Science standards

Grade 8

Summary of students' performance by the end of Grade 8

Scientific enquiry

Students plan, collect data and make observations in a systematic way, identify patterns, consider the validity of evidence, the extent to which it supports a prediction, and draw conclusions. They make working models to illustrate scientific ideas and solve scientific problems. They consider how to take representative samples during large investigations and carry out a preliminary investigation to assess practicability. They know that scientific work is often done collaboratively, sometimes with colleagues in other countries and they assess the contributions of specific scientists. They express qualitative and quantitative information through a range of techniques, including graphs and scale diagrams, and use word equations to represent chemical reactions. They process electronically logged data in appropriate ways and select and use optical equipment safely and accurately.

Life science

Students can construct and interpret a pyramid of numbers and biomass. They understand why toxins increase in concentration along a food chain. They know the structure of the digestive system and understand the functioning of enzymes. They distinguish between digestion and absorption of food. They know the basic anatomy of the lungs and describe the role of the lungs in breathing. They know that inhaled air has more oxygen and less carbon dioxide than exhaled air, and that these gases are carried to and from the body's cells in blood vessels. They know why smoking affects health. They know the difference between red and white blood cells. They know the basic structure and function of the human heart and the names and locations of the major blood vessels. They can relate the structure of arteries, veins and capillaries to their functions. They know about diabetes and obesity. They describe the structure and function of plant cells involved in photosynthesis. They know that green plants make their own food by photosynthesis, which requires light and the chlorophyll in chloroplasts, together with water and carbon dioxide, and that oxygen is produced. They can give examples of the use of micro-organisms in food production.

Materials

Students know that the smallest particle of an element is an atom and that atoms of one element are different from atoms of every other element. They know that compounds are formed from elements and that a molecule is the smallest particle of a compound. They represent elements by symbols and compounds by formulae. They classify elements according to whether they are solids, liquids or gases, and whether they are metals or non-metals. They know where the metallic and the non-metallic elements occur in the periodic table, and can identify reactivity trends for metals in the table. They arrange metals in order of reactivity based on their reactions with air, oxygen, water and dilute acids, and know the products of these reactions. They know that reactive metals can displace less reactive ones from their compounds. They test for hydrogen. They know that we use a variety of

methods to prevent iron from rusting, according to the use we make of the metal. They know that the ease of extraction of a metal from its ore depends on its position in the reactivity series. They know that metals are malleable, ductile and good conductors of heat and electricity, and they link the uses we make of well-known metals to their particular chemical and physical properties. They contrast the physical properties of metallic and non-metallic elements. They know the reactions of acids with metals, carbonates and metal oxides. They name a number of common salts and state their uses.

Earth and space

Students explain night and day, eclipses, seasons and phases of the Moon in terms of the Sun–Earth–Moon system. They describe the relative positions of the planets and their conditions compared with conditions on Earth, and identify some planets in the night sky. They know that the Sun is a star and that it radiates light and heat but that we can see the Moon and the planets because they reflect light from the Sun. They recount a number of uses for artificial satellites. They assess evidence for our modern understanding of the Solar System and show how this understanding has evolved over time.

Physical processes

Students classify common energy forms as kinetic or potential and measure it in joules. They know that energy can be transformed from one form to another, and that the total energy remains constant during a transformation. They know heat is always produced during energy transformations and that getting rid of it is often an engineering problem. They distinguish between temperature and heat. They know that heat is transferred by conduction, convection and radiation, and that radiation can occur in a vacuum. They know that the heat conductivity of different materials varies. They know the cause of convection currents and how these affect the weather. They know how the nature of a surface affects how well it absorbs and radiates heat. They know how shadows form, and represent a ray of light by a line. They know how light is reflected and refracted and describe applications and examples of reflection and refraction. They show how white light can be split into coloured light by refraction and give everyday examples of dispersion. They know that white light results from the superimposition of red, green and blue light and apply this to television and to colour vision. Students name factors affecting the strength of an electromagnet and describe some applications of electromagnets in everyday life. They know how a current-carrying wire moves in a magnetic field and can apply this to make an electric motor.

