Science Curriculum Statement

Core values

For the Spirit that God has given us does not make us timid; instead, his Spirit fills us with power, love and self-control ***2 Timothy 1:7***

At the heart of our distinctive culture is our commitment to being a dynamic learning community, rooted in Christianity, where people matter. In this, we seek wisdom and pursue excellence.

The goals of science education is not the just the knowledge of a body of facts and theories, **but a progression towards understanding key ideas of relevance to students' lives during and beyond their school years.** The 'big ideas' should be understood by all students –not just those who go on to study science or take up science-based occupations beyond school, and equally by all, regardless of gender, cultural background, socio-economic background and additional needs. For individual learners there are benefits from being able to grasp the essential features of events and phenomena in the world around them that enable them to make informed decisions affecting their own and others' health and wellbeing. The global issues faced by humanity, such as climate change, health and population growth, create an urgent need for young people to have a basic understanding of the relevant scientific ideas, technological and ethical issues and powers of reasoning, to be prepared to face these issues.

Science education also needs to take account of changes in the work place that require ability to link science with engineering, technology and mathematics (STEM). It prepares students to participate in, rather than being at the mercy of, the rapid changes in occupations and communication using technologies, developed through engineering and applications of science.

For this understanding students' need learning experiences that are interesting and engaging and seen as relevant to their lives. Science education should enhance learners' curiosity, wonder and questioning, building on their natural inclination to seek meaning and understanding of the world.

Ranelagh School Learner Profile

The Science Department at Ranelagh School aims to foster a lifelong interest in science whilst embedding the core values of the Ranelagh School Learner Profile:

Confidence: Students who are brave enough to make mistakes and willing to defend their thinking. Students that are not afraid to challenge their teacher/ classmates and are not afraid to ask for help and answer questions. Students that are willing to accept mistakes in answering questions and learning from these.

Resilience: Students are willing to learn from each other and willing to modify their ideas and abandon misconceptions. Students who are not discouraged by “unusual” results in experiments. Students who are unafraid of difficult concepts and are willing to try different approaches if something is difficult. Students who are able to use learning targets to improve and accepting that this will be a feature of lifelong learning. Students are able to respond positively to constructive criticism.

Curiosity: Students who that are willing to frame “hard to answer” questions. Students who willing to research new ideas and focus on deeper concepts, ask questions and are willing to find secondary sources to validate information. Students’ frame explanations to the questions “Why?” and “How do we know?”

Empathy: Students respond positively to the ideas of others. Students able to understand how ideas such as pollution and energy factors can relate to our own situations. Students can support fellow classmates for progress for all.

Independence: Students design and plan their own investigative experiments and activities. Students are able to manage their own learning and use the outcomes of assessments to improve. Students are able to access the relevant information and advice; show questioning minds and require evidence to accept ideas. Students are able to, resourcefully find answers. Students have opportunities to reflect and set their own targets and are able and willing to research their areas of weakness and uncertainty.

Creativity: Students are able to use equipment to test a hypothesis and are able to come up with their own explanations of experiment results. Students are able to use ideas and concepts to produce appropriate models to explain scientific phenomena. Students who model ideas using novel analogies and are able to evaluate their own limitations. Students are capable of alternative thinking and “out of the box” explanations and problem solving.

Curriculum Intent

We have specific plan of **what** we want pupils to know, and to be able to do at different stages, and by the time they leave school and it contains the following features:

- A curriculum that is ambitious for all students
- A curriculum that is coherently planned and sequenced
- A curriculum that is broad and balanced for all students
- A curriculum consisting of subject matter studied, as a vehicle for students to **understand the key ideas that they should encounter during their science education**.
- A curriculum that enables students to understand, enjoy and marvel at the natural world, develop essential skills and acquire **positive attitudes/dispositions towards science**, clarify its relevance to everyday life and its importance to their quality of life and life chances.

