Science standards

Grade 7

Summary of students' performance by the end of Grade 7

Scientific enquiry

Students plan investigations, make predictions, collect data and make observations in a systematic way, identify patterns, and draw appropriate generalised conclusions and test predictions. They use secondary evidence and information critically. They make estimates of size and quantity that they then check by accurate measurement. They understand the need for accuracy and know how to achieve it. They know that scientists in different disciplines all work by building conceptual models which can be tested by experiment. They recognise that our understanding of science has developed over time and is the work of many countries. They manipulate observations and data and use tables, graphs and ICT methods to communicate them. Students accurately read analogue meters and measure length, use laboratory glassware and heat sources safely, and follow complex written instructions. They successfully solve problems in electrical circuits. They use a microscope, prepare a slide and examine objects such as root hairs and leaf structures.

Life science

Students distinguish between environmental and inherited variation. They know that selective breeding creates organisms with desirable characteristics. They construct food chains and food webs and know why human and environmental change can alter a food web. They describe and draw typical animal and plant cells, know the function of cell structures and relate the functions of specialised cells to their structures. They know that cells form tissues and organs. They know the basic anatomy of the human reproductive system. They know about human reproduction and about the growth, development and birth of a baby. They know the importance of good nutrition during pregnancy and the importance of good nutrition and hygiene to the health of babies. They describe how water and nutrients enter and pass through a plant, and know that nitrogen and other nutrients are required for plant growth. They understand the importance of micro-organisms in nitrogen fixation, decomposition and nutrient recycling.

Materials

Students describe the characteristic movement of particles in a solid, a liquid and a gas, and use it to explain a number of common observations. They are familiar with common physical methods for purifying substances. They understand that compounds are pure substances and that pure substances are characterised by sharp melting and boiling points. They know that elements are the building blocks from which compounds are made and name some common elements and compounds made from them. They show that the properties of compounds are very different from the properties of the elements from which they are made. Students know the composition of the air and the properties of its main constituents. They name some common acids and alkalis and classify solutions as alkaline, acidic or neutral. They use indicators and understand the pH scale. They describe what happens to the pH of an acid when it is neutralised, display continuous change in pH graphically and give everyday examples of

neutralisation. They know the reaction between acids and carbonates and the test for carbon dioxide and express reactions as word equations..

Earth and space

Students describe different rocks in terms of texture, porosity and density. They know the typical features and the origins of sedimentary, metamorphic and igneous rocks. They understand the main features of geological time. They know the internal structure of the Earth.

Physical processes

Students recall that all objects exert a gravitational attraction on other objects that depends on the objects' masses and how far apart they are, and that the force of gravity due to the Earth on a 1 kg mass on its surface is approximately 10 N. They know that forces can cause objects to move and to change shape, and use the concept of centre of gravity. They represent forces in diagrams using arrows that indicate the direction and magnitude of the forces. They measure length and mass, calculate derived quantities, and express large and small units correctly using appropriate prefixes. They understand and use the concept of density. They use an electroscope to detect and identify charge and know the origin of lightning. They distinguish between magnetic and non-magnetic materials and make a permanent magnet and an electromagnet. They recognise that that the Earth has a magnetic field. They demonstrate the field pattern around a magnet, distinguish between the north and south poles, and know that magnetic fields act through non-magnetic materials but not through magnetic ones. They construct simple series and parallel circuits from circuit diagrams and investigate the current flow in them. They understand why bulbs in parallel are brighter than the same bulbs in series and recognise the implications for household circuits. They know the purpose of safety devices such as fuses and circuit breakers and explain how they work.

The balance between scientific enquiry and the subject content strands

The science standards for Grade 7 are grouped into five strands: four content strands – life science, materials, Earth and space, and physical processes – and the scientific enquiry skills strand, which addresses the development of scientific practical and intellectual skills across all the content strands. The teaching of the enquiry skills strand should be an integral part of the teaching of the content strands.

Assessment weightings for Grade 7

There are three general assessment objectives for the science curriculum:

- knowledge and understanding;
- application of knowledge and understanding, analysis and evaluation of information;
- scientific enquiry skills and procedures.