The balance between scientific enquiry and the subject content strands

The science standards for Grade 8 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 8

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 8, 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 8, 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 8

Scientific enquiry

By the end of Grade 8, students plan, collect data and make observations in a systematic way, identify patterns, consider the validity of evidence, the extent to which it supports a prediction, and draw conclusions. They make working models to illustrate scientific ideas and solve scientific problems. They consider how to take representative samples during large investigations and carry out a preliminary investigation to assess practicability. They know that scientific work is often done collaboratively, sometimes with colleagues in other countries and they assess the contributions of specific scientists. They express qualitative and quantitative information through a range of techniques, including graphs and scale diagrams, and use word equations to represent chemical reactions. They process electronically logged data in appropriate ways and select and use optical equipment safely and accurately.

Key standards

Key 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.

Students should:

1 Use methods of scientific investigation

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

1.2 Consider the extent to which the evidence justifies a conclusion or supports a prediction or hypothesis, and identify further investigations that might be needed.

1.3 Make working models to illustrate scientific concepts and applications.

1.4 Take representative samples during large investigations and decide how many measurements are required for the results to have an acceptable reliability.

1.5 Conduct preliminary investigations to assess the practicality of larger scale ones.

1.6 Search for, select and make critical use of secondary information sources, such as sources on the Internet.

2 Know how scientists work

2.1 Know that scientists often work in collaboration and with colleagues in other countries.

2.2 Assess the importance of the work of specific scientists in developing our understanding of science.

3 Process and communicate information

3.1 Present qualitative and quantitative data using a range of methods, such as descriptions and tables and through pictures, graphs and diagrams, using ICT methods where appropriate, and draw conclusions from them.

3.2 Use graphical methods for discounting experimental error.

3.3 Process electronically logged data in appropriate ways and draw conclusions from them.

3.4 Express chemical reactions in the form of word equations.

4 Handle equipment and make measurements

4.1 Use datalogging equipment to collect experimental data.

4.2 Use time-lapse digital photography to record slow events.

4.3 Select and use optical equipment safely and accurately.

Life science

By the end of Grade 8, students construct and interpret a pyramid of numbers and biomass. They understand why toxins increase in concentration along a food chain. They know the structure of the digestive system and understand the functioning of enzymes. They distinguish between digestion and absorption of food. They know the basic anatomy of the lungs and describe the role of the lungs in breathing. They know that inhaled air has more oxygen and less carbon dioxide than exhaled air, and that these gases are carried to and from the body's cells in blood vessels. They know why smoking affects health. They know the difference between red and white blood cells. They know the basic structure and function of the human heart and the names and locations of the major blood vessels. They can relate the structure of arteries, veins and capillaries to their functions. They know about diabetes and obesity. They describe the structure and function of plant cells involved in photosynthesis. They know that green plants make their own food by photosynthesis, which requires light and the chlorophyll in chloroplasts, together with water and carbon dioxide, and that oxygen is produced. They can give examples of the use of micro-organisms in food production.

Students should:

5 Construct and interpret quantitative representations of feeding relationships

5.1 Relate changes in numbers of organisms in a habitat to their feeding relationships.

Use a spreadsheet to model the changes in numbers of organisms in a food web as a consequence of increasing or decreasing the numbers of primary consumers.

Enquiry skills 1.2, 3.1

ICT opportunity

Use a spreadsheet.

Use food web diagrams to predict general changes in population numbers of animals at the top of a food chain when population numbers at the bottom of the chain change.

Construct a card game to illustrate what eats what in a range of environments.

Select examples of predator–prey relationships from video clips.

