Science Curriculum Summary May 2024

Vision:

To ensure that students appreciate that science is everywhere. Produce students who are scientifically literate and able to succeed in an increasingly technologically and scientifically advanced world. Through the teaching of scientific methods, teach students how to think, learn, solve problems and make informed decisions.

Use experimentation to combine a scientific question with research to construct a hypothesis; conduct experiments to test that hypothesis; evaluate the results to draw conclusions; and communicate those conclusions. Use critical thinking and evidence to create solutions and make decisions. Create opportunities for engagement outside of traditional lessons. Overcome the perceived inward-looking nature of life in small rural towns.

Yearly Intent Statements

What are the aims of specific stages of the curriculum?

Year 7: By the end of the year…

Students will know cells are the fundamental unit of living organisms. They will be able to identify some of the similarities and differences between plant and animal cells by observing and recording cell structure. They will know about human reproduction, pregnancy and puberty. Students should be able to combine their thoughts on the menstrual cycle, fertilisation and implantation to explain the stages that may have resulted in a woman becoming pregnant. They will know about the structure of the respiratory system and skeletal system, the multiple functions of

bones in the body including their requirement for the protection of organs and generation of blood cells. Students should be able to describe the effect of different categories of drugs and how a muscle is able to function. Students will know about different examples of habitats and the typical organisms that live there. They will have developed their practical skills both indoors and outdoors by sampling habitats in the school grounds and recording data about the plant species and animal species which are found there. Students will know the different methods of separation that exist, and the different pieces of equipment which might be required to enable each method of separation. They will develop health and safety skills when writing a risk assessment for the separating rock salt practical, which requires the use of a Bunsen burner and evaporating basin. They will know the pH scale and will be able to give examples of acidic substances, alkaline substances and neutral substances. Students will know the arrangement of particles in a solid, liquid and a gas. They will be able to give examples of each and describe what happens to the particles when a substance is changed from one state into another. They will be able to describe some of the properties of each and carry out practicals connected with diffusion. Students will know the difference between an element and a compound, as well as the difference between metals and non-metals. Students will understand the structure of the periodic table. They will also have developed the skill of writing out an equation to enhance their understanding of what a reactant and a product are. Students will know what energy is and how it is stored, transferred and the efficiency of these transfers. They will also know the wider concept of the use of energy sources and the potential consequences of this use. Students will know what electric current is and what it can do. They will have the skills to put together circuits correctly and understand the concept of potential difference and resistance. Students will know about different classifications of forces and also about specific forces, such

as friction. Students will know how to ascertain if forces are balanced or not and what the effects of this may be on the surroundings. Finally, students will know what sound is and how it is made, the basics of waves and wave properties, along with how hearing works and how our ears mechanically process sound waves.

Year 8: By the end of the year…

Students will know the structure and function of the digestive system. They will also understand what a healthy diet is and what might be the consequences of eating an unbalanced diet. Students know how enzymes can help the digestion process occur more efficiently. They will have developed practical skills with the burning food practical which allows students to make an estimation of the energy content of different foods. This experiment requires calculations and consequently develops maths skills. Students will know about the structure and function of different reproductive organs in plants, the role of insect pollinators and what the consequences would be if there were a lack of pollinators. Students know how varied wind pollinated and insect pollinated plants are, and the variation that is observed in seeds depending on how those seeds are dispersed. Students know the equations for aerobic and anaerobic respiration. They understand the differences between a smoker and a non-smokers lungs. They also know the limewater test which can be used to show the presence of carbon dioxide in the air a person is exhaling. Students will know the structure and uses of different unicellular organisms, particularly regarding our dependence on them for food production. Practical skills will be developed when students make yoghurt, and also look at the best conditions for maximising carbon dioxide production from yeast. Students will understand the importance of photosynthetic organisms such as algae in a food chain, as well as the importance of decomposers in an ecosystem. Students will learn about combustion

and oxidation reactions including word equations. They will know the concepts of conservation of mass and pollution including global warming. The students will have developed their practical skills in the safe combustion of magnesium. students will know the differences between a physical and a chemical change. They understand how the idea of the atom has developed over time and what happens in chemical reactions. Students know that there are chemical and physical trends concerning groups in the periodic table which can help with making predictions about an element's reactivity. Students will know the different types of rocks that exist and the rock cycle. They will understand the role of weathering and erosion in the rock cycle and have considered the environmental implications of trying to obtain metal from rock. Students will know the changes of state, by building on the knowledge learned in year 7. They also know about the basics of fluids, pressure, density and drag forces. Students know one possible model for the transmission of light from source to detector. They know how light can be reflected and refracted by physical objects. They understand how the eye mechanically processes light energy transfers and are able to compare this with cameras. They know how objects are coloured and what determines this colour. Students know about the relationship between heat and temperature. They understand why heat transfers from one place to another and the mechanisms for this transfer. Students are able to calculate the cost of energy usage with the specific example of electrical energy transfers. Finally, students understand what is in the solar system and how we explore it. They can explain how seasons are created, the concept of magnetism about the planet’s own gravity.

Year 9: By the end of the year…

In Biology students will understand why and how a species might evolve over time. There is opportunity for the development of complex practical skills by getting students to extract DNA from Kiwi, the method for which involves the use of a high number of chemicals and equipment. There is also the opportunity for progressing analytical skills when considering the variation observed in populations - as variation can be both continuous and discontinuous, the students can construct graphs using examples of both types of data. Students will focus on what can be done to maximise growth in plants. By the end of the unit, they should appreciate that this can be done through increasing a plant's rate of photosynthesis or by exposing them to fertilisers. There is the opportunity for the development of practical skills, including experiments concerning limiting factors and testing leaves for the presence of starch.

In Chemistry students will understand three types of materials widely used in the everyday world, ceramics, composites and polymers. The students find out how they are made, how their structure gives them the properties they are used for and how making them impacts upon the environment. This unit is the bridge between 7H atoms and molecules where students first look at the useful properties of materials and 8F where students look at metals and alloys being useful materials. This builds the concept that there are more useful materials than just metals and metal alloys. students will understand the information we can get from chemical reactions and making predictions based on the reactivity series. Students carry out a series of experiments where they look at different chemical reactions and how these outcomes are linked to the reactivity series. They also look at the idea of chemical reactions either taking in or giving out energy (exothermic and endothermic reactions). While this is not the first time that students have met the reactivity series

(8F metals) it is the first time that they have used it to make predictions about chemical reactions.

