic than normal rain due to air pollution
acidic: being a substance that contains acids; being a solution of an acid
adaptation: the features of a type of cell that are different to those of other types of cell and that allow it to carry out a particular function
agar jelly: a jelly substance used in the laboratory to grow microorganisms usually, in a Petri dish
alga (pl. algae): microorganism found in water that can photosynthesise
alkali: a base that dissolves in water
alkaline: being a solution of an alkali
alloy: a mixture of two or more different elements, at least one of which is a metal
ammeter: a device that measures the size of an electric current
ampere (A): the unit of electric current
analogue: a device that displays the measured value using a pointer that moves through a range of numbers
annelid: a group of animals of worms with segmented bodies
arachnid: a group of arthropods with eight legs and without antennae, like a spider
arrangement: a specific way in which something is put in order
arthropod: invertebrate animal group, which includes insects, which have segmented bodies and legs with joints
ash: the particles that are left after something has burnt
asteroid belt: a location between the orbits of Mars and Jupiter where we can find most of the asteroids in our solar system
atom: the smallest particle of an element
atomic theory: the theory according to which the building blocks of matter are atoms
attract: to pull something towards it
base: a chemical substance that has a bitter taste, a soapy feel and a pH value between 7 and 14
basic: being a substance that contains bases; being a solution of a base
battery: a source of electrical energy, made of two or more cells connected one after the other
boiling: the change of state to a gas throughout the whole liquid
boiling point: the temperature at which a liquid boils and changes into a gas
bond (noun): a force that holds atoms together
bond (verb): to join atoms chemically so they are held strongly together in a molecule
brass: an alloy of copper and zinc
break down: to split a compound into simpler substances
brittle: breaks easily into pieces
bronze: an alloy of copper and tin
bulge: something that sticks out from a surface and is round in shape
burette: special laboratory equipment used for adding measured volumes of a liquid
carbon dioxide (CO_2): a gas that is in the air; a compound of carbon and oxygen atoms
carnivore: an animal that eats only animals
cell: the smallest building unit of living organisms; a circuit component that stores chemical energy which can be transferred as electrical energy round the circuit
cell membrane: a thin layer on the outside of the cell that controls the flow of substances into and out of the cell
cell wall: a strong part of certain cells found on their outside (e.g. in plant cells)
cellulose: a substance from which cell walls of plant cells are made
cementation: the process by which dissolved materials like sediments stick together forming sedimentary rocks
chemical energy: the energy that is stored in fossil fuels, food, batteries, etc.
chemical formula (pl. chemical formulae): a way to represent the molecule of a substance, using chemical symbols and the number of the atoms the molecule consists of written in subscript
chemical property: a property that can only be observed and measured through chemical changes
chemical reaction: an event in which one or more substances turn into one or more new substances
chemical symbol: a unique symbol, formed from capital and lowercase letters of the latin alphabet, used to represent each element
chlorophyll: a substance which is important for photosynthesis and which makes chloroplasts green
chloroplast: a part of some plant cells in which photosynthesis happens and which is green because it contains chlorophyll
cilium (pl. cilia): structures that are part of the cytoplasm of some cells and which look like hairs

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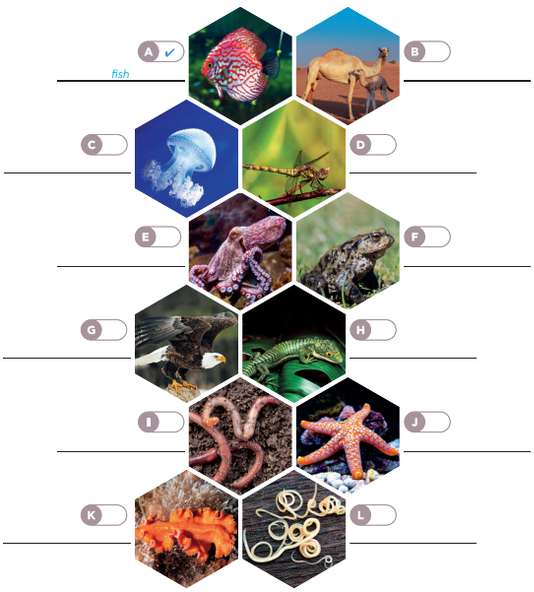
7.3

7.3 Classifying animals

1. Look at the pictures and tick (✔) the vertebrates. Then write the name of the vertebrate or invertebrate group the animal in the picture belongs to, as in the example.



2. Complete the sentences with the words in the box.

vertebrates | invertebrates | jellyfish | muscles | skin | mammals | fish

a. Birds and reptiles are _____.
b. _____ have fur and give birth to young.
c. Amphibians breathe with their lungs and through their _____.
d. Arthropods and jellyfish are _____.
e. Molluscs have soft bodies with strong _____.
f. _____ breathe with their gills.
g. _____ have long tentacles.

3. Describe how amphibians and reptiles are different, but also how they are similar.

4. Describe how molluscs and jellyfish are different, but also how they are similar.

5. A spider is not an insect. Why?

7

7 Science lab

You found a notebook of a scientist who was observing and taking pictures of animals in nature. Look at the pictures and write which groups these animals belong to, as in the example.

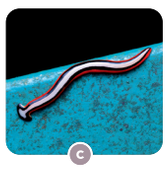

A

It has six legs and wings. It can jump high and it has antennae.

invertebrate
arthropod
insect


B

It has fur and it gives birth to young.


C

It is small with a flat and soft body. Its body is not segmented.


D

It has an exoskeleton, a long tail and eight legs. Its body is segmented and its legs have joints.

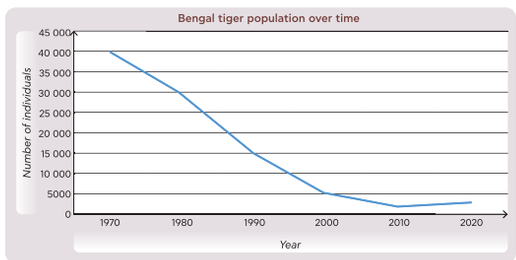

E

It can be found on land and in water. It has scales and it lays eggs only on the land.


F

It can be found in water, its body has muscles but it is soft. It does not have a backbone.

One of the animal species that the scientist observes is called the Bengal tiger. According to his notes, the Bengal tiger population has changed over the years, as shown in this graph. Look at the graph and answer the questions.



a. What has happened to the population of the tiger over the years?

b. What will happen if the population of the tiger becomes zero?