5.2 Interpret pyramids of numbers and biomass representing the organisms linked in a food chain.

Use numerical data on animal populations in various habitats to draw a pyramid of numbers for each habitat. **Enquiry skill 3.1**

5.3 Explain why toxins increase in concentration along a food chain.

Use data on the concentration of pesticides in small mammals and birds of prey (such as falcons) to draw charts to illustrate changes in concentration per unit of body mass. **Enquiry skills 1.2, 1.6, 3.1**

6 Know the simple anatomy and basic functioning of the human digestive system

6.1 Recall the general structure of the human digestive system and explain the functions of the digestive organs (mouth, oesophagus, small and large intestines and colon, stomach, liver, gall bladder and pancreas).

Use specimens, models, charts and, if appropriate, a mammal dissection to illustrate the anatomy of the digestive system. **Enquiry skills 1.3, 3.1**

Make a life-size model or wall chart of the human digestive system and label the organs and their functions.

6.2 Explain digestion as the breakdown of large insoluble food molecules into smaller soluble molecules that can be absorbed into the blood stream for transport round the body.

Use visking tubing to model the intestine. Have one model intestine filled with starch and the other with starch and amylase. Place each in separate breakers of warm water. Leave for some time and test the water in both beakers for the presence of starch and sugar. **Enquiry skills 1.2, 1.3, 3.1**

Examine molecular models of starch, protein and fat and compare their sizes with those of glucose, amino acids and fatty acids.

Test some common foods for the presence of starch, protein and fat.

6.3 Relate the digestive enzymes amylase, protease and lipase to their substrates and products, and explain how secretions of enzymes, stomach acid and bile control digestive processes.

Carry out simple chemical tests to establish if amylase acts on starch, protein or fat. **Enquiry skill 1.2**

Using plates of starch agar, determine the rate at which amylase digests starch.

Test the product of a starch and amylase reaction to demonstrate the presence of sugar.

Make a life-size model or wall chart of the human digestive system and label the organs and their functions. **Enquiry skill 1.3**

Carry out experiments to determine the substrate and products of amylase, protease and lipase.

Determine the rate of enzyme action in different pH conditions.

Do experiments to test ideas on the action of indigestion tablets.

7 Know how gases get to and from body cells

7.1 Know the basic structure of the lungs and their role in gas exchange (breathing).

Use specimens, models and charts to identify the structure of the lungs and relate structure to function. **Enquiry skill 3.1**

Measure lung capacity.

Measure breathing rate in different conditions (e.g. at rest and during exercise).

7.2 Know that inhaled air has more oxygen than exhaled air, and that exhaled air has more carbon dioxide than inhaled air.

Use limewater and/or bicarbonate indicator to illustrate that exhaled air contains carbon dioxide. **Enquiry skill 3.5**

7.3 Know that oxygen and carbon dioxide are carried round the body to and from cells in blood vessels.

Discuss data on the gaseous composition of blood in arteries and veins. **Enquiry skill 3.1**

7.4 Know that smoking damages the lungs and reduces the efficiency of gas exchange.

Using a smoking machine, collect the tar and other residues produced by cigarette smoke. **Enquiry skill 1.2**

7.5 Compare and contrast the similarities and differences between red and white blood cells and their functions.

Use a microscope to examine and draw prepared slides of red and white blood cells. **Enquiry skill 3.1**

8 Know the structure and function of the heart and associated blood vessels

8.1 Know the basic structure of the heart and relate this to its function.

Examine the structure of the heart using a model of a human heart or a specimen of an animal heart obtained from a butcher.

Find out which scientists have made a contribution to our knowledge of the heart and blood system. **Enquiry skill 2.2**

8.2 Know the different valves of the heart and how they function.

Examine a model valve to illustrate the one-way flow.

Use the Internet to find out about artificial heart valves.

Calculate the number of times a heart valve opens and closes in a day, week and year.

ICT opportunity

Obtain information from the Internet.

8.3 Know the positions, functions and names of the major blood vessels.

Prepare a wallchart of the blood system. **Enquiry skill 3.1**

Play a card game to match blood vessels, positions and functions.