When planning lessons it is important for teachers to have in mind how the goals of individual lessons fit into a wider picture of more powerful ideas that can help students make sense of a broad range of related phenomena and events. Therefore, individual teachers must have an overview of each topic, how it fits into the curriculum at each key stage and the progression that builds up understanding of the key ideas from Years 7-13.

The **schemes of work** consist of individual lesson plans in which the:

- learning objectives and outcomes are clearly stated
- opportunities to embed 'Working Scientifically' skills and 'Mathematical skills' are clearly identified
- suggested lesson activities
- risk assessments
- paper and interactive whiteboard resources for shared use.
- Suggested homework task

Each topic has a summative assessment.
Teachers are encouraged to adapt lessons to suit their own teaching style and the student needs.
There is an ongoing review and development of the schemes of work at all key stages.

Practical work in science

The Royal Society states that **practical work is integral to science,** and is not an 'additional component' of teaching and learning. When Wellcome asked students about the reasons for enjoying science at school, the leading factors turned out to be having a good teacher and enjoying practical work. (Science Education Tracker 2019).

The excitement of practical work serves the following purposes:

1. Exposure to such activities brings to life the theory and underpinning knowledge of many of the most fundamental scientific concepts.
2. It provides opportunities to develop skills crucial in science and engineering careers, including precision, accurate measurement, and the mastery of equipment.
3. It also develops important transferable skills, such as teamwork, resilience and analysis that that will be valuable in a wide range of career paths, not just science based.
4. It is critical in nurturing a life-long interest in science and engages students to follow science further, on academic or technical routes.

We want our students to understand the **process of scientific activity** as well as the ideas to which it leads, that is, **to know how the ideas that explain things in the world around have been arrived at not just what these ideas are**. Without knowing how ideas were developed requires blind acceptance of many ideas about the natural world. Learners need to understand how to evaluate the quality of the information on which explanations are based. In Science this evaluation concerns the methods used in collecting, analysing and interpreting data to test theories.
Questioning the basis of ideas enables all of us to reject claims based on false evidence and to recognise when evidence is being used selectively to support particular actions. This is a key part of using scientific evidence in order to make decisions, such as the use of natural resources. To this end, we have embedded the teaching of 'Working Scientifically' skills into our day-to-day teaching and all individual lesson plans in our schemes of work identify the opportunity for students to develop these skills.

All department teachers should know the **purpose of any practical science** activity and plan and implement it to be effective and integrated with other science learning.

Our lesson activities should:

- Be a source of enjoyment and wonder but at the same time develop understanding
- Relate to student's lives and wellbeing
- Develop ideas about science, enquiry skills and willingness to find and take note of evidence
- Build upon existing ideas, skills and dispositions and stimulate further development
- Enable students to experience scientific activity as currently understood
- Promote understanding and responsibility for their learning through formative use of assessment

Curriculum overview

Our curriculum content aims to develop an understanding of the big ideas in science as a gradual and progressive process. At primary school, students will have small and contextualized ideas. At Key Stage Three, students have an increased capacity for abstract thinking that enables them to see connections between events and phenomena. At Key Stage Four, continuation of this creation of patterns and links enables students to understand relationships and models that can be used in making sense of a wide range of new and previous experiences. There are also opportunities to revisit and consolidate previously met ideas.

Key Stage Three

- We have implemented the 2014 National Curriculum for Science.
- We have used a publisher's scheme, Pearson's Exploring Science scheme to sequence the curriculum content because the sequence of the topics/curriculum content made sense in terms of the progression of the knowledge and understanding of the key ideas.
- Students are taught in their tutor groups in Year 7 and in mixed ability groups in Years 8 and 9. They receive six one-hour lessons a fortnight delivered by a pair of teachers (with a few exceptions).
- Each teacher in the pair will teach six of the twelve units and follow a teaching rota for each term.