In Physics students learn how forces can affect objects. Specifically, they are taught about how objects can speed up, slow down, change direction because of forces. The topic links motion to energy in a mathematical way. How to calculate speed and carry out experiments to determine speed are also included here. Moments and the concept of equilibrium are introduced here. Finally, the definition of a 'machine' and how they help us to transfer energy more effectively is also revealed. Students revise the concepts learned in year 8 about magnetic and gravitational fields. They go on to learn about another non-contact force of static electricity. The unit then develops the idea of electric currents from year 7 and gives a more mathematical approach to resistance. Electromagnetism is introduced in the form of electromagnets but will go on at GCSE to be developed into an understanding of motors and generators as well.

Year 10: By the end of the year…

In Biology students know that pathogens are microorganisms such as viruses and bacteria that cause infectious diseases in animals and plants. That they depend on their host to provide the conditions and nutrients that they need to grow and reproduce. That they frequently produce toxins that damage tissues and make us feel ill. Students know how we can avoid diseases by reducing contact with them, as well as how the body uses barriers against pathogens. Students know that once a pathogen gets inside the body our immune system is triggered which is usually strong enough to destroy the pathogen and prevent disease. They know how vaccines work, and the risks associated with them. Students know how new drugs

are tested for safety and peer reviewed. They understand the use of antibiotics and how bacteria have now become resistant to these antibiotics. Students know how plants harness the Sun's energy in photosynthesis in order to make food, that this process liberates oxygen which has built up over millions of years in the Earth's atmosphere. Understand that both animals and plants use this oxygen to oxidise food in a process called aerobic respiration which transfers the energy that the organism needs to perform its functions. Students know that anaerobic respiration does not require oxygen to transfer energy and that during vigorous exercise the human body is unable to supply the cells with sufficient oxygen and it switches to anaerobic respiration, that this process will supply energy but also causes the build-up of lactic acid in muscles which causes fatigue. Students know that the Sun is a source of energy that passes through ecosystems. They know that materials including carbon and water are continually recycled by the living world, being released through respiration of animals, plants and decomposing microorganisms and taken up by plants in photosynthesis. Students know that all species live in ecosystems composed of complex communities of animals and plants dependent on each other and that are adapted to particular conditions, both abiotic and biotic. Students know that these ecosystems provide essential services that support human life and continued development. Students understand that in order to continue to benefit from these services humans need to engage with the environment in a sustainable way. They know that humans are threatening biodiversity as well as the natural systems that support it.

In chemistry students know the three ways that atoms combine to make compounds or giant metallic structures. They know the different types of bonding and their properties. Students know about alloys and nanoparticles. Students know about the

reactivity series and how it is used to extract metals from their ores using carbon. Know the terms oxidation and reduction in terms of losing or gaining oxygen. Students know the reactions of metals and acids and the concept of neutralisation. Students know how electrolysis can be used to extract chemicals and how it is used to extract highly reactive elements that carbon cannot extract. Students know that energy changes take place in a chemical reaction. They know about exothermic and endothermic reactions. They know how to calculate the total energy change using bond energies and also the sign giving endothermic or exothermic reactions. Triple science students know about cells, batteries and fuel cells. Students know why chemical reactions occur at different rates. They understand that chemical reactions are modelled by collision theory. Students know the four factors that affect the rate of reaction are temperature, surface area, concentration/ pressure and the use of a catalyst. Students know how the rate of reaction can be calculated from a graph of the reaction. They also know that the rate of reaction can be measured by the production of a gas or by the loss of mass in a reaction. Students understand the idea of reversible reactions and are able to link the idea of energy changes from C5 into this idea. Students know Le Chalatier's principle and how the factors of concentration, pressure and temperature affect the equilibrium position in a reversible reaction.

In Physics students know that the particle model is widely used to predict the behaviour of solids, liquids and gases and this has many applications in everyday life. They understand that this helps us to explain a wide range of observations and engineers use these principles when designing vessels to withstand high pressures and temperatures, such as submarines and spacecraft. Students know that ionising radiation is hazardous but can be very useful. They know that although radioactivity

was discovered over a century ago, it took many nuclear physicists several decades to understand the structure of atoms, nuclear forces and stability. They know that early researchers suffered from their exposure to ionising radiation. Students know that today's radioactive materials are widely used in medicine, industry, agriculture and electrical power generation. Students know that engineers analyse forces when designing a great variety of machines and instruments, from road bridges and fairground rides to atomic force microscopes. They understand that anything mechanical can be analysed in this way.

Year 11: By the end of the year…

In Biology students know the definition of homeostasis and factors that are kept constant within the body. They know that body control systems include receptors which sense changes and effectors that bring about changes. Students know the structure and function of the nervous system and how it can bring about fast responses. They know how the hormonal system usually brings about much slower change. Students know how hormonal coordination is particularly important in reproduction since it controls the menstrual cycle. Students know that the number of chromosomes is halved during meiosis and then combined with new genes from the sexual partner to produce unique offspring. Students know that gene mutations occur continuously and on rare occasions can affect the functioning of the animal or plant. That these mutations may be damaging and lead to a number of genetic disorders or death or very rarely a new mutation can be beneficial and consequently, lead to increased fitness in the individual. Students know that variation generated by mutations and sexual reproduction is the basis for natural selection; this is how species evolve. An understanding of these processes has allowed scientists to intervene through selective breeding to produce livestock with favoured

characteristics. Once new varieties of plants or animals have been produced it is possible to clone individuals to produce larger numbers of identical individuals all carrying the favourable characteristic. Students know scientists have now discovered how to take genes from one species and introduce them into the genome of another by a process called genetic engineering. In spite of the huge potential benefits that this technology can offer, genetic modification still remains highly controversial.