At the end of each unit the Workbook contains a Science lab activity which the teacher can assign as homework. This activity helps students be more creative and use all the knowledge they have gained from the unit in a more complex and combined activity.

Unit map 7

Classification of living things

Scientific information

Our planet is about 5 billion years old and life on Earth has been around since about 3.5 billion years ago. It is estimated that today there are about 8 million species on our planet that can be found from the deepest oceans to the highest mountains. There is so much diversity between living organisms that scientists have been classifying organisms for years in order to study them and they still haven't classified them all. Classification happens through the comparison of one organism to another, however it is not as simple as it might sound. There is a need to have a universal classification system to recognise organisms and scientists have had disagreements as to how to create such a system.

The system of classification agreed upon and used today is based on the work of Carolus Linnaeus who lived in the 18th century. In this system, all living organisms are classified into different subdivisions according to their characteristics. The largest division is into kingdoms. Linnaeus only described two kingdoms, the plant and the animal kingdom, however today with the development of technologies like the microscope there are more kingdoms described. Scientists have argued over how many kingdoms there are for a long time. The most accepted number of kingdoms is five, the kingdoms of animals, plants, fungi, monera (prokaryotes), and protista.

After the division into kingdoms, organisms are further divided into phylum, class, order, family, genus and finally into the smallest taxonomic group of species. According to this classification system, each organism has a unique Latin name consisting of two words. For example, humans are named *Homo sapiens*, Homo is the genus and sapiens is the species. In the example of the common mouse, it is called *Mus musculus* and its classification is the following: kingdom: animal, phylum: chordata, class: mammals, order: rodents, family: Muridae, genus: Mus, species: *musculus*. The classification is based on the characteristics of each species. There are smaller subgroups after the classification into species called subspecies or breeds. We usually see such subgroups in animals that have been bred by humans such as pets like cats and dogs. However, breeds are not officially recognised classification divisions, instead they are practical terms.

Defining a species is not an easy task. In fact, it has been a very hard task for scientists to define species. The definition of a species is a group of animals with similar characteristics which can reproduce with each other and have fertile offspring. In practice there are many issues with this definition. First, animals may live in very different geographic locations so we cannot easily know if they can reproduce and have fertile offspring. Second, species evolve. The species of the past are not the same today. Evolution is key in understanding how species change and evolve with time.

Today, some of the issues with defining species are being solved by modern technologies including DNA sequencing. Scientists use the DNA of each organism or species, and they can 'read' its sequence and compare it to other organisms. By doing this they can see the degree of similarity between organisms and also understand if organisms have a similar ancestor through evolution. All in all, even if technologies and categories change, the logic behind classifying organisms has stayed the same through the years. The classification of living organisms is a very useful tool to recognise organisms according to their characteristics in order to study them in detail.

Language focus

There are plenty of new terms in this unit. Spend the time needed to study them in detail and ensure you illustrate their use orally and in writing during the following lessons. Give Ss motivation and opportunities to use these terms themselves.

annelid: a group of animals of worms with segmented bodies
arachnid: a group of arthropods with eight legs and without antennae, like a spider
arthropod: invertebrate animal group, which includes insects, which have segmented bodies and legs with joints

The first pages of each unit contain all the scientific background information that a teacher may require in a lesson.

The language focus section contains all the keywords with definitions. Additional vocabulary items included in lessons are marked with an asterisk (*). At the same time, we inform the teacher about possible problems that may arise when using some terms in the Be aware section.

classification: the process of sorting organisms or things into groups according to shared characteristics
cone: a dry part of conifer plants in which the reproductive structures, like the seeds, are kept
conifer: a group of plants that have needle shaped leaves and make cones in which seeds are kept
dichotomous (for identification keys): when the questions of the key have only one of two answers, yes or no
earthworm*: a common type of an annelid worm that lives in the ground
echinoderm: invertebrate animal group which live in the water and the bodies of which are hard outside and covered with spikes
excretion: the process of removing waste products from the body
external: referring to the outside part of something
extinction: the situation in which there are not any individuals of a species alive; when a species goes extinct
fern: a group of plants which reproduces with spores and does not have flowers
fertile: being able to reproduce and create new organisms
flatworm: a group of worms with flat non-segmented bodies
growth: the process of changing to be larger in size, height and weight
identical: the same in every detail
identification: the process by which something is recognised
identification key: a way to identify living organisms using questions at each step about their characteristics
individual: one single organism
infertile: not being able to reproduce and create new organisms
invertebrate: an animal that does not have an inner skeleton with a backbone
jellyfish: invertebrate group of animals that live in the water and have a soft and jelly-like body with tentacles and stinging cells
kingdom: the largest group into which living organisms are classified
mollusc: invertebrate animal group with a soft body with strong muscles
moss: a group of plants that do not have real roots or flowers and reproduce with spores
movement: the process of something or someone moving
nematode: a group of worms with soft, thin and non-segmented bodies
nutrition: the process of a living thing getting or making the substances it needs
offspring: organisms created by the reproduction of their parents
reproduction: the process of producing new living things of the same kind; having young
respiration: the process of getting energy from food which happens in every cell of an organism
sensitivity: the ability of living organisms to respond to a change in their environment
species: a group of organisms of the same type with similar characteristics which can reproduce with each other and create new organisms that can also reproduce
spore: a reproductive body of some plants like mosses
starfish: an invertebrate echinoderm animal that lives in the sea and has a star shape usually with five arms
stinging cell: a type of specialised cell found in some animals that contains chemicals which can harm other organisms when in contact
tentacle: a long and soft organ that can be found in jellyfish and other animals, they might seem like arms or antennae
variation: differences in the characteristics of organisms that might otherwise look very similar
vertebrate: an animal that has an inner skeleton with a backbone
worm: a type of invertebrate animal without arms or legs that usually moves by crawling

Be aware

- The word 'respiration' can have different meanings. In this unit, 'respiration' is the process of getting energy from food which happens in every cell of an organism. However, in everyday life this word can also mean the process of breathing.
- The word 'kingdom' can have different meanings. In biology 'kingdom' is a classification term of a large group of organisms with certain similar characteristics, like the plant kingdom and the animal kingdom. However, in everyday life the word is also used to describe a territory governed by a king or queen.