8.4 Recognise the differences between arteries, veins and capillaries, and relate their structure to their function.

Examine slides of blood vessels with a microscope. **Enquiry skill 1.2**

8.5 Explain blood pressure and why high blood pressure is an indicator of circulatory problems.

9 Know about some common metabolic problems

9.1 Know the symptoms, causes and problems of diabetes and obesity.

Chart the statistics on the frequency of diabetes and obesity in Qatar and compare with other countries. **Enquiry skills 1.2, 3.1**

Consult an encyclopaedia to find out which scientists have contributed to our understanding of diabetes. **Enquiry skill 2.2**

10 Know the requirements for green plants to make their own food by photosynthesis and the products released

10.1 Describe the structure and function of plant cells involved in photosynthesis.

Make sections and slides of the leaves of green plants, examine them under a microscope and draw their structures.

Enquiry skills 1.2, 3.1

10.2 Know that green plants make their own food by photosynthesis and that water and carbon dioxide are required and oxygen is produced.

Test green leaves for the presence of starch.

Enquiry skills 1.1, 3.5

Keep green plants (e.g. oats) in conditions of low and high light and low and high levels of carbon dioxide and record their growth over time.

Develop an exhibition of human food that is produced by green plants.

10.3 Know that light energy and chlorophyll contained in chloroplasts are requirements for photosynthesis.

Extract chlorophyll from green leaves and show that it absorbs light.

Enquiry skill 1.2

Make models of cells with chloroplasts.

Use a microscope and photomicrographs to study the structure of cells containing chlorophyll.

10.4 Construct the chemical equation for photosynthesis in words and symbols.

Enquiry skill 3.5

11 Give examples of the use of micro-organisms in food production

11.1 Know that micro-organisms are used in making foods such as bread, cheese and yoghurt.

Using a starter culture of live bacteria, make pots of yoghurt.

Safety

If the yoghurt is to be tasted, work in a food preparation area, not a laboratory.

11.2 Know that micro-organisms are used to make beer and wine.

Materials

By the end of Grade 8, students know that the smallest particle of an element is an atom and that atoms of one element are different from atoms of every other element. They know that compounds are formed from elements and that a molecule is the smallest particle of a compound. They represent elements by symbols and compounds by formulae. They classify elements according to whether they are solids, liquids or gases, and whether they are metals or non-metals. They know where the metallic and the non-metallic elements occur in the periodic table, and can identify reactivity trends for metals in the table. They arrange metals in order of reactivity based on their reactions with air, oxygen, water and dilute acids, and know the products of these reactions. They know that reactive metals can displace less reactive ones from their compounds. They test for hydrogen. They know that we use a variety of methods to prevent iron from rusting, according to the use we make of the metal. They know that the ease of extraction of a metal from its ore depends on its position in the reactivity series. They know that metals are malleable, ductile and good conductors of heat and electricity, and they link the uses we make of well-known metals to their particular chemical and physical properties. They

contrast the physical properties of metallic and non-metallic elements. They know the reactions of acids with metals, carbonates and metal oxides. They name a number of common salts and state their uses.

Students should:

12 Distinguish between compounds and elements

12.1 Know that the smallest particle of an element is an atom and that atoms of one element are of one kind and are different from atoms of every other element.

Develop an exhibition of mixtures and compounds of various kinds. Indicate the main elements present in each exhibit.

Make a display of common elements and classify them according to whether they are solids, liquids or gases, metals or non-metals and consider the work of Mendeleev in developing a classification system for the elements.

Enquiry skill 2.2

12.2 Know that elements join together chemically to form compounds, that the smallest particle of a compound is a molecule, and that all molecules of a compound are made up of the same fixed number of atoms of the constituent elements.

Study the reaction between iron filings and powdered roll sulfur.

Enquiry skill 1.1

Compare properties of some common compounds with those of the elements from which they are made.

Recall Grade 7 activities that distinguish mixtures from pure compounds to emphasise the difference between mixtures and compounds.

Electrolyse solutions of ionic compounds to obtain their constituent elements (e.g. copper II chloride, water, molten lead bromide).