Key Stage Four

- Students have a choice to study GCSE Combined Science (AQA Trilogy) of GCSE separate sciences (AQA).
- For the separate science GCSE course, students receive fourteen one-hour lessons a fortnight. They are taught five lessons a fortnight for Biology in Years 10 and 11, four and five lessons for Chemistry and four and five lessons for Physics.
- For Combined Science students receive nine one-hour lessons a fortnight, three for each science.
- Currently, Separate science students choose science in option blocks and we group Combined Science students in one top, two middle and one foundation class.
- **Key Stage Five**

- We follow the AQA course for A-Level Biology, Chemistry and Physics.
- Students receive nine one-hour lessons a fortnight taught by two teachers.

Mapping of the progression of the big ideas of science

1. All matter in the Universe is made of very small particles.

Year 7, first term: Arrangement of particles in solids, liquids and gases explain their properties (7G: Particle model)
Year 7, second term: Understanding the more abstract ideas of diffusion and dissolving and solubility (7E: Separating mixtures)
Year 7, third term: Atoms, molecules, elements, compounds and mixtures (7H: Atoms, elements and compounds)
Year 7, third term: Understanding Electrical current (7J: Current electricity)
Year 8, first term: Heat transfer by conduction, convection and evaporation (8J: Energy transfers)
Year 8, third term: Fluids, density of and pressure in fluids. Changes of state (8I: Fluids)
GCSE Chemistry: The development of the model of the atom; Atom structure, sub-atomic particles; electron configuration and reactivity (Topic 1).
GCSE Chemistry: Ions, ionic bonding and ionic compounds, covalent bonding and compounds and metallic bonding. (Topic 2).
GCSE Chemistry: Particle model and predicting state of substances at different temperatures; limitations of the particle model (Topic 2).
GCSE Chemistry: Conservation of mass and balanced chemical equations; Moles and molar solutions (Topic 3).
GCSE Physics: Atomic structure including nucleons; alpha and beta particles; radioactive decay (Topic 4).

2. Objects can affect other objects at a distance.

Year 7, first term: Show and explain how non-contact forces such as magnetism and electrostatic forces can act on objects at distances. Explain how weight is a force that acts between objects as a result of gravitational fields (7K: Forces)
Year 8, second term: Gravitational fields act at a distance between [planet-sized] masses resulting in weight and centripetal forces. How gravitational field strength decreases with increasing distance. Explain how orbital speeds of natural and artificial satellites/planets change as a result of varying gravitational field strength. Explain and show how magnetic field lines demonstrate the effect of a magnet over distance (8L: Earth and Space)
Year 9, first term: Explain how non-contact forces acting on objects produce accelerations from a distance above the Earth's surface, and when these are balanced by other resistive forces terminal velocities result (9I: Forces and motion)
Year 9, second term: Explain how magnetism can be visualised as a force field surrounding a magnet/electromagnet that can exert a force on an object from a distance. Explain and show how the strength of a magnetic field of an electromagnet can be increased by several means. Explain how the concept of positive and negative electrostatic charge can determine the type and direction of the force between 2 charged objects. Explain how weight, mass and gravitational field strength are linked, leading to 9.8 N/kg and 9.8 m/s^2 (9J Force fields and electromagnets)

GCSE Physics: Show and explain in detail how non-contact forces such as magnetism and electrostatic forces can act on objects at distances, and how non-contact forces vary in strength and direction depending on a number of factors. Explain how weight is a force that acts between objects as a result of gravitational fields, the strength of which depend on the mass of the attracting objects. (Topic 5: Forces and motion)
Gravitational fields result in the balanced forces of weight and centripetal forces, causing elliptical orbits, whose radius and velocities are a result of the varying strengths of gravitational attraction with masses and distance. (Topic 8: Space physics)

3. Changing the movement of an object requires a net force to be acting on it.

Year 7, first term: Types of forces, how they are measured and forces used to explain floating and sinking (7K: Forces and their effects)
Year 8, second term: Planetary orbits and gravity (8L: The Earth and Space)
Year 9, first term: Balanced an unbalanced forces and the motion of objects (9J: Forces and Motion)
GCSE Physics: Newton's Laws of Motion and free body diagrams (Topic 5: Forces and Motion).