7.1 The seven life processes

In this lesson, Ss will recognise the difference between organisms that are alive, organisms that were once alive and objects that were never alive. Then they will extend their knowledge of the seven life processes that define a living organism.

Learning Objectives
• Identify living, once alive and never alive things based on the seven life processes.
Scientific Enquiry Skills
• Investigate phenomena, objects, materials and living things in order to sort and classify them.
Keywords
For the presentation of the keywords, see the guidelines in the TB map. > **nutrition** > **growth** > **movement** > **respiration** > **reproduction** > **excretion** > **sensitivity**
Cross Curriculum Links (CCL)
• This lesson can be linked with lesson 3.1, as Ss already know that living organisms are made of cells which are the smallest units of life.
Materials and Resources
> RS Alive or not, WS b More practice > Explore Science: A3 white card (1 piece per group), coloured markers > More practice for higher-performing Ss: plastic cup (1 per S), limewater solution (50 *ml* per S), test tube (1 per S), straw (1 per S)
Common Student Preconceptions
• Ss may think that a characteristic of living things is breathing air. • Some Ss may confuse respiration with breathing. • Some Ss may not understand that plants also carry out all seven life processes.

The next pages contain an informative overview of the lessons of each unit. The learning objectives, scientific enquiry skills, keywords, Cross curriculum links, materials and resources needed as well as a list of students possible difficulties and/or preconceptions are provided in well-organised tables that enable the teacher to monitor the progression of knowledge and observe the structure of the scientific content.

7 Classification of living things

Prior knowledge
- Ss are familiar with the term 'adaptation'.
- Ss already know what is meant by the term 'characteristics' of an organism.
- Ss can recognise what a skeleton, backbone and exoskeleton are.

Science around us
- Draw Ss' attention to the Science around us section.
- Have a S read aloud each paragraph of the Science around us section.
- Be ready to support Ss with the pronunciation of the scientific words.
- Make sure a different group of Ss read the text aloud each time so that everyone has the chance to read throughout the school year.

Revise your knowledge:
- Ask Ss ***What is adaptation?*** (Accept all reasonable answers. Suggested answer: Adaptation is the changing of characteristics and/or the way an organism responds to things so that the organism can survive in an environment.), ***What is meant by the characteristics of an organism?*** (Accept all reasonable answers. Suggested answer: A characteristic is something that makes an organism different from another.), ***What is a skeleton?*** (A skeleton is all the bones inside a human's or animal's body.), ***What is the backbone?*** (The backbone is the line of bones in an animal's or human's back that are connected together.), ***What is an exoskeleton?*** (An exoskeleton is the hard outside part that covers, supports, and protects the body of some animals without an inner skeleton.).
- Allow Ss some time to think about their answers.
- Encourage Ss to express their opinions, and initiate a short discussion in class about their prior knowledge.
- Make sure that by the end of this discussion Ss have revised their prior knowledge of this topic.

Learning objectives:
- Have a S read aloud the learning objectives that will be covered in this unit.
- Encourage Ss to express their opinions, and initiate a short discussion in class about what they will learn in this unit.
- Make sure that by the end of this discussion Ss understand what this unit will be about.

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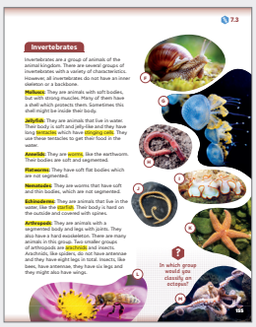
After the aggregate information about the unit, the presentation of the unit begins with the cover page. Here we can find the answers to the questions shown in the Revise your knowledge section.

7.3 Classifying animals



Invertebrates
- Draw Ss' attention to the theory section Invertebrates.
- Explain to Ss that invertebrates belong to the animal kingdom and that they do not have an inner skeleton or backbone.
- Point out to Ss that there are seven groups of invertebrates described in this lesson.
- Focus Ss' attention on picture F.
- Explain to Ss that in picture F, we can see an example of a mollusc.
- Explain to Ss that a mollusc has a soft body with strong muscles and (sometimes) a protective shell.
- Focus Ss' attention on picture G.
- Explain to Ss that in picture G, we can see an example of a jellyfish.
- Explain to Ss that jellyfish live in water. They have soft bodies with long tentacles with stinging cells.
- Focus Ss' attention on picture H.
- Explain to Ss that in picture H, we can see an example of an annelid.
- Explain to Ss that annelids are worms with soft segmented bodies.
- Focus Ss' attention on picture I.
- Explain to Ss that in picture I, we can see an example of a flatworm.
- Explain to Ss that flatworms have soft flat bodies which are not segmented.
- Focus Ss' attention on picture J.
- Explain to Ss that in picture J, we can see an example of a nematode.
- Explain to Ss that nematodes are worms with soft thin bodies that are not segmented.
- Focus Ss' attention on picture K.
- Explain to Ss that in picture K, we can see an example of an echinoderm.
- Explain to Ss that echinoderms live in water and their body is hard on the outside and covered with spines.
- Focus Ss' attention on picture L.
- Explain to Ss that in picture L, we can see an example of an arthropod.
- Explain to Ss that arthropods are animals with segmented bodies and joints in their legs.
- Point out to Ss that arthropods are further divided into arachnids which have eight legs and insects which have six legs, antennae and might also have wings.
- Be aware that at this point of the lesson there is an opportunity for you to recognise and then resolve any difficulty that some Ss may have telling the difference between insects and arachnids.
- Have a S read aloud each paragraph of the theory section Invertebrates.
- Focus Ss' attention on picture M.
- Explain to Ss that in picture M, we can see an octopus.
- Ask Ss ***In which group would you classify an octopus?*** (An octopus is an invertebrate because it has no backbone or inner skeleton. Its body is soft but with strong muscles therefore it belongs to the group of molluscs.).
- You can also ask Ss ***In which group would you classify an ant?*** (An ant is an invertebrate because it has no backbone. Its body is segmented and it has legs with joints. It therefore belongs to the group of arthropods.), ***What are the similarities and differences between a spider and a bee?*** (A spider and a bee are both invertebrates because they have no backbone and they belong to the invertebrate group of arthropods because they have segmented bodies and legs with joints. A spider has eight legs and no antennae and therefore it is an arachnid, while a bee has six legs, antennae and wings and it belongs to the group of insects.), ***Which invertebrates have tentacles with stinging cells?*** (Jellyfish are invertebrates which have tentacles with stinging cells.).
- Allow Ss some time to think about their answers.
- Encourage Ss to express their opinions, and initiate a short discussion in class.