12.3 Know that all elements can be represented by a symbol, compounds by formulae and reactions by equations.

ICT opportunity

Use applets of molecules to show reactions.

Use symbols routinely in displays and on the chalkboard. (A suggested minimum list of elements for which symbols should be known and used is Na, K, Mg, Ca, Al, Fe, Cu, Zn, Au, Ag, H, O, S, C, Cl.)

Enquiry skill 3.5

Use symbols and formulae in the labelling of the exhibition of mixtures and compounds.

Use molecular models to represent elements and compounds and to show how atoms rearrange during simple reactions.

12.4 Know that mass is conserved during a chemical reaction and that the number of atoms of each element taking part in the reaction remains unchanged.

Use models to show that there is always the same number of atoms of each element in the products of a reaction as in the starting materials.

12.5 Recognise Mendeleev's periodic table as a means of classifying elements according to their properties. Identify where the more reactive and the less reactive metals occur on the periodic table and where the metals and the non-metals occur.

Enquiry skill 2.2

12.6 Know that elements with similar properties are arranged in columns in the periodic table and that the properties of elements change gradually along the rows.

Refer to experiments with the alkali metals in section 13.

See Standard 13.1

Compare the properties of the common transition metals and note their positions on the periodic table.

Enquiry skill 1.1

Compare the properties of the elements, their oxides and chlorides from sodium to argon.

13 Deduce a reactivity series for metals

13.1 Deduce a reactivity series for common metals based on their reactions with air, oxygen, water and dilute acids.

Investigate how metals corrode or tarnish when left in dry or moist air.

Enquiry skill 4.2

Demonstrate:

- *the spontaneous combustion of sodium and/or potassium;*
- *the reaction between metals and oxygen;*
- *the production of hydrogen when sodium reacts with water;*
- *the reaction between iron or magnesium and steam.*

Safety

Take appropriate care when using potassium and sodium and when using gas from cylinders.

Investigate the reaction between calcium or lithium and water.

13.2 Know that the test for hydrogen is that it explodes when mixed with air and ignited.

Carry out small-scale generation of, and testing for, hydrogen from zinc and dilute acid.

Safety

Hydrogen gas is explosive.

13.3 Know that when metal reacts with air, oxygen or water, an oxide or hydroxide is formed and that if this is soluble in water, the solution is alkaline.

Use the products of the reactions with air and water in Standard 13.1. Dissolve them in water, where possible, and test the resulting solution with an indicator.

13.4 Correctly place a metal in the reactivity series based on experimental evidence.

Carry out tests on an unknown metal (e.g. nickel) and place it on the reactivity series.

13.5 Account for the anomalous behaviour of aluminium in its reactions with air, water and dilute acids.

13.6 Know that iron will rust in the presence of air and water, and that it can be protected from rusting by oiling, painting, galvanising, coating with plastic, electroplating and tin plating.

Investigate rusting of iron under a variety of conditions.

Enquiry skill 1.1

Investigate the effectiveness of the different ways of preventing rusting.

13.7 Understand that reactive metals can displace less reactive ones from their compounds.

Investigate the displacement of metals from solutions of their salts and from solid compounds.

Enquiry skill 3.1

Demonstrate the thermit reaction.

Safety

The thermit reaction should only be done outdoors.

13.8 Know that the ease of extraction of a metal from its ore depends on its position in the reactivity series.

Discuss the occurrence of uncombined metals at the bottom of the reactivity series and methods used to recover alluvial gold. Link this natural low reactivity with the use of these metals in jewellery.

Study the displacement of metals in the middle of the reactivity series from their oxides by carbon. Extract copper from copper oxide on a charcoal block using a blowpipe.

Show that the most reactive metals (e.g. group 1 and 2 metals and aluminium) cannot be extracted on a charcoal block. Obtain information on their extraction by electrolysis from the Internet.

Safety

Fire risk. Charcoal blocks must be carefully extinguished after use.

ICT opportunity

Use the Internet as an information source.