In Chemistry Students know how fuels and feedstocks are made from crude oil. They know the formation of crude oil and how (and why) it is separated using fractional distillation. Students know the term alkane and the general formula for an alkane. They know the combustion of fuels and the products of complete and incomplete combustion. Students know that long chain hydrocarbons that are not useful as fuels can be cracked and turned into useful shorter chain alkanes and alkenes. Students know the test for alkenes and their general formula. Triple scientists know about organic chemistry including how to name the structure, properties and uses of alkenes, alcohols, carboxylic acids and esters. Students know how to identify pure substances from their boiling point. Students know chromatograms are used to identify pure substances and mixtures (impure substances) using the Rf values measured. Students know how the Earth's atmosphere has changed over time and continues to change due to humanities activities. They know the main atmospheric pollutants and their adverse effects on humans and the environment. Students know many of the earth's resources we need for our modern lifestyles are finite. Students know the terms renewable and non-renewable and are able to give some examples. Students know water can be treated by desalination. They understand the stages in producing drinking water from potable water. Students know the different ways of extracting valuable metals from low grade ores and what a life cycle assessment is.

Students studying triple science know about alloys, the corrosion of iron, the Haber process and the production of fertilisers.

In Physics students know wave behaviour and that waves carry energy from one place to another and can also carry information. They understand that designing comfortable and safe structures such as bridges, houses and music performance halls requires an understanding of mechanical waves. Also, modern technologies such as imaging and communication systems show how we can make the most of electromagnetic waves. Students know electromagnetic effects are used in a wide variety of devices and that engineers make use of the fact that a magnet moving in a coil can produce electric current and also that when current flows around a magnet it can produce movement. Separate Physics students know about the structure of the universe.

In Year 10 and 11 we deliver the AQA Combined Science Trilogy and AQA Biology, Chemistry and Physics.

https://www.aqa.org.uk/subjects/science/gcse/combined-science-trilogy-8464

https://www.aqa.org.uk/subjects/science/gcse/biology-8461

https://www.aqa.org.uk/subjects/science/gcse/chemistry-8462

https://www.aqa.org.uk/subjects/science/gcse/physics-8463

Year 12: By the end of the year…

Biology

Students know that carbohydrates are commonly used by cells as respiratory substrates. They also form structural components in plasma membranes and cell walls. Lipids have many uses, including the bilayer of plasma membranes, certain hormones and as respiratory substrates. Proteins form many cell structures. They are also important as enzymes, chemical messengers and components of the blood. Students know that nucleic acids carry the genetic code for the production of proteins. The genetic code is common to viruses and to all living organisms, providing evidence for evolution. The most common component of cells is water; hence our search for life elsewhere in the universe involves a search for liquid water.

Students know that all life on Earth exists as cells. These have basic features in common. Differences between cells are due to the addition of extra features. This provides indirect evidence for evolution. All cells arise from other cells, by binary fission in prokaryotic cells and by mitosis and meiosis in eukaryotic cells. All cells have a cell-surface membrane, and, in addition, eukaryotic cells have internal membranes. The basic structure of these plasma membranes is the same and enables control of the passage of substances across exchange surfaces by passive or active transport. Cell-surface membranes contain embedded proteins. Some of these are involved in cell signalling – communication between cells. Others act as antigens, allowing recognition of ‘self’ and ‘foreign’ cells by the immune system. Interactions between different types of cells are involved in disease, recovery from disease and prevention of symptoms occurring at a later date if exposed to the same antigen, or antigen-bearing pathogen.

Students know that the internal environment of a cell or organism is different from its external environment. The exchange of substances between the internal and external environments takes place at exchange surfaces. To truly enter or leave an organism, most substances must cross cell plasma membranes. In large multicellular organisms, the immediate environment of cells is some form of tissue fluid. Most cells are too far away from exchange surfaces, and from each other, for simple diffusion alone to maintain the composition of tissue fluid within a suitable metabolic range. In large organisms, exchange surfaces are associated with mass transport systems that carry substances between the exchange surfaces and the rest of the body and between parts of the body. Mass transport maintains the final diffusion gradients that bring substances to and from the cell membranes of individual cells. It also helps to maintain the relatively stable environment that is tissue fluid.

Students know that biodiversity is reflected in the vast number of species of organisms, in the variation of individual characteristics within a single species and in the variation of cell types within a single multicellular organism. Differences between species reflect genetic differences. Differences between individuals within a species could be the result of genetic factors, of environmental factors, or a combination of both. A gene is a section of DNA located at a particular site on a DNA molecule, called its locus. The base sequence of each gene carries the coded genetic information that determines the sequence of amino acids during protein synthesis. The genetic code used is the same in all organisms, providing evidence for evolution. Genetic diversity within a species can be caused by gene mutation, chromosome mutation or random factors associated with meiosis and fertilisation. This genetic diversity is acted upon by natural selection, resulting in species becoming better adapted to their environment. Variation within a species can be

measured using differences in the base sequence of DNA or in the amino acid sequence of proteins. Biodiversity within a community can be measured using species richness and an index of diversity.

Chemistry

Students will know about atomic structure, quantitative chemistry (including formulae, equations, amount of substance and the mole), reactions of acids, oxidation number and redox reactions bonding and structure.

Students will know and have an understanding of the important chemical ideas that underpin the study of inorganic and physical chemistry: the periodic table: periodic and group properties, enthalpy changes and their determination, rates of reaction reversible reactions and chemical equilibrium, consideration of energy and yield in improving sustainability.

Students will know Atoms, moles and stoichiometry, Acid and redox reactions, Bonding and structure.
Students will study basic organic chemistry including alkanes, alkenes, haloalkanes, alcohols, carboxylic acids, esters and different routes for organic synthesis.

Physics

These sections are about waves, images, simple optics and electric circuits.

The physics of the imaging and signalling section is approached through how information is gathered, processed, transmitted and presented. Learners have opportunities to develop IT skills through the use of image processing, data capture and data analysis software. The material can be taught using contexts such as smart

phones, data streaming, medical scanning and remote sensing. There are opportunities to address human and social concerns, for example, consequences of the growth of worldwide digital communications (HSW9) and the ethical issues of sharing information (HSW10).

The sensing section covers the ideas involved in understanding electrical circuits, especially charge, current, potential difference, resistance, conductance and potential dividers. Some of this work will be in the context of sensors and instrumentation. There are many opportunities for gaining experimental experience and skills in these sections of the course

This section is about materials and how their mechanical properties (and hence their applications) are related to their structures. The physics may be put into context through a study of materials in medicine and engineering. Human and cultural issues arise in considering the impact of materials on technology and society (HSW7, 9, 10, 11, 12).