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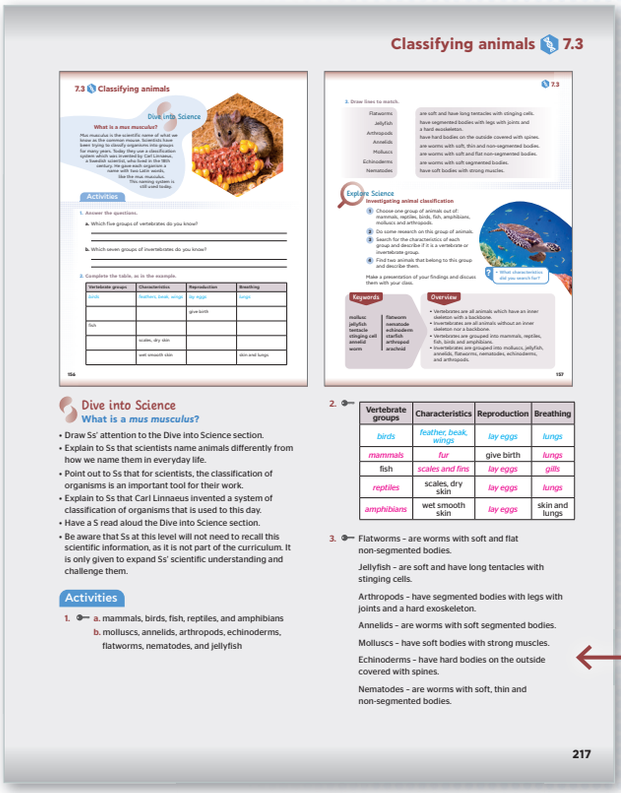
This section refers to the corresponding theory sections. During this phase, the teacher introduces the topic, while students begin to engage with the topic through questions, discussions, etc. Afterwards, questions arise in students' minds and prior knowledge (including preconceptions) is accessed. The identification of students' current conceptions and preconceptions is very important for conceptual development to take place. Students are encouraged to explain concepts in their own words and to listen critically to each other's explanations. Meanwhile, teachers can introduce specific scientific vocabulary and help students to use this vocabulary to explain the results and justify their explanations. Students should feel free to express themselves, and teachers should accept all thoughts, views and opinions expressed by students.



Classifying animals 7.3

Dive into Science
What is a *mus musculus*?

- Draw Ss' attention to the Dive into Science section.
- Explain to Ss that scientists name animals differently from how we name them in everyday life.
- Point out to Ss that for scientists, the classification of organisms is an important tool for their work.
- Explain to Ss that Carl Linnaeus invented a system of classification of organisms that is used to this day.
- Have a S read aloud the Dive into Science section.
- Be aware that Ss at this level will not need to recall this scientific information, as it is not part of the curriculum. It is only given to expand Ss' scientific understanding and challenge them.

Activities

1. a. mammals, birds, fish, reptiles, and amphibians
   b. molluscs, annelids, arthropods, echinoderms, flatworms, nematodes, and jellyfish

2.

Vertebrate groups	Characteristics	Reproduction	Breathing
birds	*feather, beak, wings*	*lay eggs*	*lungs*
mammals	*fur*	give birth	*lungs*
fish	*scales and fins*	*lay eggs*	*gills*
reptiles	scales, dry skin	*lay eggs*	*lungs*
amphibians	wet smooth skin	*lay eggs*	skin and lungs

3. Flatworms – are worms with soft and flat non-segmented bodies.

   Jellyfish – are soft and have long tentacles with stinging cells.

   Arthropods – have segmented bodies with legs with joints and a hard exoskeleton.

   Annelids – are worms with soft segmented bodies.

   Molluscs – have soft bodies with strong muscles.

   Echinoderms – have hard bodies on the outside covered with spines.

   Nematodes – are worms with soft, thin and non-segmented bodies.

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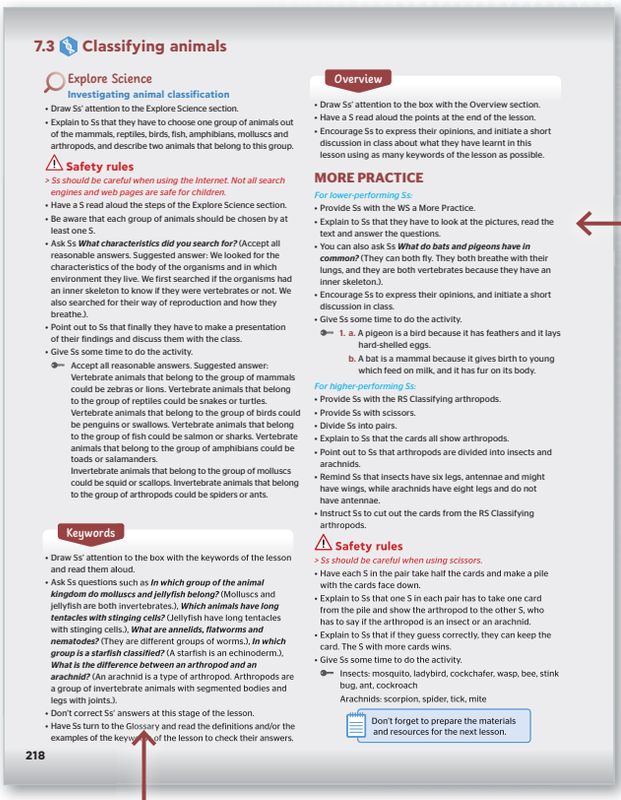
This section includes the key to the activities of the Student's Book.



7.3 Classifying animals

Explore Science
Investigating animal classification

- Draw Ss' attention to the Explore Science section.
- Explain to Ss that they have to choose one group of animals out of the mammals, reptiles, birds, fish, amphibians, molluscs and arthropods, and describe two animals that belong to this group.

Safety rules
> Ss should be careful when using the Internet. Not all search engines and web pages are safe for children.

- Have a S read aloud the steps of the Explore Science section.
- Be aware that each group of animals should be chosen by at least one S.
- Ask Ss ***What characteristics did you search for?*** (Accept all reasonable answers. Suggested answer: We looked for the characteristics of the body of the organisms and in which environment they live. We first searched if the organisms had an inner skeleton to know if they were vertebrates or not. We also searched for their way of reproduction and how they breathe.).
- Point out to Ss that finally they have to make a presentation of their findings and discuss them with the class.
- Give Ss some time to do the activity.