13.9 Know that metals are ductile, malleable and good conductors of heat and electricity, and that these physical properties vary from metal to metal.

Recall the experiments in earlier years showing the conductivity of heat and electricity.

13.10 Link the properties and uses of some well-known metals, such as gold, silver, copper, iron and aluminium.

Create a display or make a PowerPoint presentation showing the main uses of common metals.

Make a study, using information from the Internet, of the history of our knowledge of metals, noting that the order in which they were discovered and exploited is the reverse reactivity order.

ICT opportunities

Obtain secondary information from the Internet.

Make a PowerPoint presentation.

13.11 Know that some metals, such as iron and nickel, can be magnetised.

Recall the experiments in earlier years on which metals are magnetic and can be magnetised.

13.12 Contrast the physical properties of metallic and non-metallic elements.

13.13 Explain the physical properties of metals by the particle theory.

14 Know that salts are important compounds of metals and that they can be made in a variety of ways

14.1 Know the different reactions by which salts can be made.

Prepare salts (e.g. zinc chloride, calcium nitrate) by the reaction of a metal and dilute acid.

Enquiry skill 3.5

For all examples in this standard.

Prepare salts by adding a number of different carbonates to different dilute acids.

Prepare copper sulfate from copper oxide.

Neutralise vinegar with portions of slaked lime (calcium hydroxide). Test the solution with litmus paper to determine when the reaction is complete.

14.2 Explain why calcium carbonate does not react easily with sulfuric acid.

14.3 Name a number of common salts and state their uses.

Earth and space

By the end of Grade 8, students explain night and day, eclipses, seasons and phases of the Moon in terms of the Sun–Earth–Moon system. They describe the relative positions of the planets and their conditions compared with conditions on Earth, and identify some planets in the night sky. They know that the Sun is a star and that it radiates light and heat but that we can see the Moon and the planets because they reflect light from the Sun. They recount a number of uses for artificial satellites. They assess evidence for our modern understanding of the Solar System and show how this understanding has evolved over time.

Students should:

15 Know about the Solar System

15.1 Explain night and day, eclipses, seasons, tides, and phases of the Moon in terms of the movement and relative sizes of the Sun, Earth and Moon.

Show night and day, eclipses, seasons and phases of the Moon using a model of the Sun–Earth–Moon system.

Collect and interpret data on temperature and time of day and the position of the Sun.

Enquiry skill 4.1

Examine tide tables (or measure high-tide marks) for neap and spring tides and link them with the relative orientations of the Sun and the Moon.

ICT opportunity

Use a datalogger.

15.2 Describe the relative positions of the planets, and their conditions compared with conditions on Earth.

Construct a scale model of the Solar System (note that different scales must be used for distance from the Sun and planet diameter). Collect data on size, composition, density, day and year length, and on special features, such as moons, rings and atmospheric phenomena.

Make a collection and display of photographs of planets sent back by various spacecraft.

Enquiry skill 2.1

Make a study, with the help of the Internet, of the historical development of our understanding of the Solar System. Note particularly the events leading to the discovery of Neptune, the existence and position of which was predicted, based on scientific evidence, before it was sighted.

Enquiry skill 1.2

ICT opportunity

Obtain secondary information from the Internet.

Debate why life seems to exist on only one planet – the Earth.

15.3 Be able to identify some planets in the night sky; know that we can see them and the Moon because they reflect light from the Sun.

Make observations of the night sky at regular intervals over the year. Keep an astronomical diary and make displays. Interpret a star map.

15.4 Know that the Sun is a star and that, like all stars, it radiates light and heat.

15.5 Know that the source of the Sun's heat and light is a nuclear reaction in which matter is turned into energy.

15.6 Recount a number of uses for artificial satellites.

Observe large satellites, such as the international space station, passing overhead at night; obtain orbital details from the Internet.

ICT opportunity

Use the Internet as an information source.

Use a GPS (global positioning system) receiver to determine the position and height above sea level of the school gate or other landmark. Understand how the GPS uses satellites.