The balance between these three general objectives will vary from grade to grade. As students' scientific proficiency and experience develops, there should be a greater emphasis on the application of knowledge to solve problems in new situations.

For Grade 7, the weightings of the subject content strands are as follows:

	Life science	Materials	Earth and space	Physical processes
Assessment weighting	30 to 40%	25 to 35%	5 to 15%	30 to 40%

For Grade 7, the weightings of the assessment objectives to be applied to each content strand are as follows:

	Knowledge and understanding	Application, analysis and evaluation	Scientific enquiry skills and procedures
Assessment weighting	45 to 55%	25 to 35%	20 to 25%

Science standards

Grade 7

Scientific enquiry

By the end of Grade 7, students plan investigations, make predictions, collect data and make observations in a systematic way, identify patterns, and draw appropriate generalised conclusions and test predictions. They use secondary evidence and information critically. They make estimates of size and quantity that they then check by accurate measurement. They understand the need for accuracy and know how to achieve it. They know that scientists in different disciplines all work by building conceptual models which can be tested by experiment. They recognise that our understanding of science has developed over time and is the work of many countries. They manipulate observations and data and use tables, graphs and ICT methods to communicate them. Students accurately read analogue meters and measure length, use laboratory glassware and heat sources safely, and follow complex written instructions. They successfully solve problems in electrical circuits. They use a microscope, prepare a slide and examine objects such as root hairs and leaf structures.

Key standards

Key performance standards are shown in shaded rectangles, e.g. 1.3.

Examples of learning exercises

The examples of active learning exercises shown in italics are intended to be illustrative and do not represent the full range of possible exercises.

Cross-references to scientific enquiry skills

Some of the suggested learning exercises are cross-referenced where appropriate to scientific enquiry skills.

Use of laboratories

The Grade 7 standards have been written in such a way as to allow consolidation of work done in earlier grades using laboratory conditions and more extensive equipment.

Students should:

1 Use methods of scientific investigation

1.1 Plan investigations, controlling variables and collecting an appropriate range of evidence, identify patterns in observations and data, draw appropriate generalised conclusions and test predictions.

1.2 Use secondary evidence and information selectively and critically.

1.3 Make estimates of size and quantity, and check estimates against accurate measurement.

1.4 Understand the importance of accuracy and use techniques such as repetition of measurements to ensure it.

2 Know how scientists work

2.1 Know that scientists work by looking for patterns in data, building conceptual models that explain the patterns.

2.2 Know that science is divided into many different fields of study and realise that although scientists working in these fields may use very different techniques, they share a common methodology.

2.3 Know that our understanding of science has accumulated and changed over time and is the result of work in many countries.

3 Process and communicate information

3.1 Use a range of methods, such as description, diagrams, pictures, tables, graphs and calculations, using ICT methods where appropriate, to communicate observations, data, results and conclusions.

3.2 Display data in the form of tables, including secondary data derived from primary data through calculation.

3.3 Display data using appropriate graphical methods, such as diagrams, pie charts, bar charts and line graphs.

3.4 Express quantitative data using the appropriate prefixes to the units and be able to convert data from one unit to another.

4 Handle equipment and make measurements

4.1 Follow complex written instructions accurately.

4.2 Accurately read analogue meters with unitary and more complex divisions.

4.3 Use a trundle wheel, tape measure, ruler, callipers and micrometer for measuring lengths to an appropriate degree of accuracy.

4.4 Use laboratory glassware and heat sources safely.

4.5 Prepare a microscope slide correctly; use a microscope to examine objects such as leaf surfaces and root hairs.

4.6 Select and use electrical components appropriately and successfully solve problems in malfunctioning electrical circuits.