  Accept all reasonable answers. Suggested answer: Vertebrate animals that belong to the group of mammals could be zebras or lions. Vertebrate animals that belong to the group of reptiles could be snakes or turtles. Vertebrate animals that belong to the group of birds could be penguins or swallows. Vertebrate animals that belong to the group of fish could be salmon or sharks. Vertebrate animals that belong to the group of amphibians could be toads or salamanders. Invertebrate animals that belong to the group of molluscs could be squid or scallops. Invertebrate animals that belong to the group of arthropods could be spiders or ants.

Keywords

- Draw Ss' attention to the box with the keywords of the lesson and read them aloud.
- Ask Ss questions such as ***In which group of the animal kingdom do molluscs and jellyfish belong?*** (Molluscs and jellyfish are both invertebrates.), ***Which animals have long tentacles with stinging cells?*** (Jellyfish have long tentacles with stinging cells.), ***What are annelids, flatworms and nematodes?*** (They are different groups of worms.), ***In which group is a starfish classified?*** (A starfish is an echinoderm.), ***What is the difference between an arthropod and an arachnid?*** (An arachnid is a type of arthropod. Arthropods are a group of invertebrate animals with segmented bodies and legs with joints.).
- Don't correct Ss' answers at this stage of the lesson.
- Have Ss turn to the Glossary and read the definitions and/or the examples of the keywords of the lesson to check their answers.

Overview

- Draw Ss' attention to the box with the Overview section.
- Have a S read aloud the points at the end of the lesson.
- Encourage Ss to express their opinions, and initiate a short discussion in class about what they have learnt in this lesson using as many keywords of the lesson as possible.

MORE PRACTICE

For lower-performing Ss:

- Provide Ss with the WS a More Practice.
- Explain to Ss that they have to look at the pictures, read the text and answer the questions.
- You can also ask Ss ***What do bats and pigeons have in common?*** (They can both fly. They both breathe with their lungs, and they are both vertebrates because they have an inner skeleton.).
- Encourage Ss to express their opinions, and initiate a short discussion in class.
- Give Ss some time to do the activity.

  1. a. A pigeon is a bird because it has feathers and it lays hard-shelled eggs.
     b. A bat is a mammal because it gives birth to young which feed on milk, and it has fur on its body.

For higher-performing Ss:

- Provide Ss with the RS Classifying arthropods.
- Provide Ss with scissors.
- Divide Ss into pairs.
- Explain to Ss that the cards all show arthropods.
- Point out to Ss that arthropods are divided into insects and arachnids.
- Remind Ss that insects have six legs, antennae and might have wings, while arachnids have eight legs and do not have antennae.
- Instruct Ss to cut out the cards from the RS Classifying arthropods.

Safety rules
> Ss should be careful when using scissors.

- Have each S in the pair take half the cards and make a pile with the cards face down.
- Explain to Ss that one S in each pair has to take one card from the pile and show the arthropod to the other S, who has to say if the arthropod is an insect or an arachnid.
- Explain to Ss that if they guess correctly, they can keep the card. The S with more cards wins.
- Give Ss some time to do the activity.

  Insects: mosquito, ladybird, cockchafer, wasp, bee, stink bug, ant, cockroach
  Arachnids: scorpion, spider, tick, mite

Don't forget to prepare the materials and resources for the next lesson.

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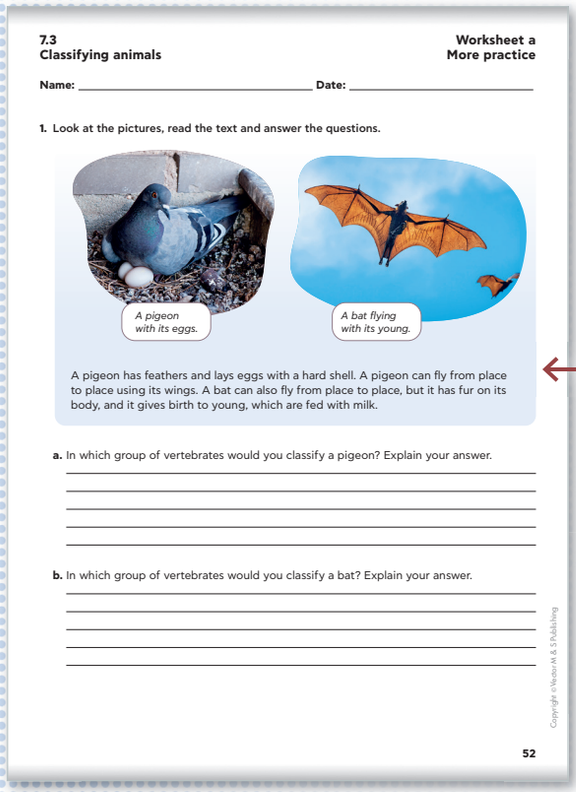
This section includes differentiated activities for lower or higher performing students.

Students should look at the box with the keywords and read them aloud. Refer students to the Glossary at the back of the Student's Book, read the definitions and the examples of the keywords of the lesson aloud. A list of suggested questions is provided to check whether the knowledge of the new keywords has been consolidated or not.

Worksheets and Resources are provided as additional supportive material that reinforce and expand newly acquired knowledge.



7.3
Classifying animals

Worksheet a
More practice

Name: _____ **Date:** _____

1. Look at the pictures, read the text and answer the questions.

A pigeon has feathers and lays eggs with a hard shell. A pigeon can fly from place to place using its wings. A bat can also fly from place to place, but it has fur on its body, and it gives birth to young, which are fed with milk.

a. In which group of vertebrates would you classify a pigeon? Explain your answer.

_____
_____
_____
_____
_____

b. In which group of vertebrates would you classify a bat? Explain your answer.