4. The total amount of energy in the Universe is always the same but can be transferred from one energy store to another during an event.

Year 7, first term: Describe how energy can be considered as a number of stores, which can be transferred between these stores by events. The level of energy in stores is constant, and can be explained by transfers. Large energy stores such as fossil fuels are used by society. (7I Energy resources)
Year 8, first term: Explain how energy and temperature are related, but not the same. Explain how thermal energy can break the bonds between particles, leading to changes of state. Describe the 3 transfer processes of thermal energy, conduction, convection and radiation. Describe 2 aspects of social/domestic science involving transfer processes, reducing unwanted energy transfers and what is meant by efficiencies of transfer processes. (8K: Energy transfers)
GCSE Chemistry: Exothermic and endothermic reactions; the energy change of reactions; energy level diagrams (Topic 5).
GCSE Physics: Describe, explain and calculate using the concept of energy being considered as a number of stores, which can be transferred between these stores by events termed as transfer pathways. Describe how energy stores are part of the process by which work is done. The level of energy in stores is constant, and can be explained by these transfer pathways, taking into account dispersal of thermal energy. Large energy stores such as fossil fuels are used by society. Explain using quantitative processes the specific heat capacity as a link between temperature changes and thermal energy level. Explain unwanted energy transfers and describe how these may be reduced by considering thermal transfer, conduction and convection in particular. (Topic 1: Energy)

5. The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate.

Year 7, second term: Describe how fossil fuels were formed; explain how the Sun is the original source of energy for fossil fuels (7I: Energy).
Year 7, second term: Describe the gases in the air. (7H: Atoms, elements and compounds)
Year 8, third term: Explain how sulphur dioxide and nitrogen can cause acid rain. Explain how pollution from fossil fuel combustion can be reduced. Evaluate measures for reducing pollution from fossil fuel consumption. State the meaning of greenhouse effect, global warming and climate change. Explain how human activities are affecting global warming. (8E: Combustion)
Year 8, third term: Learn about the Earths structure, the earth's crust and the rock cycle. (8H: Rocks)
Year 8, second/third term: Describe differences in the seasons and use a model to explain the differences in the seasons. (8L: Earth and Space)
GCSE Biology: Air, land and water pollution including bioaccumulation; the greenhouse effect and its environmental impact (Topic 7).
GCSE Chemistry: Evolution of the atmosphere, greenhouse gases and climate change, carbon footprint and air pollution (Topic 9).

6. Our solar system is a very small part of one of billions of galaxies in the Universe.

Year 8, second term: Describe how Earth is a planet in a body of celestial objects called a solar system. The appearance of objects in the sky depends upon their motion and whether they orbit the Sun or Earth. The distances between the objects in the solar system are vast, and need to be scaled down to comprehend them. Human ideas about the solar system and other celestial objects have evolved over time. (8L Earth and space).
GCSE Physics: Describe and explain how Earth is a planet in a body of celestial objects called a solar system, involving a central star, planets, minor planets and many other smaller objects. The appearance of objects in the sky depends upon their motion and whether they orbit the Sun or Earth, these are important to explain lunar phases, solar and lunar eclipses. The distances between the objects in the solar system are vast, and need to be scaled down to comprehend them. Human ideas about the solar system and other celestial objects have evolved over time, and have evolved from an Earth-centric to a helio-centric model. Describe how stars are the central part of solar systems, they have a life span, the time cycles and detail of these life cycles depend on the size of the star. Describe and explain to some extent the organization of solar systems into galaxies. Describe how there is evidence of a Big Bang 'start' to our universe, and how evidence for this involves the red shift of receding galaxies and the cosmic microwave background (Topic 8).