Life science

By the end of Grade 7, students distinguish between environmental and inherited variation. They know that selective breeding creates organisms with desirable characteristics. They construct food chains and food webs and know why human and environmental change can alter a food web. They describe and draw typical animal and plant cells, know the function of cell structures and relate the functions of specialised cells to their structures. They know that cells form tissues and organs. They know the basic anatomy of the human reproductive system. They know about human reproduction and about the growth, development and birth of a baby. They know the importance of good nutrition during pregnancy and the importance of good nutrition and hygiene to the health of babies. They describe how water and nutrients enter and pass through a plant, and know that nitrogen and other nutrients are required for plant growth. They understand the importance of micro-organisms in nitrogen fixation, decomposition and nutrient recycling.

Students should:

5 Distinguish between environmental and inherited variation

5.1 Know that some features of organisms are inherited while others are determined by their environment.

Germinate some oat seeds in a number of small containers. Place several containers in each of a variety of conditions of light and temperature. Measure the height of the seedlings at regular intervals. Compare the results and present the outcomes.

Enquiry skills 1.1, 1.4, 3.3

5.2 Know that selective breeding can produce organisms with desirable characteristics.

Study the pedigree charts of such animals as champion racehorses or racing camels, or prize-winning cattle. **Enquiry skill 1.2**

6 Construct and interpret food webs

6.1 Construct food chains and food webs.

Play a game in which cards depicting simple feeding relationships are organised to form food chains and a more complex food web. **Enquiry skill 3.1**

6.2 Know why human action and environmental change can alter a food web.

Discuss data on the organisms living in an area before and after development or environmental change. **Enquiry skill 1.2**

Interview adults about their memories of the plants and animals that were found in different places in their youth and compare this with what is found today.

Obtain data on fish catches over time and discuss possible reasons for changes in species and quantities. **Enquiry skill 2.1**

7 Relate cell structure to function

7.1 Describe and draw typical animal and plant cells; know that cells are the basic building blocks of organisms and form tissues and organs.

Use a microscope to observe and draw a wide variety of animal and plant cells. **Enquiry skill 4.5**

Make slide preparations from various parts of plants (e.g. onion epidermis, leaf tissue, plant stems). Observe with a microscope and draw.

7.2 Recognise and know the function of the cell nucleus, cell membrane, cytoplasm, vacuole and cell wall, and relate the overall structure of some specialised cells (e.g. nerve cells, sperm cells, xylem cells, palisade cells) to their functions.

From the study of microscope slides, photographs, drawings, pictures and models, construct charts to illustrate common and unique cell structures and relate these to their function. **Enquiry skills 3.1, 4.5**

Make a display of large drawings or models of specialised cells and label them with their function.

8 Know about human reproduction

8.1 Know the simple anatomy of the human female and male reproductive systems; know the basic facts about human reproduction and about the growth, development and birth of a baby.

Construct scale drawings to illustrate the growth of a baby over the duration of a pregnancy. **Enquiry skills 1.2, 3.1**

Collect and chart the birth weights of members of the class.

View and discuss suitable videos and models.

8.2 Know the importance of good nutrition during pregnancy and of good nutrition and hygiene to the health of babies.

Compare the nutritional information given on the labels of baby food and other foodstuffs. **Enquiry skills 1.2, 3.1**

Listen to a nurse talking about baby care.

9 Know about water and nutrient uptake in green plants

9.1 Describe how water and nutrients enter a root hair and pass up through a plant.

Use a microscope to examine the surfaces of roots and leaves and the cellular structures of plant stems, roots and root hairs. **Enquiry skill 4.5**

Place a cut shoot in coloured dye and observe the movement of the dye.

Place a leafy plant in good light. Cover some of the leaves in a clear polythene bag and make a seal. Observe the water from transpiration gather on the sides of the bag.

9.2 Know that nitrogen and other nutrients are required for plant growth.

Examine plants (e.g. oats) that are growing in compost with different amounts of nitrogen fertiliser. **Enquiry skill 1.1**

10 Know the beneficial value of micro-organisms in nitrogen fixation and decomposition

10.1 Know that specialised bacteria in the soil and in the roots of some plants fix atmospheric nitrogen.

Examine the roots of some legumes and locate the root nodules. **Enquiry skill 4.5**

Use a microscope to examine prepared slides of sections of root nodules.