It is not intended that learners acquire a detailed knowledge of a range of materials. Learners should have a reading comprehension of terms needed to understand accounts of structure, uses and properties of materials. Examples should include: a metal, a ceramic and a long-chain polymer. Learners should be given opportunities to discuss and share their understanding of the uses and properties of these materials (HSW8).

This module is mainly about superposition phenomena of waves with a brief account of the quantum behaviour of photons. This is a rich field for practical physics and learners will have many opportunities to extend their experimental and analytical skills. In addition, the topics provide a picture of the development of theories and

understanding over time (HSW1, HSW2, HSW7). Quantum behaviour is discussed through considering possible photon paths, avoiding the wave/particle dichotomy.

This section develops classical mechanics, including vectors. The conservation of momentum, the kinematics of uniformly accelerated motion and the dynamics of motion in two dimensions under a constant force are covered. IT skills may be developed through a variety of data capture techniques and simple mathematical modelling

Year 13: By the end of the year…

Biology

Students know that life depends on continuous transfers of energy. In photosynthesis, light is absorbed by chlorophyll, and this is linked to the production of ATP. In respiration, various substances are used as respiratory substrates. The hydrolysis of these respiratory substrates is linked to the production of ATP. In both respiration and photosynthesis, ATP production occurs when protons diffuse down an electrochemical gradient through molecules of the enzyme ATP synthase, embedded in the membranes of cellular organelles. The process of photosynthesis is common in all photoautotrophic organisms and the process of respiration is common in all organisms, providing indirect evidence for evolution. In communities, the biological molecules produced by photosynthesis are consumed by other organisms, including animals, bacteria and fungi. Some of these are used as respiratory substrates by these consumers. Photosynthesis and respiration are not 100% efficient. The transfer of biomass and its stored chemical energy in a community from one organism to a consumer is also not 100% efficient.

Students know that a stimulus is a change in the internal or external environment. A receptor detects a stimulus. A coordinator formulates a suitable response to a stimulus. An effector produces a response. Receptors are specific to one type of stimulus. Nerve cells pass electrical impulses along their length. A nerve impulse is specific to a target cell only because it releases a chemical messenger directly onto it, producing a response that is usually rapid, short-lived and localised. In contrast, mammalian hormones stimulate their target cells via the blood system. They are specific to the tertiary structure of receptors on their target cells and produce responses that are usually slow, long-lasting and widespread. Plants control their response using hormone-like growth substances.

Students know that the theory of evolution underpins modern Biology. All new species arise from an existing species. This results in different species sharing a common ancestry, as represented in phylogenetic classification. Common ancestry can explain the similarities between all living organisms, such as common chemistry (e.g. all proteins made from the same 20 or so amino acids), physiological pathways (e.g. anaerobic respiration), cell structure, DNA as the genetic material and a 'universal' genetic code. The individuals of a species share the same genes but (usually) different combinations of alleles of these genes. An individual inherits alleles from their parent or parents. A species exists as one or more populations. There is variation in the phenotypes of organisms in a population, due to genetic and environmental factors. Two forces affect genetic variation in populations: genetic drift and natural selection. Genetic drift can cause changes in allele frequency in small populations. Natural selection occurs when alleles that enhance the fitness of the individuals that carry them rise in frequency. A change in the allele frequency of a population is evolution. If a population becomes isolated from other populations of

the same species, there will be no gene flow between the isolated population and the others. This may lead to the accumulation of genetic differences in the isolated population, compared with the other populations. These differences may ultimately lead to organisms in the isolated population becoming unable to breed and produce fertile offspring with organisms from the other populations. This reproductive isolation means that a new species has evolved. Populations of different species live in communities. Competition occurs within and between these populations for the means of survival. Within a single community, one population is affected by other populations, the biotic factors, in its environment. Populations within communities are also affected by, and in turn affect, the abiotic (physicochemical) factors in an ecosystem.

Students know that cells are able to control their metabolic activities by regulating the transcription and translation of their genome. Although the cells within an organism carry the same coded genetic information, they translate only part of it. In multicellular organisms, this control of translation enables cells to have specialised functions, forming tissues and organs. There are many factors that control the expression of genes and, thus, the phenotype of organisms. Some are external, environmental factors, others are internal factors. The expression of genes is not as simple as once thought, with epigenetic regulation of transcription being increasingly recognised as important. Humans are learning how to control the expression of genes by altering the epigenome, and how to alter genomes and proteomes of organisms. This has many medical and technological applications.

Chemistry

Students will know the main areas of physical chemistry including:

Rate of reaction

The factors that affect the rate of reaction, be able to recognise the order of reaction, construct rate equations, identify the rate determining step and suggest reaction mechanisms.

Equilibrium

Students should be able to construct equations to find equilibrium constants, calculate the equilibrium constant for concentration and pressure (Kc and Kp). Students will be able to explain how and why different conditions affect the position of equilibrium.

Acids and buffers

Students should be able to calculate acid–base equilibria including pH, Ka and buffer solutions. Students should be able to explain the uses of acid and buffers, particularly in relation to the human body.

Enthalpy and entropy

Students can calculate lattice enthalpy and Born–Haber cycles, entropy and free energy, electrochemical cells.

Redox, electrochemistry and transition elements

Students will know the main areas of inorganic chemistry including redox chemistry and transition elements.

Students will know several new functional groups and the importance of organic synthesis. They will know about NMR spectroscopy to the instrumentation techniques used in organic and forensic analysis.

Students will know the main areas of organic chemistry including aromatic compounds, carboxylic acids and esters, organic nitrogen compounds: amines and amino acids, polymerisation: addition polymers and condensation polymers, synthetic organic chemistry.

Physics

This module builds upon the work covered earlier in the course. The first section uses simple techniques to model radioactive decay, capacitor charging and discharging and simple harmonic motion. In this framework, the formalism of the differential equation is developed along with the concept of field. There are many opportunities for practical work and empirical data can be compared and contrasted to the predictions made by the simple mathematical models. The field model is developed through consideration of gravitational fields. The section raises questions about simplification in models, their usefulness and limitations. The difference can be highlighted between those models in which well-determined behaviour is due to exact rules operating on variables (as in the harmonic oscillator) and those in which well determined behaviour is due to smooth averages over many particles (as in radioactive decay). The second section develops ideas about gravitational field strength and potential. Space flight and astronomical data can provide a context and there are further opportunities to consider the development of the modern view of the universe. The third section covers a descriptive and mainly qualitative outline of the main features of the observable universe consistent with the hot big bang model of its origin. The ideas of the universality of the speed of light and the relativistic consequence of time dilation are introduced.