Realise why satellites that broadcast TV channels to Earth are geostationary with an orbital period the same as the Earth's rotational period.

15.7 Assess evidence for our modern understanding of the Solar System and show how this understanding has evolved over time.

Use secondary sources to find out how the Solar System was interpreted in the past. Interpret the evidence that refuted these ideas.

15.8 Understand the importance of the Sun–Earth–Moon system in telling the time. Know the reasons for the differences between the Islamic calendar and the Gregorian calendar.

Physical processes

By the end of Grade 8, students classify common energy forms as kinetic or potential and measure it in joules. They know that energy can be transformed from one form to another, and that the total energy remains constant during a transformation. They know heat is always produced during energy transformations and that getting rid of it is often an engineering problem. They distinguish between temperature and heat. They know that heat is transferred by conduction, convection and radiation, and that radiation can occur in a vacuum. They know that the heat conductivity of different materials varies. They know the cause of convection currents and how these affect the weather. They know how the nature of a surface affects how well it absorbs and radiates heat. They know how shadows form, and represent a ray of light by a line. They know how light is reflected and refracted and describe applications and examples of reflection and refraction. They show how white light can be split into coloured light by refraction and give everyday examples of dispersion. They know that white light results from the superimposition of red, green and blue light and apply this to television and to colour vision. Students name factors affecting the strength of an electromagnet and describe some applications of electromagnets in everyday life. They know how a current-carrying wire moves in a magnetic field and can apply this to make an electric motor.

Students should:

16 Understand how energy is transformed

16.1 Classify common forms of energy as either kinetic or potential energy.

16.2 Give examples of processes and devices that transform one form of energy into others.

Make some devices that convert one form of energy into others. **Enquiry skill 1.3**

Create an exhibition of energy transducers, listing the energy forms changed and whether they are kinetic or potential.

List some common everyday examples of energy transformations; represent them diagrammatically in a manner that also indicates the relative proportions of the different forms of energy formed in a transformation.

16.3 Know that during energy transformations energy is converted from one form to others but that the total energy remains the same.

16.4 Know that heat is produced in all energy transformations and that getting rid of waste heat energy is an engineering problem in many energy transformations.

List a number of important energy transformations in living and physical systems and describe how waste heat is removed.

16.5 Know that the petrochemical complexes in Qatar use seawater to remove waste heat and know why there are strict regulations that control the temperature of the seawater that is returned to the sea.

Make an industrial visit to study cooling by seawater.

16.6 Know and use the joule as the unit of energy.

Measure or calculate energy transformed in some simple processes.

17 Understand the concepts of heat and temperature, and know how heat is transferred

17.1 Know that temperature is a measure of how hot something is and the common unit of temperature is the degree Celsius.

17.2 Know that the amount of heat energy in an object depends on the mass of the object and what it is made of as well as than how hot it is.

17.3 Know that heat is transferred by conduction, convection and radiation and cite everyday examples of each.

List everyday objects that are associated with heat production and transfer, and classify them according to how the heat is transferred (consider objects such as a refrigerator, a cooker, a fire, a water boiler, a car radiator).

17.4 Know that some materials are better conductors of heat than others; know the differences in the ability to conduct heat between solids, liquids and gases, and between metals and non-metals, and know some applications of these differences.

Test the heat conductivity of rods made of different materials.

Enquiry skills 1.1, 1.2

Compare the heat insulating properties of a variety of materials.

Use models to compare the effectiveness of different roof structures and materials in keeping buildings cool.

17.5 Explain the cause of convection currents in air and water.

Demonstrate convection currents in a liquid.

Draw a diagram of a domestic water system, showing how it depends on convection to operate correctly.

17.6 Show how convection currents in air cause weather features.

Explain why onshore and offshore winds are common at different times of the day.

17.7 Know that the nature of a surface influences how well it absorbs and radiates heat.

Measure radiant heat from different surfaces at the same temperature.

Show that absorption of heat depends on the nature of the material covering a thermometer bulb.