_____
_____
_____
_____
_____

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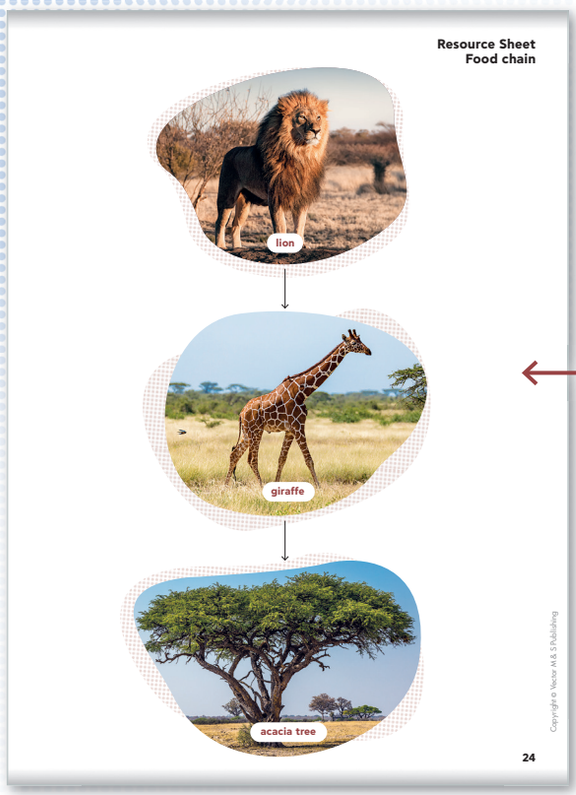
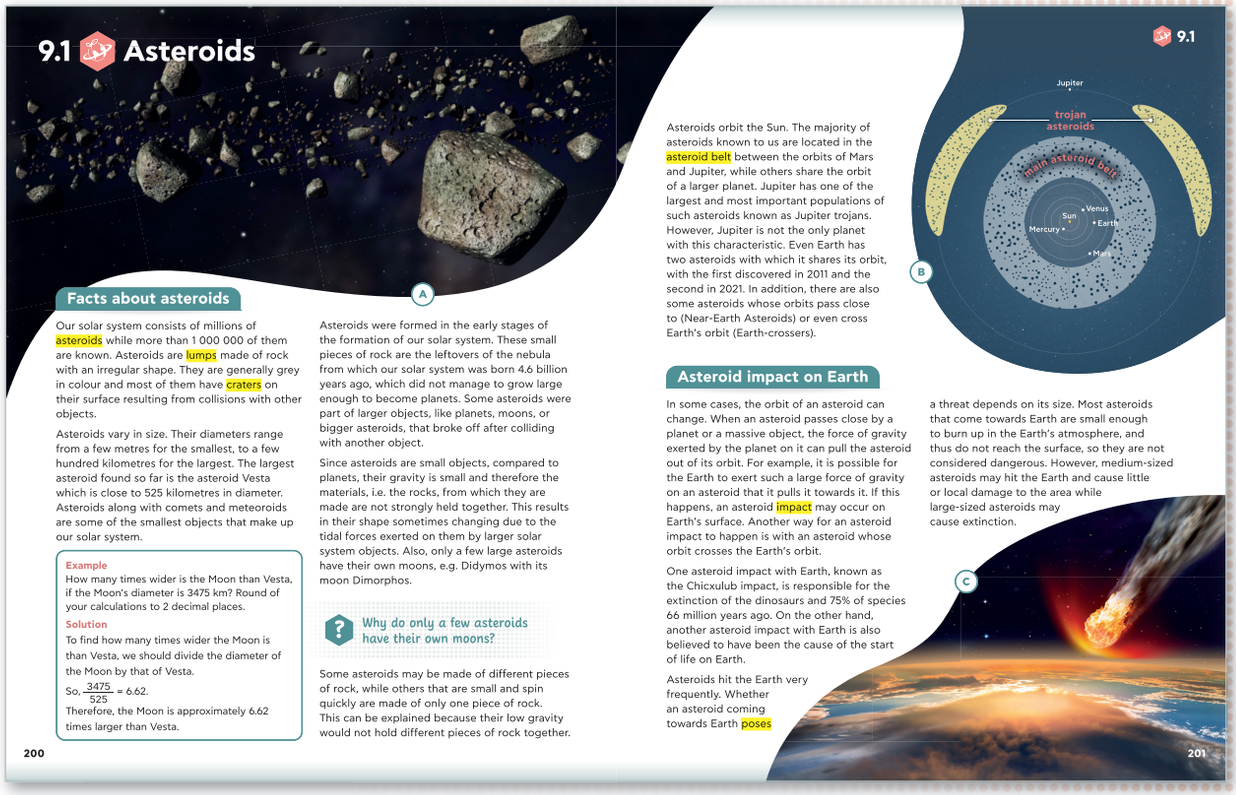
Worksheets follow a well-defined and structured template for a comprehensive learning experience and they also support experimentation and investigation activities.



Resource Sheet
Food chain

24

Resource Sheets serve as an additional reference point with pictures and extra information useful for more practice sections.



9.1 Asteroids

Facts about asteroids

Our solar system consists of millions of asteroids while more than 1 000 000 of them are known. Asteroids are lumps made of rock with an irregular shape. They are generally grey in colour and most of them have craters on their surface resulting from collisions with other objects.

Asteroids vary in size. Their diameters range from a few metres for the smallest, to a few hundred kilometres for the largest. The largest asteroid found so far is the asteroid Vesta which is close to 525 kilometres in diameter. Asteroids along with comets and meteoroids are some of the smallest objects that make up our solar system.

Example
How many times wider is the Moon than Vesta, if the Moon's diameter is 3475 km? Round of your calculations to 2 decimal places.

Solution
To find how many times wider the Moon is than Vesta, we should divide the diameter of the Moon by that of Vesta.

So, $\frac{3475}{525} = 6.62$.

Therefore, the Moon is approximately 6.62 times larger than Vesta.

Asteroids were formed in the early stages of the formation of our solar system. These small pieces of rock are the leftovers of the nebula from which our solar system was born 4.6 billion years ago, which did not manage to grow large enough to become planets. Some asteroids were part of larger objects, like planets, moons, or bigger asteroids, that broke off after colliding with another object.

Since asteroids are small objects, compared to planets, their gravity is small and therefore the materials, i.e. the rocks, from which they are made are not strongly held together. This results in their shape sometimes changing due to the tidal forces exerted on them by larger solar system objects. Also, only a few large asteroids have their own moons, e.g. Didymos with its moon Dimorphos.

Why do only a few asteroids have their own moons?

Some asteroids may be made of different pieces of rock, while others that are small and spin quickly are made of only one piece of rock. This can be explained because their low gravity would not hold different pieces of rock together.