10.2 Know that micro-organisms in soil decompose organic matter and dead organisms and help to recycle nutrients.

Bury some leaves or fruit in garden soil. Place a similar amount of leaves and fruit in a sealed container and bury this alongside. Predict what will happen. Leave for some time and dig up. Compare the two samples. **Enquiry skill 1.1**

Start a compost heap.

Make a field trip to a sewage farm.

Materials

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Students should:

11 Understand the particulate nature of matter

11.1 Know that solids remain the same volume and shape, that liquids remain the same volume but take up the shape of the container, and that gases expand to fill any container they are placed in.

11.2 Know of, and cite evidence for, the movement of particles in solids, liquids and gases, and draw diagrams to represent particles in solids, liquids and gases; know that this process is called diffusion.

Observe that coloured particles from a crystal placed at the bottom of a beaker of water will slowly move throughout the water, eventually colouring the whole solution equally.

Observe that a coloured gas (e.g. nitrogen dioxide) in a beaker will quite quickly move into a beaker of air placed upside down on top of it.

Safety

Nitrogen dioxide is toxic.

Observe that a coloured gas (e.g. bromine vapour) appears to move much faster through a partial vacuum than through air and explain this in terms of collision with particles in air.

Safety

Bromine is toxic.

Model, using students as particles, the changes in the movement of particles in matter as it is heated and turns from a solid to a liquid and to a gas.

11.3 Explain, in terms of the particle model, a variety of common phenomena, such as thermal expansion, gas pressure, the compressibility of gases (but not liquids and solids) and the regular growth of crystals in a saturated solution.

Explain in terms of particles, the behaviour of a balloon or a tyre as it is inflated.

Refer to a distribution of energy in particles which means that some are moving much faster than the average speed of the particles and have sufficient energy to escape from the liquid.

Show the expansion of a heated metal rod with one end firmly clamped. The movement of the other end can be detected by placing it on top of a roller to which is attached a needle, which moves as the rod expands.

Enquiry skill 1.1

Grow a variety of crystal types (e.g. copper sulfate or aluminium chromium sulfate) to show regularities.

Cleave a crystal to show that the split faces are parallel.

Compare the ease with which a syringe full of air can be compressed compared with a syringe full of water.

Explain everyday observations in terms of particle theory (e.g. clothes drying, water leaking from an air conditioner, ice in a refrigerator, smelling a perfume, the pressure in a balloon).

11.4 Cite evidence for the existence and size of particles.

Oil-drop experiment

The mathematics required for the full treatment of this is demanding.

Demonstrate the oil-drop experiment to give a maximum diameter for an oil particle.

Demonstrate Brownian motion using a smoke cell.

Study and discuss the evolution of the particle model of matter, considering evidence for and against it.

Enquiry skill 2.1

12 Distinguish between mixtures, compounds and elements

12.1 Explain how the processes of solution, filtration, evaporation and distillation can be used to make pure substances from mixtures and cite common examples of the use of each.

Separate salt from sand by filtration and evaporation.

Purify dirty water by distillation.

Collect information on the distillation of sea water to provide drinking water for Qatar.

Enquiry skill 1.1

12.2 Perform chromatographic separations and explain why chromatography is widely used as a method for analysing mixtures.

Use chromatography to show whether a dye is a single substance or a mixture.

12.3 Explain qualitatively the mechanism of chromatography.

12.4 Know that fractional distillation is used widely in the oil industry for separating liquids of different boiling points, and explain how fractional distillation works.

Separate alcohol from a mixture of alcohol and water.

Demonstrate the distillation of crude oil.

Safety

Take fire precautions.

12.5 Know that most pure substances are characterised by sharp melting and boiling points and that they are either compounds or elements.

Compare freezing and boiling points of pure water and seawater.

12.6 Use electrolysis to separate compounds into their elements.

See Standards 20.1–7

Demonstrate the electrolysis of water.

Deposit copper on an electrode by electrolysis.

12.7 Know that all matter is made from a small number of elements and that they can be classified as solids, liquids or gases, metals or non-metals.