7. Organisms are organised on a cellular basis and have a finite life span.

Year 7, first term: Organisms are made of cells, Animal and plant cell structure; Using a light microscope to observe a plant and animal cell
Cell specialisation; Tissue organisation; Examples of organs and organ systems and their functions; Main plant organs (7A: Cells).

Year 7, third term: Reproductive system; Fertilisation; Periods; Pregnancy; Birth (Topic 7B Reproduction).
Year 8, first term: A balanced diet; Digestive system: main organs; Digestive enzymes as simply breaking down large into small molecules. (8A Food and digestion).
Year 8, first term: The structure of the human gas exchange system; the mechanism of breathing (8B: Breathing and respiration).
Year 9, first term: Leaf structure; Role of stomata; Water transport in plants (Topic 9B Growing our food).
GCSE Biology: Eukaryotic and Prokaryotic cells; Light and electron microscopy; Scale and size of cells; Cell differentiation; Mitosis; Stem cells-
embryonic and adult; Therapeutic cloning; IAM calculations; Cell transport (Topic 1).
Principles of organisation; The digestive system and enzymes; Heart; Cardiac Cycle; Blood vessels; Blood; Coronary heart disease;
Non-communicable diseases; Cancer; Plant tissues, organs and systems (Topic 2)
Types of microbe: viruses, bacteria, protists and fungi; Examples of diseases caused by each type; Disease transmission; Human defence
systems; Vaccination; Antibiotics; Drug development; Monoclonal antibodies (Topic 4).

8. Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.

Year 7, first term: Characteristics of life including respiration (Topic 7A).
Year 7, term 3: Food chains and webs; Competition between organisms for resources (Topic 7D Ecosystems).
Year 8, first term: aerobic respiration (Topic 8C). **Year 9, first term:** Photosynthesis reaction; Adaptations of leaves to Photosynthesis; increasing crop yields using pesticides, biological
Control and fertilisers (Topic 9B Growing our food).
GCSE Biology: Rate of photosynthesis; Limiting factors and food production; Products of photosynthesis; Aerobic respiration; Anaerobic
respiration and oxygen debt; Fermentation reaction; Rate of fermentation; Response to exercise; Metabolism (Topic 4).

9. Genetic information is passed down from one generation of organisms to another.

Year 7, first term: Cell structure and function of nucleus; Genetic information as chromosomes in the nucleus made of DNA (Topic 7A Cells).
Year 8, first term: Flower structure, pollination and fertilisation; Seed dispersal (Topic 8B Reproduction in flowering plants).
Year 9, first term: Human karyotype; Model basic structure of DNA; Sex determination; Inherited variation limited to one gene/one characteristic (Topic 9A Genetics and Inheritance).
GCSE Biology: DNA Structure and replication; Stem cells (Topic 1). **GCSE Biology:** Advantages and disadvantages of asexual and sexual reproduction; Meiosis and variation; DNA and the genome; DNA structure; Protein synthesis; Mutations; Genetic inheritance including alleles; Inherited disorders; Selective breeding; Genetic engineering;
Adult cell cloning; Speciation; Understanding of genetics; Extinction (Topic 6).

10 The diversity of organisms, living and extinct, is the result of evolution.

Year 7, third term: Causes and types of variation: genes or environment; Adaptations; Response to environmental changes-daily and seasonal (Topic 7D Ecosystems).
Year 8, third term: Five kingdoms and main features; Animal phyla; Examples of interdependence (Topic 8B Reproduction in flowering plants).
Year 9, first term: Reasons for extinction; Methods of conservation; Introduction to biodiversity and its importance (topic 9A Genetics and Evolution).
GCSE Biology: Classification of living things; Taxonomic hierarchy; Linnaeus Binomial system; Domains; Phylogeny; Variation and evolution, Evidence for evolution; resistant bacteria; Fossils (Topic 6). **GCSE Biology:** Adaptations; Biodiversity and its importance; Threats to biodiversity: waste, pollution and land use; conserving biodiversity (Topic 7).