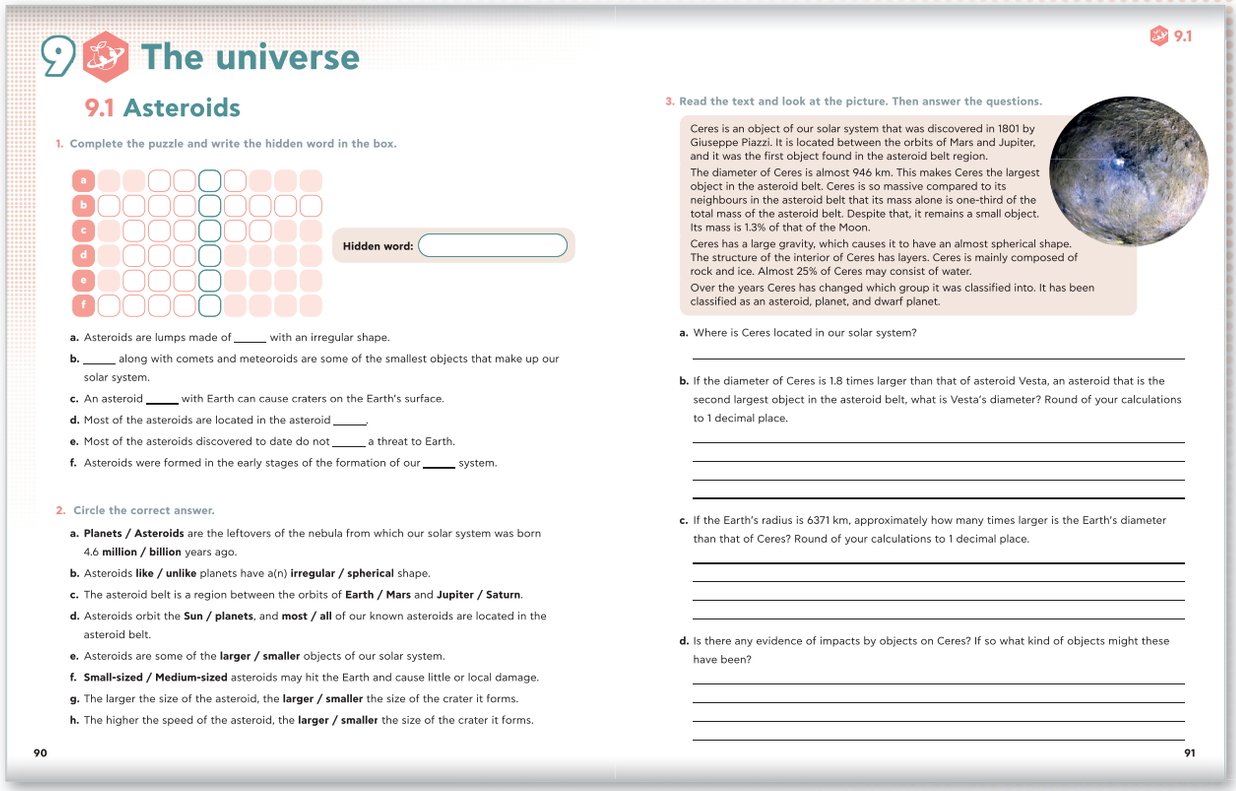
Asteroids orbit the Sun. The majority of asteroids known to us are located in the asteroid belt between the orbits of Mars and Jupiter, while others share the orbit of a larger planet. Jupiter has one of the largest and most important populations of such asteroids known as Jupiter trojans. However, Jupiter is not the only planet with this characteristic. Even Earth has two asteroids with which it shares its orbit, with the first discovered in 2011 and the second in 2021. In addition, there are also some asteroids whose orbits pass close to (Near-Earth Asteroids) or even cross Earth's orbit (Earth-crossers).

Asteroid impact on Earth

In some cases, the orbit of an asteroid can change. When an asteroid passes close by a planet or a massive object, the force of gravity exerted by the planet on it can pull the asteroid out of its orbit. For example, it is possible for the Earth to exert such a large force of gravity on an asteroid that it pulls it towards it. If this happens, an asteroid impact may occur on Earth's surface. Another way for an asteroid impact to happen is with an asteroid whose orbit crosses the Earth's orbit.

One asteroid impact with Earth, known as the Chicxulub impact, is responsible for the extinction of the dinosaurs and 75% of species 66 million years ago. On the other hand, another asteroid impact with Earth is also believed to have been the cause of the start of life on Earth.

Asteroids hit the Earth very frequently. Whether an asteroid coming towards Earth poses a threat depends on its size. Most asteroids that come towards Earth are small enough to burn up in the Earth's atmosphere, and thus do not reach the surface, so they are not considered dangerous. However, medium-sized asteroids may hit the Earth and cause little or local damage to the area while large-sized asteroids may cause extinction.



9 The universe

9.1 Asteroids

1. Complete the puzzle and write the hidden word in the box.

Hidden word: _____

a. Asteroids are lumps made of _____ with an irregular shape.

b. _____ along with comets and meteoroids are some of the smallest objects that make up our solar system.

c. An asteroid _____ with Earth can cause craters on the Earth's surface.

d. Most of the asteroids are located in the asteroid _____.

e. Most of the asteroids discovered to date do not _____ a threat to Earth.

f. Asteroids were formed in the early stages of the formation of our _____ system.

2. Circle the correct answer.

a. **Planets / Asteroids** are the leftovers of the nebula from which our solar system was born 4.6 **million / billion** years ago.

b. Asteroids **like / unlike** planets have a(n) **irregular / spherical** shape.

c. The asteroid belt is a region between the orbits of **Earth / Mars** and **Jupiter / Saturn**.

d. Asteroids orbit the **Sun / planets**, and **most / all** of our known asteroids are located in the asteroid belt.

e. Asteroids are some of the **larger / smaller** objects of our solar system.

f. **Small-sized / Medium-sized** asteroids may hit the Earth and cause little or local damage.

g. The larger the size of the asteroid, the **larger / smaller** the size of the crater it forms.

h. The higher the speed of the asteroid, the **larger / smaller** the size of the crater it forms.

3. Read the text and look at the picture. Then answer the questions.

Ceres is an object of our solar system that was discovered in 1801 by Giuseppe Piazzi. It is located between the orbits of Mars and Jupiter, and it was the first object found in the asteroid belt region.