Make an exhibition of different elements and classify them.

Draw a Carroll diagram showing the overlapping of different categories.

Enquiry skill 3.1

12.8 Know that elements combine to form compounds and that the properties of compounds are different from the properties of their constituent elements.

Carry out the reaction between carbon and oxygen (air).

Demonstrate the reaction between hydrogen and oxygen (air).

Safety

Demonstrate the reaction between magnesium and oxygen.

Take care with burning magnesium burning and handling hydrogen.

Carry out the reaction between iron filings and (powdered roll) sulfur, testing both the starting materials and the product with a magnet to show changes in properties.

Find information about elements on the Internet.

ICT opportunity

Design an experiment to show whether a pure substance is an element or a compound. Substances used can include copper carbonate or copper sulfate and sugar.

Use the Internet as a source of information.

12.9 Know that compounds can react chemically with each other to form new compounds.

Carry out a number of test-tube chemical reactions (e.g. sodium carbonate plus iron (II) chloride, dilute acid on a carbonate, ammonia solution on copper sulfate solution).

Enquiry skill 4.4

13 Know the composition of air and understand the principles of combustion

13.1 Know that air consists of one-fifth oxygen, four-fifths nitrogen, small quantities of other gases, principally argon and carbon dioxide, and a variable proportion of water.

Express the composition of air in the form of a pie chart. **Enquiry skill 3.3**

13.2 Demonstrate that part of the air is used up by burning.

Show that when a jar is placed over a burning candle, the time taken for the candle to go out depends on the size of the jar. **Enquiry skill 1.1**

Show that when a candle burns in a container floating on water under a bell jar, the water in the bell jar rises.

Show that when a fixed volume of air is passed repeatedly over hot, clean copper, black copper oxide is formed and the volume of the air decreases by 20%.

13.3 Know that when a substance burns, it combines chemically with the oxygen in the air and that the overall mass of the product(s) is greater than the original mass of the material.

Show that when magnesium is heated in a covered crucible so that it burns, the mass of the magnesium oxide formed is greater than the mass of the magnesium used. **Enquiry skill 4.4**

Investigate the rise and fall of the phlogiston theory of combustion. **Enquiry skills 1.1, 2.1**

13.4 Know the common properties of oxygen and nitrogen, such as the reactivity of oxygen towards both metals and non-metals forming oxides and the relative chemical unreactivity of nitrogen.

Compare the combustion of a number of materials in oxygen and nitrogen. **Enquiry skill 4.4**

Carry out the tests for oxygen and nitrogen.

Safety

Take care with burning in oxygen.

13.5 Use word equations to describe the reactions when elements burn.

14 Know that acidity is an important property of aqueous solutions

14.1 List the widely known characteristics of common acids and alkalis, such as the sharp taste of acids and the soapy feel and bitter taste of alkalis.

Safety

Chemicals should not be tasted in a laboratory.

Cite examples of the common characteristics of acids and alkalis (e.g. the sharp taste of acids such as lemon juice and vinegar, the bitter taste of alkalis such as sodium hydrogencarbonate and the soapy feel of alkalis).

14.2 Know that some acids and alkalis can be corrosive and hazardous, and be aware of the use of hazard symbols to describe this.

Display a list of hazard symbols in the laboratory and discuss how chemical spills should be safely treated.

14.3 Know that litmus solution is an indicator that can be used to classify some common solutions as acidic or alkaline.

Make solutions of fruit (lemon) juice, vinegar, toothpaste, baking powder, tartaric acid, and test with litmus.

Safety

Wear eye protection when using acids and alkalis.

14.4 Know that many naturally occurring colours act as indicators.

Make and test a natural indicator by extracting a natural pigment (e.g. red hibiscus flowers, red cabbage) in alcohol. **Enquiry skill 1.1**

14.5 Know that the pH scale is a measure of the acidity of an aqueous solution and that the pH of a solution can be determined by universal indicator colour changes.

Measure the pH of a number of common solutions using universal indicator paper.

Demonstrate the use of a pH meter.