Year	Autumn Term	Spring Term	Summer Term
7	Working Scientifically skills Cells, tissues and organs Forces Acids and alkalis Energy Particle Model	Muscles and bones Mixtures and separation Sound	Atoms, elements and compounds Ecosystems Current electricity Sexual reproduction in animals
8	Food and digestion Light Energy transfers Breathing and respiration The periodic table	The Earth and space Unicellular organisms Metals and their uses	Rocks Fluids Combustion Sexual reproduction in plants
9	Genetics and evolution Growing our food Making materials Reactivity Forces and Motion Force fields and electromagnets Working Scientifically	**Start the AQA GCSE Science course** in March **Biology** Topic 1: Cells **Chemistry** Topic 1: Atomic Structure and the periodic table **Physics** Topic 1: Energy	Revision of Key Stage Three Science course **Continue with the GCSE Science course:** teaching the first eight lessons of: **Biology** Topic 1: Cells **Chemistry** Topic 1: Atomic Structure and the periodic table **Physics** Topic 1: Energy
10	**Biology** Topic 1: Cells **Biology** Topic 2: Organisation **Chemistry** Topic 1: Atomic structure and the periodic table **Chemistry** Topic 2: Bonding, structure and properties of matter **Physics** Topic 2: Electricity **Physics** Topic 3: Particle model of matter.	**Biology** Topic 3: Infection and response **Biology** Topic 4: Bioenergetics **Chemistry** Topic 3: Quantitative Chemistry **Chemistry** Topic 4: Chemical changes **Physics** Topic 4: Atomic structure	**Biology** Topic 5: Homeostasis and responses **Chemistry** Topic 5: Energy Changes **Chemistry** Topic 6: Rate and extent of chemical change **Physics** Topic 5a: Forces
11	**Biology** Topic 5: Homeostasis and response **Biology** Topic 6: Variation, inheritance and evolution **Chemistry** Topic 7: Organic Chemistry **Chemistry** Topic 8: Chemical analysis **Physics** Topic 5a: Forces **Physics** Topic 5b: Motion **Physics** Topic 6: Waves	**Biology** Topic 6: Variation, inheritance and evolution **Biology** Topic 7: Ecology **Chemistry** Topic 9 : Chemistry of the atmosphere Chemistry Topic 10: Using resources **Physics** Topic 7: Magnetism and electromagnetism	**Biology:** Examination preparation **Chemistry:** Examination preparation **Physics:** Examination preparation

		Physics Topic 8: Space Physics (GCSE Physics only)	
12	**Biology** Topic 1: Biological Molecules **Biology** Topic 2: Cells **Chemistry** topics: 3.1.2: Amount of substance 3.1.4: Energetics 3.1.1: Atomic structure 3.3.1: Introduction to organic chemistry 3.3.2: Alkanes 3.1.3: Bonding **Physics** Topic 1: Measurements and their errors **Physics** Topic 4: Mechanics and materials **Physics** Topic 2: Particles and radiation	**Biology** Topic 3: Exchange with the environment. Biology Topic 4: Genetic information, variation and relationships between organisms. **Chemistry** Topics: 3.1.6: Equilibria 3.1.7: Oxidation reduction + redox reactions 3.2.2: Group 2, the alkaline earth metals 3.1.5: Kinetics 3.3.3: Halogenalkanes **Physics** Topic 5: Electricity	**Biology** Topic 5: Energy Transfers in and between organisms **Biology** Topic 7: Genetics, populations, evolution and ecosystems. **Chemistry** Topics: 3.2.3: Group 7, the halogens 3.2.1: Periodicity 3.3.6: Organic Analysis 3.3.4: Alkenes 3.3.5: Alcohols **Physics** Topic 3: Waves Topic 6b: Thermal Physics
13	**Biology** Topic 5: Energy transfers in and between organisms **Biology** Topic 7: Genetics, populations, evolution and ecosystems. **Chemistry** topics: 3.1.8: Thermodynamics 3.1.12: Acids and Bases 3.1.11: Electrode potentials and electrochemical cells 3.2.6: Reactions of ions in aqueous Solution 3.3.7: Optical isomerism 3.3.8: Aldehydes and ketones 3.3.9: Carboxylic acids and derivatives 3.3.10: Aromatic chemistry 3.3.11: Amines **Physics** Topic 6a: Further Mechanics **Physics** Topic 7: Fields and their consequences **Physics** Topic 8: Nuclear Physics	**Biology** Topic 6: Organisms respond to changes in their environment. **Biology** Topic 8: The control of gene expression. **Chemistry** topics: 3.2.5: Transition metals 3.2.4: Properties of Period 3 elements and their oxides 3.1.9: Rate equations 3.3.12: Polymers 3.3.13: Amino acids, proteins and DNA 3.1.10: Equilibrium constant for homogeneous systems 3.3.15: Nuclear magnetic resonance spectroscopy 3.3.16: Chromatography 3.3.14: Organic synthesis **Physics** Topic 9: Astrophysics	Examination preparation