The diameter of Ceres is almost 946 km. This makes Ceres the largest object in the asteroid belt. Ceres is so massive compared to its neighbours in the asteroid belt that its mass alone is one-third of the total mass of the asteroid belt. Despite that, it remains a small object. Its mass is 1.3% of that of the Moon.

Ceres has a large gravity, which causes it to have an almost spherical shape. The structure of the interior of Ceres has layers. Ceres is mainly composed of rock and ice. Almost 25% of Ceres may consist of water.

Over the years Ceres has changed which group it was classified into. It has been classified as an asteroid, planet, and dwarf planet.

a. Where is Ceres located in our solar system?

_____

b. If the diameter of Ceres is 1.8 times larger than that of asteroid Vesta, an asteroid that is the second largest object in the asteroid belt, what is Vesta's diameter? Round of your calculations to 1 decimal place.

_____
_____
_____
_____

c. If the Earth's radius is 6371 km, approximately how many times larger is the Earth's diameter than that of Ceres? Round of your calculations to 1 decimal place.

_____
_____
_____
_____

d. Is there any evidence of impacts by objects on Ceres? If so what kind of objects might these have been?

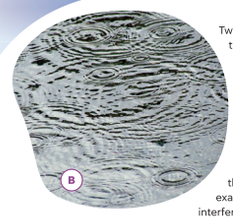
_____
_____
_____
_____

Science 3 • Student's Book • Sample pages

8.3 Interference

Wave interference

When a drop of water falls in water, a wave spreads out on the surface of the water. When a series of drops fall into water, waves spread out on the surface of the water forming circles around the point the drops fall. We can use this as an analogy of how sound waves travel in a medium, since sound waves cannot be seen.



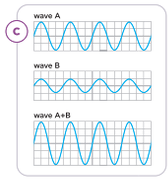
Two or more waves from different sources can meet while travelling through the same medium. This causes the particles of the medium to vibrate in a way that results from the effect of both waves. This is a phenomenon known as wave interference. The amplitudes of the waves that interfere add together. Since sound waves are invisible, the effect of interference can more easily be seen by analogy with water waves. There will be some points that vibrate with a higher amplitude, and others that stay still.

Although interference happens between any waves of the same type, e.g. between two sound waves, we will only examine waves of the same frequency and amplitude that interfere with each other.

Types of interference

Constructive interference

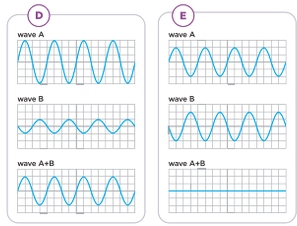
If two waves, coming from two different sources, meet while travelling through a medium and their peaks line up with peaks and troughs line up with troughs, they reinforce each other. This type of interference is called constructive interference. In the case of constructive interference between two sound waves this means their compressions line up together and their rarefactions line up together. Constructive interference results in a wave that has the same frequency as the waves that interfere and an amplitude equal to the sum of the two waves' amplitudes.



How is the loudness of the sound affected when sound waves reinforce each other?

Destructive interference

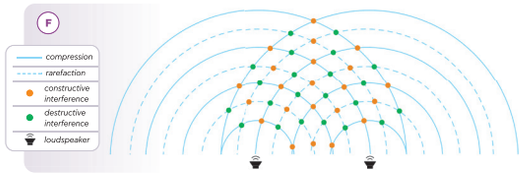
Waves, coming from two different sources, can also meet in such a way that their peaks line up with troughs. This type of interference is called destructive interference and it causes the amplitude to decrease. In the case of destructive interference between two sound waves, the compressions of one sound wave line up with the rarefactions of the other sound wave. Destructive interference results in a wave that has the same frequency as the waves that interfere and an amplitude equal to the difference between the two waves' amplitudes. If the waves that interfere have the same amplitude, they cancel each other out since the amplitude of the wave produced is zero.



How is the loudness of the sound affected during destructive interference?

Uses of interference

In concerts, at least two loudspeakers produce sound waves that travel through air in front of the loudspeakers, spreading out into the area. The sound waves interfere in such a way that there will be positions of louder sounds and positions of no sounds. The louder sounds are heard where two waves reinforce each other, i.e. where two compressions or two rarefactions cross each other, while no sounds are heard where two waves cancel out, i.e. where compressions of one sound wave cross rarefactions of the other sound wave. Even though the sound waves coming directly from the two loudspeakers are cancelling each other out in some positions, you will still hear some sound in these positions, because sound waves also reflect off the walls, objects and even the people at the concert.



Science 3 • Workbook • Sample pages

8.3 Interference

1. Circle the correct phrase to complete the sentences.

a. You hear a note played on two guitars at the same time louder than they are heard separately because of _____.

1. constructive interference **2.** destructive interference

b. The frequency of two sound waves that reinforce each other _____.

1. stays the same **2.** increases

c. Sound waves can cancel each other out if _____.

1. they have double the frequency **2.** they have the same amplitude

d. At a concert, there are positions where you can hear the sound louder, and positions where _____.

1. you cannot hear any sound **2.** you can hear the sound softer

e. Theatres are designed so that _____.

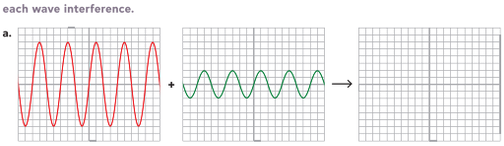
1. destructive interference is prevented **2.** constructive interference is prevented

f. Noise-cancelling headphones work by making sound waves _____.

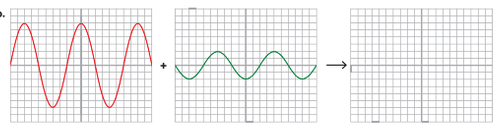
1. reinforce each other **2.** cancel out

2. Look at the waveforms of different waves that interfere and draw the result of each wave interference.

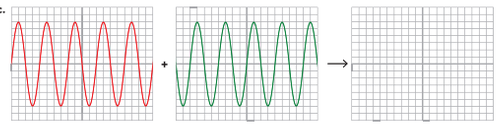
a.



b.



c.



3. Look at the pictures and answer the questions.

a. Why might some people hear louder sounds than others at a concert?

_____

_____

_____

_____

b. Why do theatres have soft seats, curtains and carpets?

_____

_____

_____

_____

vector maths & science

International Lower Secondary

SCIENCE

Biology Chemistry Earth and Space Physics

3 LEVELS 1 2 3

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