This part of the module considers how kinetic theory explains the behaviour of matter in probabilistic and mechanical terms. The beginnings of the basis of thermodynamic thinking appear in the study of the Boltzmann factor.

The first section explains ideal gas behaviour in terms of the kinetic theory.

The second section introduces the Boltzmann factor as the link between energy and temperature. The important idea that differences drive change is introduced here.

The idea of field has been met in the earlier module. The first section treats the electromagnetic field in a practical context. The electric field, as the interaction between charges at rest, links back to the mathematically analogous model of the gravitational field. There are opportunities for discussing the social impact of the widespread distribution and use of electrical power and its influence on industrial societies. The second section covers interactions between charged particles and ideas about electric field and potential.

The work here concerns the structure and binding of atoms and nuclei and the nature of fundamental particles. The practical implications of radioactivity are considered, introducing the idea of risk.

The first section considers scattering experiments as a source of evidence about the structure of atoms and nucleons. Ideas from earlier in the module are used to consider particle paths in magnetic and electric fields in the context of particle accelerators. Evidence for discrete energy levels leads on to a crude model of the atom as a particle in a box. This section gives more opportunities to discuss the development of models in physics and the international cooperation needed to fund large experiments.

The second section sees changes in nuclear binding energy per nucleon as driving different types of decay. This leads to a consideration of nuclear power generation. The biological effects of ionising radiation are also considered, giving more opportunity to consider issues of ethics, decision making and the risks and benefits of technology.

A levels in Biology, Chemistry and Physics we deliver the following specifications

https://www.aqa.org.uk/subjects/science/as-and-a-level/biology-7401-7402

https://www.ocr.org.uk/qualifications/as-and-a-level/chemistry-a-h032-h432-from-2015/

https://ocr.org.uk/qualifications/as-and-a-level/physics-b-advancing-physics-h157-h557-from-2015/

Rationale behind sequencing:

Year 7

This skills unit is taught before any of the other units as it develops skills which would be required in multiple biology, chemistry and physics units. An ability with practical equipment is required in all three sciences, as are the maths and analytical skills enhanced throughout this unit, therefore it is essential this unit is taught at the beginning of key stage three.

7E At key stage 2, students will have been introduced to the idea that some materials will dissolve in liquid to form a solution and worked on describing how to recover a substance from a solution. They should also have used their knowledge of solids, liquids and gases to decide how mixtures might best be separated, including

through filtering, sieving and evaporating. For KS3, the 7E unit should ideally be delivered earlier than other chemistry topics, due to the high amount of practical work contained within it. If it is taught in quick succession with the year 7 induction unit, then the students will be provided with the chance to quickly apply the knowledge gained about equipment and reading equipment. It is therefore timetabled earlier on, primarily to provide opportunity for consolidation of skills developed in the induction lessons.

7F This unit is similar to 7E in that it needs to be delivered earlier than most of the other science topics. This is due to the high amount of practical work contained within it. If it is taught in quick succession with the year 7 induction unit and the 7E unit, then the students will be provided with the chance to quickly apply the knowledge gained about equipment and reading equipment. It is therefore timetabled earlier on primarily to provide opportunity for consolidation of skills developed in the induction and 7E lessons.

7G In key stage 2 students will have already gained an idea of what would class as an example of a solid, liquid and gas. In this 7G unit, they will become more familiar with the arrangement and behaviour of the particles in those three states of matter. In terms of links with other key stage three units, diffusion is built upon further in the following 8C biology unit, in which gas exchange at the alveoli is covered.

7H At key stage 2 pupils will have compared and grouped together everyday materials on the basis of their properties, including their hardness, solubility, transparency, electrical conductivity, thermal conductivity and response to magnets. They will also have considered that some changes might result in the formation of new materials, including changes associated with burning and the action of acid on

bicarbonate of soda. This will be built upon in the 7H unit, through which pupils will have the opportunity to conduct different chemical reactions in their practical work to demonstrate these concepts. The topics in this unit are developed further in the aqa C1 unit, in which the periodic table and chemical equations are a focus.

7I There is no link from ks2 as this concept is not taught in terms of physics at that level. There is no specific requirement for this topic to be taught before any other unit in this programme of study as all the physics units are independent of each other. In year 8 the idea of energy is expanded into the transfer of heat energy and the concepts of power and work. In year 9 the topic is expanded to include the energy of motion.

7J In ks2 pupils are taught about conductors and insulators. They are given the basic parts of a series circuit and can predict if a circuit is complete or not. There is no specific requirement for this topic to be taught before any other unit in this programme of study as all the physics units are independent of each other. In year 9 there is a connection made between circuits and electromagnetism. At GCSE these skills will be utilised more in the topic on electricity.

7K In ks2 students are taught that forces can act at a distance or when objects are in contact. They also learn the names of several types of forces and that machines can be used to enable a smaller force to have a greater effect. There is no specific requirement for this topic to be taught before any other unit in this programme of study as all the physics units are independent of each other. In year 8 they will build on this knowledge in terms of pressure and gravity.

7L In ks2 the students are taught about how sounds are made, pitch and volume. There is no specific requirement for this topic to be taught before any other unit in

this programme of study as all the physics units are independent of each other. In year 8 some of these concepts are used in the module on light.

7A In terms of knowledge from key stage 2, students will have already covered the basic functions of the different organs in the body, but at primary level it is unlikely they would have had an opportunity to use light microscopes and prepare animal and plant cell slides.

7B This unit should ideally be taught after or at the same time as the cells unit, 7A. This is because 7B develops students' understanding of what a specialised cell is by focusing on a sperm cell's adaptations for fertilising an egg. The students would have previously been introduced to the concept of specialised forms of tissue in the 7A unit, so the 7B reproduction unit furthers this by giving them a more specific context.