Appendix

Ten principles of science education

1 Throughout the years of compulsory schooling, schools should, through their science education programmes, aim systematically to develop and sustain learners' curiosity about the world, enjoyment of scientific activity and understanding of how natural phenomena can be explained.

2 The main purpose of science education should be to enable every individual to take an informed part in decisions, and to take appropriate actions, that affect their own wellbeing and the wellbeing of society and the environment.

3 Science education has multiple goals. It should aim to develop:

- understanding of a set of 'big ideas' in science which include ideas of science and ideas about science and its role in society
- scientific capabilities concerned with gathering and using evidence
- scientific attitudes.

4 There should be a clear progression towards the goals of science education, indicating the ideas that need to be achieved at various points, based on careful understanding of how learning takes place.

5 Progression towards big ideas should result from study of topics of interest to students and relevance in their lives.

6 Learning experiences should reflect a view of scientific knowledge and scientific inquiry that is explicit and in line with current scientific and educational thinking. Science is by no means static; theories are dependent on available evidence and as such may change as new evidence emerges.

7 All science curriculum activities should deepen understanding of scientific ideas as well as having other possible aims, such as fostering attitudes and capabilities.

8 Programmes of learning for students, and the initial training and professional development of teachers, should be consistent with the teaching and learning methods required to achieve the goals set out in Principle 3.

9 Assessment has a key role in science education. The formative assessment of students' learning and the summative assessment of their progress must apply to all goals.

10 In working towards these goals, schools' science programmes should promote cooperation among teachers and engagement of the community including the involvement of scientists.

Ideas of science

1 All matter in the Universe is made of very small particles
Atoms are the building blocks of all matter, living and non-living. The behaviour and arrangement of the atoms explains the properties of different materials. In chemical reactions atoms are rearranged to form new substances. Each atom has a nucleus containing neutrons and protons, surrounded by electrons. The opposite electric charges of protons and electrons attract each other, keeping atoms together and accounting for the formation of some compounds.

2 Objects can affect other objects at a distance
All objects have an effect on other objects without being in contact with them. In some cases the effect travels out from the source to the receiver in the form of radiation (e.g. visible light). In other cases action at a distance is explained in terms of the existence of a field of influence between objects, such as a magnetic, electric or gravitational field. Gravity is a universal force of attraction between all objects however large or small, keeping the planets in orbit round the Sun and causing terrestrial objects to fall towards the centre of the Earth.

3 Changing the movement of an object requires a net force to be acting on it
A force acting on an object is not seen directly but is detected by its effect on the object's motion or shape. If an object is not moving the forces acting on it are equal in size and opposite in direction, balancing each other. Since gravity affects all objects on Earth there is always another force opposing gravity when an object is at rest. Unbalanced forces cause change in movement in the direction of the net force. When opposing forces acting on an object are not in the same line they cause the object to turn or twist. This effect is used in some simple machines.