14.6 Know where strong and weak acids, strong and weak alkalis, and pure water occur on the pH scale.

Display a large pH scale showing regions of strong and weak acids and alkalis. Include examples of common acids and alkalis on the scale. **Enquiry skill 3.1**

14.7 Know that acids and alkalis react with each other and that the process is called neutralisation.

Neutralise a common acid such as lemon juice by adding small fixed amounts of baking soda and noting the pH after each addition. Plot a graph of pH (y-axis) against the amount of alkali added to some acid. **Enquiry skills 3.2, 3.3**

Investigate the action of an antacid tablet on the pH of vinegar or lemon juice.

14.8 Know that acids react with carbonates to liberate carbon dioxide, which can be identified by bubbling it through fresh limewater.

Investigate the reaction between acids and carbonates using several different acids and several different carbonates. **Enquiry skills 1.1, 3.1, 3.2**

Test the gas produced when an acid reacts with a carbonate with fresh limewater.

14.9 Express chemical reactions in the form of word equations.

Write word equations for the reactions in this section.

Earth and space

By the end of Grade 7, students describe different rocks in terms of texture, porosity and density. They know the typical features and the origins of sedimentary, metamorphic and igneous rocks. They understand the main features of geological time. They know the internal structure of the Earth.

Students should:

15 Recognise and describe the origins and properties of rocks

15.1 Recognise properties of rocks, such as texture, porosity and density.

Make a rock collection suitable for all the standards in this section, containing samples of rock that have a wide variety of distinguishing features and represent all three basic types of rock.

Compare the shapes of naturally occurring crystals with those grown in the laboratory. **Enquiry skill 1.1**

15.2 Describe how igneous rocks crystallise from magma released during movements of the surface of the Earth, and relate crystal size to cooling rate.

Compare densities and colour of iron-rich igneous rocks (e.g. granite) and silicon-rich rocks (e.g. basalt). **Enquiry skill 1.1**

15.3 Use the distinctive features of igneous, sedimentary and metamorphic rocks to distinguish between them.

Examine rock samples using a magnifying glass for evidence of structure, such as individual mineral crystals or layering.

Study the effects of immersing rocks in water, weighing them before and after. **Enquiry skill 1.1**

Calculate the densities of different rocks.

Name and describe some typical common sedimentary, metamorphic and igneous rocks in the collection.

15.4 Describe how sedimentary rocks are formed from sediment under the influence of pressure.

Carry out an investigation into how limestone and chalk arose from layers of shells that are formed at the bottom of oceans and look for evidence of this by examining rock specimens with a magnifying glass. **Enquiry skill 1.1**

Study the chemical and physical changes that led to the formation of coal. Examine samples or pictures of coal for evidence of things that have lived in the past. **Enquiry skill 1.2**

15.5 Know that metamorphic rocks are formed from sedimentary rocks that are subjected to high pressure and/or temperature.

Compare metamorphic rocks with the sedimentary ones from which they were derived: marble and limestone; sandstone and quartzite; shale and slate.

15.6 Know that rocks are made up of pure compounds called minerals, many of which are important raw materials for industry.

Make a display of some common examples of minerals and their uses.

15.7 Describe the formation of oil and gas and how it is now extracted and used.

Make a study of the origins of the Qatar gas field. **Enquiry skill 1.2**

Show, using a flow chart, how Qatar gas is used.

15.8 Know that Earth's history can be conveniently divided into periods categorised by particular geological and climatic conditions and by the nature of the things that were living during the periods.

Construct a timescale and include any interesting or significant geological and biological activity.

15.9 Know the main features of the internal structure of the Earth.

15.10 Know that the surface of the Earth consists of moving continental plates floating on a layer of molten rock below the surface.

15.11 Show how the theory of plate tectonics can explain the main mountain ranges and volcano and earthquake zones.

Investigate, using secondary sources, some major earthquakes and volcanoes that have happened in the past, noting that these happen at plate boundaries. **Enquiry skill 1.2**

ICT opportunity

Use the Internet as a secondary data source.