7C Out of the year 7 biology topics, it is recommended that this unit be taught later; it is an opportunity for the development of more complex practical skills, including the dissection of muscle and bone which has several health and safety considerations associated with it. It also builds on the preceding 7A unit organs and organ systems, by more specifically looking at examples of organ systems such as the skeletal system and respiratory system. Many of the concepts covered in 7C would be revisited later in key stage three in the 8C unit when pupils compare human gas exchange with the gas exchange of a range of different organisms, including plants and fish.

7D In terms of knowledge from key stage 2, it is likely that students will have covered some simple versions of food chains, but they will not have looked at the more complex food web arrangements which are introduced within 7D or thought about the consequences of the removal of a species from that food web. Out of the year 7

biology topics, it is recommended that this unit be taught later in the spring / summer, as it is an opportunity for the development of practical skills outdoors, which requires permitting weather that is more likely to occur towards the end of the academic year. This unit also makes links with concepts covered in other year 7 biology and chemistry units, so if taught towards the end of year 7 it can succeed those related topics and help reinforce their content.

Year 8

8A At a key stage 2 level students will have been introduced to the main body parts associated with the digestive system, for example, mouth, tongue, teeth, oesophagus, stomach and small and large intestine .The 8A unit also builds on content covered in year 7, unit 7A, in which students will have considered the functions of different organs within the digestive system. 8A introduces students to the concept of food tests, a GCSE required practical they will cover later in the B2 unit.

8B Students cover the basic structure of a plant at a key stage 2 level and have already learnt about the basic functions of those parts of the plant. The 8B unit is more appropriate to cover in year 8 as students can apply and consolidate some of the knowledge and keywords learnt in the year 7 human reproduction unit (7B) to this unit.

8C The students have already covered the structure of the respiratory system in unit 7C. The 8C unit builds upon this by looking at how the alveoli are adapted for carrying out gas exchange efficiently, as well as considering the effect of smoking and exercise on the lungs. Students will carry out a lung dissection in this unit which will enhance any dissection skills gained in 7A and 8B.

8D This unit builds on the cells content covered in the 7A unit. In this, students will have learnt about the functions of different parts of a plant cell and animal cell, and so the succeeding 8D unit will provide students the opportunity to recap some of the functions of parts of the cell as well as furthering their knowledge by introducing them to some new terminology specific to only prokaryotic cells. The 8D unit also makes links with the previous 8C unit; anaerobic respiration is revisited when explaining how these unicellular organisms can assist with food production.

8I At a key stage 2 level, students will have considered the effects of air resistance, water resistance and friction, that act between moving surfaces, and it is suggested that to explore resistance in water they might make and test boats of different shapes. At ks3 students learn a little about drag forces in terms of air resistance and water resistance. They also learn about buoyancy and upthrust. This unit builds upon the year 7 particle model topic, primarily.

8J In KS2 students are taught that light is required to see things and that looking at the Sun is dangerous. They also learn about shadows and how light travels in straight lines. This topic builds upon the year 7 sound topic but does not link with other topics at ks3.

8K This topic builds upon the year 7 energy topic and, to a lesser extent, the year 7 electricity topic. It will lead onto the GCSE topic on Energy where students will gain a more mathematical understanding of energy and how it can be stored or transferred.

8L In ks2 students learn about the solar system and how the bodies within it move. They learn about the day and night cycle and how this relates to this movement. This unit builds upon the year 7 topic on forces in that gravity is the force that holds the objects in the solar system together.

8E At a key stage 2 level students will have explained that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda. This unit also builds upon the chemical reactions met in unit 7H.

8F At a key stage 2 level, students will have compared and grouped together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets. They will also know that some materials will dissolve in liquid to form a solution and be able to describe how to recover a substance from a solution. The 8F unit builds upon ideas met in unit 7E (changes of state), 7G (the particle model) and 7H (atoms and molecules). After 8F, it would be most ideal to progress onto the 8G unit, which looks more specifically at the metals in the Periodic Table

8G At a key stage 2 level, the students will have conducted simple experiments in which they considered how different materials respond to magnets, including different metallic and non-metallic items. This unit builds upon concepts met in 7F acids and alkalis and further develops ideas from 8F which introduces the Periodic Table.

8H During key stage 2, students will have compared and grouped together different kinds of rocks on the basis of their appearance and simple physical properties. They will also have described in simple terms how fossils are formed when organisms are trapped within rock and have learnt that soils are made from rocks and organic matter. At key stage 3, the 8H unit develops some of those concepts further by allowing pupils to investigate how porous different rocks are through measuring how much water they absorb.

Year 9

Biology

9A Genetics and evolution

This unit builds on the knowledge gained in the preceding 7A unit (structure of cells), 7B unit (reproduction) and the 7D unit (ecology). It is reliant on students already having an understanding of animal cells and plant cells so that in this unit they can more specifically detail the location of chromosomes within a cell. The 7D ecology unit will have introduced the concept of what an adaptation is, which would be built upon in 9A when students describe the consequences of an organism being poorly adapted to its surroundings. The 7B reproduction unit also provides students with the knowledge needed regarding the fertilisation process to then progress further in 9A and explain how the inheritance of characteristics from parents would occur. In terms of development at key stage 4, combined science students would consider evidence that exists for evolution in the B6 unit, and in the same unit separate Biologists would move onto a more complex consideration of the structure of DNA.

9B Plant growth

The students will have learnt about the structure of the plant cell in the 7A cells unit. From here they revisit plant content again in 8B when covering plant reproduction. The 9B unit focuses on photosynthesis, so if taught in close succession with 8C it would allow for a comparison between this reaction and the respiration reactions covered in the preceding 8C unit. The pupil's retention of these similar equations is more likely if they have been exposed to them in multiple units taught closely together. It is also important that 9B be taught after 8A (nutrition). In 8A, the concept

of testing for starch has already been introduced with the food tests, so students have the opportunity to reinforce knowledge gained here regarding the use of iodine and the expected colour change that should be observed in the case of a positive result. The 9B unit develops the practical skills which will be needed for the photosynthesis required practical undertaken at key stage 4. In 9B pupils are able to practice the limiting factors experiment and gain an understanding of how to use the equipment. They will have the opportunity to consider the control variables associated with the method and come up with ideas on how to monitor those factors carefully before undertaking a more complex attempt at the practical in the B4 unit of GCSE.