Enquiry skill 1.2

17.8 Know that heat can be radiated through a vacuum and that this is how the heat from the Sun reaches the Earth.

Make a study of the different ideas incorporated into the design of buildings and clothing that make them cool in hot weather.

18 Understand the reflection, refraction and dispersion of light

18.1 Know that light travels in straight lines and that objects in the path of light cast shadows.

Show a laser beam travelling though dust.

Safety

Take care when handling lasers.

18.2 Know that the intensity of light can vary depending on the light source and its distance away; measure the intensity using a light sensor.

Use light sensors to study light from different sources. Show the 50 Hz switching in a fluorescent tube.

Enquiry skills 3.1, 4.3

ICT opportunity

Use a datalogger to show how light intensity varies over time.

18.3 Represent a ray of light by a line in diagrams showing reflection, refraction and dispersion of light.

Show, in diagrammatic form, the pathway of light in examples cited in Standards 18.4–9.

18.4 Describe how light is reflected at a surface and understand the difference between reflection by rough and smooth surfaces. Know the characteristics of an image formed in a plane mirror. Describe everyday applications of reflection.

Measure the intensity of light before and after reflection.

Plot the path of a ray of light reflected in a mirror using a ray box or optical pins. **Enquiry skills 3.1, 4.3**

Determine the nature and position of an image in a plane mirror. **Enquiry skill 3.1**

Make a model periscope; make a kaleidoscope; make a model illustrating 'Pepper's ghost'. **Enquiry skill 1.2**

18.5 Describe how light is refracted at a plane surface and describe everyday applications of refraction.

Investigate the path of a ray of light refracted through a glass block. **Enquiry skills 3.1, 4.3**

Perform the 'disappearing coin' experiment, showing how a coin can be made visible at the bottom of an opaque beaker by filling it with water.

Study the formation of mirages on a hot day, noting how they can be explained by refraction.

Study examples of real and apparent depth (e.g. the 'bent stick' in water).

18.6 Demonstrate how white light can be split into coloured light by refraction and explain examples of dispersion in everyday life (e.g. oil on water, rainbows).

Create a spectrum from sunlight using a mirror in a bowl of water.

Draw diagrams showing how the separate paths of red and blue light result in the formation of a visible spectrum. **Enquiry skill 3.1**

Study the formation of primary and secondary rainbows in a watering spray.

18.7 Know that objects appear coloured when viewed in white light because some colours are reflected by the object but others are absorbed.

18.8 Explain why objects appear one colour in white light but a different colour in coloured light.

18.9 Know the effect of superimposing red, green and blue colour filters.

Show overlapping red, green and blue filters on the top of an overhead projector.

18.10 Know that red, green and blue light, when superimposed, create white light and apply this knowledge to television screens and to colour vision.

Show overlapping beams of red, green and blue light from a projector.

18.11 Know that red–green colour-blindness is common among males.

Carry out red–green colour-blindness tests on students.

19 Make an electromagnet and explain some of its applications

19.1 Know that a coil of wire carrying a current produces a magnetic field similar to a bar magnet; list the factors affecting the strength of an electromagnet.

Make an electromagnet and test it (by finding out how many paperclips it can pick up in a chain). Test its strength while varying the number of coils, the current and nature of the core.

19.2 Explain the function of the electromagnet in some everyday examples, such as in relays, electric bells and lifting devices.

19.3 Demonstrate that a wire carrying a current creates a magnetic field.

Detect the magnetic field produced by a straight wire carrying a current.

19.4 Demonstrate and explain how a wire and a coil carrying a current moves in a magnetic field.

Show how a wire in a magnetic field will move when a current is switched on in it.

19.5 Know how the movement of a current-carrying wire in a magnetic field can be exploited to make an electric motor; know how and why an electric motor turns and understand the function of the commutator.

Make and test a model electric motor. **Enquiry skill 1.3**

19.6 List and explain the main differences between a model electric motor, with a single coil and a permanent magnet, and commercial electric motors.