Physical processes

By the end of Grade 7, students recall that all objects exert a gravitational attraction on other objects that depends on the objects' masses and how far apart they are, and that the force of gravity due to the Earth on a 1 kg mass on its surface is approximately 10 N. They know that forces can cause objects to move and to change shape, and use the concept of centre of gravity. They represent forces in diagrams using arrows that indicate the direction and magnitude of the forces. They measure length and mass, calculate derived quantities, and express large and small units correctly using appropriate prefixes. They understand and use the concept of density. They use an electroscope to detect and identify charge and know the origin of lightning. They distinguish between magnetic and non-magnetic materials and make a permanent magnet and an electromagnet. They recognise that that the Earth has a magnetic field. They demonstrate the field pattern around a magnet, distinguish between the north and south poles, and know that magnetic fields act through non-magnetic materials but not through magnetic ones. They construct simple series and parallel circuits from circuit diagrams and investigate the current flow in them. They understand why bulbs in parallel are brighter than the same bulbs in series and recognise the implications for household circuits. They know the purpose of safety devices such as fuses and circuit breakers and explain how they work.

Students should:

16 Understand the effects of forces

16.1 Know that all objects exert a gravitational attraction on other objects, the size of which depends on their mass and distance apart, and that the force of gravity on a mass of 1 kg on the Earth's surface is approximately 10 N.

Measure the force of gravity on objects.

Consider and compare the force of gravity on humans on Earth, in the International Space Station and on the Moon. Look at pictures or videos from the space station to illustrate weightlessness.

ICT opportunity
Obtain video clips of weightlessness from the Internet.

Work out the weight of an object of known mass on Earth, in space and on the Moon, where gravity is one-sixth of that on Earth.

16.2 Give and explain everyday examples of how forces can cause stationary objects to move and can change the direction and speed of an object that is already moving.

Measure the force required to perform everyday operations (e.g. opening a door, picking up a book).

16.3 Give and explain everyday examples of how forces can cause objects to change shape.

Plot a graph of the extension of a spring against the force causing it and show that they are proportional.

Enquiry skill 3.3

16.4 Know that more than one force is acting on an object that is resting on the floor and know that these forces are balanced so that the object is stationary.

16.5 Represent the forces acting on an object diagrammatically, using arrows that show direction and magnitude.

16.6 Recognise that there may be many forces acting on an object that may not be in balance, and be able to represent them in diagrams and to make deductions about the size and direction of any resultant forces.

16.7 Know that the centre of gravity of an object is the point through which its weight appears to act.

Determine the centre of gravity of an irregular lamina.

16.8 Know that if the centre of gravity is not above the base of an object, the object will be unstable.

Pour water into a container whose shape is such that it will topple over as its centre of gravity changes as it fills.

17 Understand density and its application to floating and sinking

17.1 Measure mass and length, use correctly the units of mass (kilogram) and length (metre), and calculate derived quantities, such area and volume of regular objects.

Measure various masses using a top-pan balance and measure various distances using a metre rule and a trundle wheel. **Enquiry skill 4.3**

17.2 Express large and small units correctly using appropriate prefixes.

Produce a table showing the relative sizes of common objects from the very large (e.g. the distance to the Sun) to the very small (e.g. the size of a bacterium). **Enquiry skill 3.2**

17.3 Calculate the density of liquids, gases and regular and irregular solids.

Determine the densities of regular solids made from various materials. **Enquiry skills 1.1, 1.4**

Determine the volume of an irregular solid such as a stone by displacement of water, and hence determine its density.

Determine the density of a liquid.

Determine the density of air.

17.4 Know that the weight of an object is less in water because of the upthrust of the water acting on it.

Lower objects hanging from a spring balance into water and measure the change in weight. **Enquiry skills 1.1, 1.4**

Measure the densities of floating and sinking objects and compare them with the density of water.

17.5 Know that the difference in weight of an object when it is lowered into water is equal to the weight of the water displaced by the object.