Chemistry

9E Making materials

This unit is the study of different types of widely used materials. It builds from the ideas of using metals from unit 8F metals and their uses and 7H atoms and molecules where students have looked at the properties for useful materials. The students study ceramic materials, composite materials and polymers. They look at how these materials are made and why they are useful. They also study the impacts of making and using these materials. This leads on to unit C10 using materials where students following double science study life cycle assessments and recycling materials. Triple scientists study these three materials in slightly more depth.

9F Reactivity

This unit follows on from 7F acids and alkalis where students first looked at the order of reactivity in chemical reactions. The next step was looking at classifying reactions using the reactivity series in unit 8F metals. This unit builds on both of these ideas and develops the reactivity series further by linking the rate of reaction and energy released in that reaction to the reactivity series. This will then lead to unit C4 chemical changes where the students go on to use the reactivity series to make predictions and link the reactivity series to new areas like electrolysis. Another unit linked to this topic is C5 energy changes where the students measure and calculate (H/T) the energy change is a chemical reaction.

Physics

9L Forces and motion

This topic builds upon previous topics from year 7 and 8. It will be developed further at GCSE in the topics on Energy and Forces.

9J Force Fields and electromagnets.

This topic builds upon previous topics in both year 7 and 8. The concepts will be developed in the GCSE topics on Electricity and Electromagnetism.

Year 10

Biology

B3- This unit builds upon ks3 knowledge of cells acquired in 7A, blood cells taught in 7C, and microorganisms introduced in 8D. This leads onto examples of evolution covered in B6 and is also built upon in Y12 immunity and selection topics.

B4- This builds upon KS3 knowledge on the different types of respiration taught in 8C, also the process of photosynthesis and how important the products of this process are which builds on KS3 knowledge from 8D, 8B and 9B. Students review knowledge of how plants acquire the raw materials for photosynthesis covered in B2 and also how the cells of humans acquire the substrates needed for respiration, linking in digestion and circulation taught in B2. B4 leads on the KS5 units of mass transports, respiration and photosynthesis.

B7- Is a topic best taught in the summertime or autumn so the practical work can be completed. So, we have placed it slightly out of sequence before B5 or B6 are taught. The topic builds on ks3 knowledge learnt in 7D and 9A in particular the interdependence of organisms in an ecosystem, including food webs. This B7 knowledge is the foundation the Y12 topic 4 Genetic information, variation and relationships between organisms.

Chemistry

C3- This unit builds upon ks3 knowledge of solutions acquired in 7E. Other than that, the material covered is entirely new and students will not have met before.

C4- This unit builds upon ks3 knowledge of the reactivity series and extracting metals from 8F the periodic table & 8G metals. Acids were covered in topic 7F where students will have met the idea of neutralisation. Oxidation has been covered in terms of oxygen previously in unit 8E combustion and oxidation.

C5-This unit builds upon ks3 knowledge of exothermic and endothermic reactions from 8G metals and their uses and 9F reactivity. It also builds on the knowledge of what batteries or cells do in circuits from 7J.

C6- This unit builds upon ks3 knowledge of 9E reactivity. Students will have only described qualitatively how quickly or slowly a reaction progresses. They won't have considered the reasons why, other than the relative reactivity of substances from 8G metals and their uses and 9F reactivity. The idea of a catalyst will have been met in 8G metals and their uses and 9E reactivity.

Physics

P3-This topic builds on work done on the particle model at KS3 as well as concepts from PA1. It will be extended by topics at KS5 such as P1, P4, P8 and ultimately P10

P4-This topic stems from KS3 work on Atoms and Elements and also from the KS4 Chemistry course. Parts will be reviewed in PA8. It will be revisited and expanded upon in the KS5 Physics topics P5, P7 and P10

P5-Forces are an integral part of the subject of physics and this unit reflects that in it's depth and breadth of content. We find it typically requires to be taught during the last term of year 10 and first term of year 11. KS3 topics on forces and their effects provide a solid grounding for this topic. At KS5 students will continue to increase their depth of knowledge in the topics P4, P6, P7 and P9

Year 11

Biology

B5- This builds upon KS3 knowledge about reproduction and the menstrual cycle taught in 7B, along with the role of muscles and the nervous system in movement taught in 7C. This topic links to PSME knowledge of contraction and is taught at a similar time. Knowledge of specialised nerve cells is built upon which requires and reinforces B1 knowledge. The knowledge gained in this topic is fundamental to the Y13 topic 6 Organisms respond to changes in their internal and external environments.

B6-Builds upon the KS3 topics of 7B reproduction and predominantly 9A, where the concept of inheriting genetic information and the features of this information were first taught. The topic also covers selective breeding, key knowledge from 9B. It reinforces the concept of antibiotic resistance introduced in B3 and uses this concept to support the process of evolution. B6 is the fundamental knowledge required for Y13 topic 7 Genetics, populations, evolution and ecosystems.

Chemistry

C6- This unit builds upon ks3 knowledge of 9E reactivity. Students will have only described qualitatively how quickly or slowly a reaction progresses. They won't have considered the reasons why, other than the relative reactivity of substances from 8G metals and their uses and 9F reactivity. The idea of a catalyst will have been met in 8G metals and their uses and 9E reactivity.

C7- Students will have met the concept of hydrocarbon fuels and combustion from 8E combustion and oxidation. The basic idea of polymers will have been met before in 9E materials.

C8- This builds on the idea of identifying pure substances and mixtures using chromatography from 7E separating mixtures. Students will have met the pop test for hydrogen before in unit 7F acids and unit 8G metals and their uses. Similarly, students will have met precipitate reactions in unit 7H atoms, elements and molecules, although they won't have been taught you can identify metal ions. The test for carbon dioxide will have been met before in 8C breathing and respiration. The other tests won't have been met before at KS3 and represent new concepts for the students.

C9- Students will have met the atmosphere in topic 7H atoms, elements and molecules and again in topic 8H the atmosphere and the Earth. Global climate change and air pollution will have previously covered in unit 8E combustion and oxidation.

C10- Students will have previously met recycling before in topic 8G metals and their uses. They will have met polymers, composites and ceramics in topic 9E materials. The idea of artificial fertilizers will have been met before in the topic 8B plants and reproduction.