4 The total amount of energy in the Universe is always the same but can be transferred from one energy store to another during an event
Many processes or events involve changes and require an energy source to make them happen. Energy can be transferred from one body or group of bodies to another in various ways. In these processes some energy becomes less easy to use. Energy cannot be created or destroyed. Once energy has been released by burning a fossil fuel with oxygen, some of it is no longer available in a form that is as convenient to use.

5 The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate
Radiation from the Sun heats the Earth's surface and causes convection currents in the air and oceans, creating climates. Below the surface heat from the Earth's interior causes movement in the molten rock. This in turn leads to movement of the plates which form the Earth's crust, creating volcanoes and earthquakes. The solid surface is constantly changing through the formation and weathering of rock.

6 Our solar system is a very small part of one of billions of galaxies in the Universe
Our Sun and eight planets and other smaller objects orbiting it comprise the solar system. Day and night and the seasons are explained by the orientation and rotation of the Earth as it moves round the Sun. The solar system is part of a galaxy of stars, gas and dust, one of many billions in the Universe, enormous distances apart. Many stars appear to have planets.

7 Organisms are organised on a cellular basis and have a finite life span
All organisms are constituted of one or more cells. Multi-cellular organisms have cells that are differentiated according to their function. All the basic functions of life are the result of what happens inside the cells which make up an organism. Growth is the result of multiple cell divisions.

8 Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms
Food provides materials and energy for organisms to carry out the basic functions of life and to grow. Green plants and some bacteria are able to use energy from the Sun to generate complex food molecules. Animals obtain energy by breaking down complex food molecules and are ultimately dependent on green plants as their source of energy. In any ecosystem there is competition among species for the energy resources and materials they need to live and reproduce.

9 Genetic information is passed down from one generation of organisms to another
Genetic information in a cell is held in the chemical DNA. Genes determine the development and structure of organisms. In asexual reproduction all the genes in the offspring come from one parent. In sexual reproduction half of the genes come from each parent.

10 The diversity of organisms, living and extinct, is the result of evolution
All life today is directly descended from a universal common ancestor that was a simple one-celled organism. Over countless generations changes resulting from natural diversity within a species lead to the selection of those individuals best suited to survive under certain conditions. Species not able to respond to changes in their environment become extinct.

Ideas for science

1. Science is about finding the cause of phenomena in the natural world
Science is a search to explain and understand phenomena in the natural world. There is no single scientific method for doing this; the diversity of natural phenomena requires a diversity of methods and instruments to generate and test scientific explanations. Often an explanation is in terms of the factors that have to be present for an event to take place as shown by evidence from observations and experiments. In other cases supporting evidence is based on correlations revealed by patterns in systematic observation.

2. Scientific explanations, theories and models are those that best fit the evidence available at a particular time
A scientific theory or model representing relationships between variables of a natural phenomenon must fit the observations available at the time and lead to predictions that can be tested. Any theory or model is provisional and subject to revision in the light of new data even though it may have led to predictions in accord with data in the past.

3. The knowledge produced by science is used in engineering and technologies to create products to serve human ends
The use of scientific ideas in engineering and technologies has made considerable changes in many aspects of human activity. Advances in technologies enable further scientific activity; in turn this increases understanding of the natural world. In some areas of human activity technology is ahead of scientific ideas, but in others scientific ideas precede technology.

4. Applications of science often have ethical, social, economic and political implications
The use of scientific knowledge in technologies makes many innovations possible. Whether or not particular applications of science are desirable is a matter that cannot be addressed using scientific knowledge alone. Ethical and moral judgments may be needed, based on such considerations as justice or equity, human safety, and impacts on people and the environment.

(Working with Big ideas of Science Education: Edited by Wynne Harlen 2015).