Weigh objects in and out of water. Measure the volume and weight of water displaced by objects when they are lowered into water. Compare the weight of the displaced water with the loss in weight of the object when it is lowered into water. **Enquiry skills 1.1, 1.4**

17.6 Know that air also causes upthrust and explain why helium and hot air balloons rise in the air.

18 Understand electrostatics

18.1 Know that electrostatic charges are caused by friction when an insulator is rubbed, that two kinds of charge, positive and negative, can be created in this way and that unlike charges attract each other and like charges repel.

Show attraction and repulsion of electrostatic charges using hanging rods of opposite charge (polythene negative, acrylic positive). Show that electrostatic force acts at a distance.

18.2 Explain the movement of the gold leaf when an electroscope is used to detect charge.

Use an electroscope to detect charge and to distinguish between positive and negative charge (by contact, not induction).

18.3 Know that lightning is an electrical discharge caused by a static charge that results from friction between moving air masses, and that it can be dangerous.

Demonstrate electrical discharge using a Van de Graaff generator.

Collect traditional views worldwide on what causes lightning and what you should, and should not, do in a thunderstorm. Discuss the extent to which these ideas are scientific.

Safety

The Van de Graaff generator produces high voltages, which can be dangerous under certain circumstances.

18.4 Show that electrostatic charges discharge most easily at a point and know some applications of this, such as pointed lightning conductors.

Show point discharge and related phenomena using the Van de Graaff generator.

19 Understand magnetism

19.1 Distinguish between magnetic and non-magnetic materials.

Test a variety of metals and non-metals for magnetism.

19.2 Distinguish between an object that is a magnet and one that is attracted to a magnet but which is not itself a magnet. Know how magnets can be made and understand that the test for magnetism is repulsion.

Show repulsion and attraction using two bar magnets.

Make a magnet from a large nail by the stroking method.

19.3 Recognise that the Earth has a magnetic field and realise that the Earth's south magnetic pole is in its geographical north and vice versa.

Suspend a magnet from an unspun thread and note that it settles in a north–south direction. Place a magnet on a floating cork and note that the same thing happens.

Make a compass and use it for navigation.

19.4 Distinguish between the north and south poles of a magnet and know that similar magnetic poles repel each other and opposite poles attract each other.

Use a compass to identify the north and south poles of a magnet.

Demonstrate attraction and repulsion using suspended bar magnets.

19.5 Demonstrate the pattern of the lines of force of a magnetic field around a magnet using both iron filings and plotting compasses.

Plot the lines of force around a bar magnet using a plotting compass. Show that the lines of force have direction and do not cross each other.

Enquiry skill 3.3

19.6 Know that magnetic fields act through non-magnetic materials.

Enquiry skill 1.1

Devise a test to show which materials stop the action of a magnetic field.

20 Understand how electricity flows in circuits

20.1 Know that electricity requires a complete circuit to flow.

Make simple circuits and investigate the current flow in them. **Enquiry skills 4.2, 4.6**

Set up circuits using cells and bulbs to investigate the brightness of bulbs in series and parallel circuits.

20.2 Represent circuits by circuit diagrams and construct circuits given a circuit diagram.

Set up and test circuits from diagrams. Draw diagrams of circuits set up. **Enquiry skill 3.3**

20.3 Know that current flows around a circuit from the positive to the negative pole of the cell and that in a series circuit it is the same at all points in the circuit but it divides along the branches of a parallel circuit.

Use an ammeter to measure current in different parts of a circuit. **Enquiry skill 4.2**

20.4 Know why bulbs in parallel are brighter than the same bulbs in series and recognise the implications for household circuits.

Test the brightness of bulbs in series and parallel circuits.

20.5 Understand why adding cells in series will increase the current flowing in a circuit and that adding cells in parallel will not increase the current that flows but will allow the current to flow for a longer time before the cells run down.

Measure the current taken from cells in series and in parallel. **Enquiry skill 4.2**

20.6 Know that batteries are cells connected in series.

Take apart and examine a 5 V or 9 V battery.

20.7 Be aware of the hazards of mains electricity and explain the purpose of safety devices such as fuses and circuit breakers and how they work.

Demonstrate the working of a model fuse when too large a current is passed along the circuit.