Physics

P6- This topic begins at KS3 with topics on Light and Sound and will be extended at KS5 by topic P5

P7-Magnets and electromagnetic effects were taught in the latter stages of KS3 and crop up in PA2 at KS4. In KS5 they are extended by the topics P3 and P9

P8-This topic is one which engages students well. KS3 begins with introducing the concepts of the Solar system and the force of gravity. KS5 will extend this work in terms of the universe and cosmology more broadly in topic P7.

Year 12

Biology

1, Biological molecules-This topic is taught alongside topic 2 at the beginning of the AS level course. It contains the key biochemical knowledge for example the structure of the monosaccharide glucose and how that forms a variety of polysaccharides, that is fundamental in all of the biological processes which are taught later in the course. Students are also given opportunities to start to develop their practical skills during the food test practicals and enzyme work, these are building on KS4 skills.

2, Cells- This topic is taught at the start of the AS course alongside topic 1. The knowledge taught builds on knowledge from B1 and B3 at GCSE and recaps the summer work students were set. The function of organelles and methods of crossing a membrane are core knowledge required to understand the complex processes of photosynthesis and respiration. Students develop their skills in using microscopes and making slides.

3, Organisms exchange substances with their environment-Students now build on their knowledge acquired in topics 1 and 2 and from B2 at GCSE, from a cellular level to a large multicellular organism level. Their topic 1 and 2 knowledge is fundamental in allowing them to understand how organisms exchange substances

with their environment. Practical skills are further developed with dissections and potometers.

4, Genetic information, variation and relationships between organisms- In this topic the end point knowledge from B6 at GCSE is built upon. With the students understanding of DNA structure from topic 1 they can appreciate how the genetic code works and thus how variation is achieved. Statistical skills are introduced in this topic to be able to assess diversity and correlations.

Chemistry

Topic 1- This unit builds upon the practical skills learnt in ks3 and ks4 and is developed in every unit in y12 and y13. The practical skills build up to cover the Practical skills assessment tasks leading to the Practical endorsement

Topic 2-This unit builds upon the key concepts learnt in Topic 1 and on ks4. It builds upon AQA GCSE Chemistry units c1,2,3,4,8,10 and is used in all of the units in y12 and y13

Topic 3- This topic builds on Topics 1 and 2 and also on AQA GCSE Chemistry topics c1, c3, c5, c6, c8, c10. It is expanded and developed on in module 5

Topic 4- This module builds upon module 1 and 2 and also on ks4 AQA GCSE Chemistry units c1, c2, c3, c7, c8, c9, c10. It leads on to module 6

Topic 5- This module builds on modules 1,2 and 3 as well as KS4 AQA GCSE Chemistry units c1,2,3,4,5,6,8,9,10.

Physics

P1- This unit builds upon the practical skills learnt in ks3 and ks4 and is developed in every unit in y12 and y13. The practical skills build up to cover the Practical skills assessment tasks leading to the Practical endorsement

P2-The Physics B approach to data analysis builds on the practical skills in topic 1.

P3-This section builds on the GCSE topics on waves and electricity

P4-This topic builds on KS3 topics on material properties and classification. It also links into subject matter in KS4 chemistry

P5-This continues to build on topic 3 and KS4 topics on waves

P6-This topic builds upon the KS4 topic of forces

P7-This topic builds upon GCSE topics of Radioactivity, Forces and Electricity and links to the later A Level topics of P9 Fields.

P8-This topic builds upon the GCSE topic of Energy

P9-This builds on P7 and the GCSE topics of Electromagnetism and Forces

P10-This builds on P8 and the GCSE topics of Radioactivity and Atomic Structure

Year 13

Biology

5, Energy transfers- The GCSE B4 topic is essential baseline knowledge required before energy transfer is taught. Here the knowledge from topics 1 and 2 about cell organelles and biological molecules are brought together to explain the processes introduced in B6. How the energy flows through the environment builds on knowledge taught in B7 about food chains and decay cycles.

6, Organisms respond to change-This topic builds on GCSE B5 and also uses key knowledge from topics 1 and 2 of AS. For example, specialised neurons use a variety of methods to transport ions across the membrane to achieve the formation and continuation of a nervous impulse.

7, Genetics, populations, evolution and ecosystems- GCSE topic B6 and B7 are the key prior knowledge that is built upon in this topic, along with topic 4 from AS. The understanding of DNA and genetic code are furthered by the teaching of inheritance of genetics and all of the factors that affect the offspring produced. From dominant and recessive genes that students already know about to co-dominance and epistasis. More maths and statistical skills are also introduced with Hardy Weinberg equation and Chi-squared.

8, Control of gene expression- This final topic brings together all of the knowledge at a cellular level and teaches about the control of these activities. Prior knowledge of GCSE topics B3 especially cancer and B6 particularly the genome is very important. By this topic students need to have a fundamental knowledge of all of the AS and A2 topics to fully the concepts being taught.

Chemistry

Topic 1- This unit builds upon the practical skills learnt in ks3 and ks4 and is developed in every unit in y12 and y13. The practical skills build up to cover the Practical skills assessment tasks leading to the Practical endorsement

Topic 2-This unit builds upon the key concepts learnt in Topic 1 and on ks4. It builds upon AQA GCSE Chemistry Topic 5- This module builds on modules 1,2 and 3 as well as ks 4 AQA GCSE Chemistry units c1,2,3,4,5,6,8,9,10.

Topic 6- This module builds on modules 1,2,4 and also on KS4 AQA GCSE Chemistry units c1,2,3,7,8,9,10

Physics

P1- This unit builds upon the practical skills learnt in ks3 and ks4 and is developed in every unit in y12 and y13. The practical skills build up to cover the Practical skills assessment tasks leading to the Practical endorsement

P2-The Physics B approach to data analysis builds on the practical skills in topic 1.

P7-This topic builds upon GCSE topics of Radioactivity, Forces and Electricity and links to the later A Level topics of P9 Fields.

P8-This topic builds upon the GCSE topic of Energy

P9-This builds on P7 and the GCSE topics of Electromagnetism and Forces

P10-This builds on P8 and the GCSE topics of Radioactivity and Atomic Structure