Curriculum Design

To design our KS3 curriculum we have taken influence from BEST (Best Evidence Science Teaching) which has been developed by the University of York Science Education Group along with the Salters' Institute and has been endorsed by the STEM learning network. We have enhanced this where necessary to include pieces of legacy curriculums and our own professional knowledge and judgement to ensure we have a curriculum which is as broad and engaging as it should be, for our young scientists. We have developed our curriculum to spiral and build in increasing challenge from the ten "big ideas" in Science.

Big Ideas

Biology	Chemistry	Physics
• The Cellular Basis of Life • Ecosystems • Genes & Life Cycles • Health and Disease	• Particles and Matter • Chemical Reactions • Earth & Atmosphere	• Forces & Motion • Waves & Space • Energy

Topic Sequencing and Rationale

Key Stage 3 Science

	Year	What is taught? Overview of Topics	Why this? Why then?
KS3	**7**	**Term 1** **Matter 1;** Particle Model **Forces 1:** Balanced and Unbalanced Forces **Cells 1:** Cells **Term 2** **Reactions 1;** Chemical Change **Energy 1:** Electrical Circuits **Ecosystems 1:** Interdependence of Organisms **Term 3** **Earth and Atmosphere 1;** Earth's structure the Rock Cycle **Waves 1:** Sound and Light **Genes 1:** Variation and Classification	**Matter 1:** The particle model is fundamental to our understanding of Chemistry and forms the fundamentals on which we can build. By understanding the particle model students are gaining the basic knowledge of substances in terms of macroscopic and sub-microscopic (particulate) observations. The understanding of matter is key to explain chemical reactions. **Forces 1:** Forces make things change. Understanding forces helps us to predict and control physical change. Forces are fundamental to our understanding of Physics, and they form the big idea on which we can build. The understanding of balanced and unbalanced forces must first be taught to understand how forces affect motion. **Cells 1:** Cells are the building blocks of all living things. Students must understand what is "alive" and how cells work together to form tissues, organs, systems and organisms to understand all later concepts in Biology. Most cells are too small to be seen with the naked eye but can be seen using a light microscope. There are many different types of cells with different shapes and sizes, but all cells are made up of common parts. An organism may be made up of a single cell or many cells working together. This is why scientists think of cells as the basic units of life.

			Reactions 1: Chemical reactions are the basis behind forming many useful everyday substances. Without chemical reactions these substances would not be available to species. This topic enables students to understand that particles are made from indivisible atoms, that atoms make up elements and compounds and how atoms can be re-arranged to form new useful substances in basic chemical reactions. **Energy 1:** The everyday world is largely a consequence of electrical change. Understanding electricity and magnetism helps us develop technology to improve lives. Building on our work covered in Forces 1 student will learn how electrons are 'pushed' around the circuit by the electromotive force. Understanding of electricity is key to explain electromagnetic waves and how charges / magnets interact. **Ecosystems 1:** Now students understand the fundamentals of what make up living thing from Cells 1 we will expand this idea to explain how many organisms survive in an ecosystem together. All organisms, including humans, depend on, interact with and affect the environments in which they live and other organisms that live there. Biomass is transferred between populations when organisms are eaten. The size of each population in a community is limited by predation and by competition for food and other resources including space, water, light, shelter, mates, pollinators and seed dispersers. **Earth 1:** The Earth's crust, atmosphere and oceans are the only sources of the resource's humans need. By introducing the core knowledge of the structure, composition of the Earth and its atmosphere this unit enables students to gain a better understanding of where the resources that are needed for survival come from and the processes by which they are formed. **Waves 1:** In this unit, students will deepen their understanding of energy by considering how energy is transferred in waves. Students will consider their understanding of light to construct ray diagrams and explore phenomena such as reflection and refraction and shadows. They will consider the difference in how light and sound waves are similar and how they are different. **Genes 1:** Now we know how organisms interact in an ecosystem we will start to use classification Keys to identify and categorise those organisms in the lab and in the field according to their observable characteristics. Organisms can be classified within larger groups,

			according to similarities and differences. There is variation between individual organisms of the same species, Variation can be caused by differences in the genome, lifestyle and interactions with the environment. Only variation caused by differences in the genome can be inherited.
	8	**Term 1** **Matter 2;** Conservation of mass **Forces 2:** Speed and Motion **Cells 2:** Transport around the body **Term 2** **Reactions 2;** Making Salts **Energy 2:** Heating and Cooling **Genes 2:** Reproduction **Term 3** **Earth 2;** Atmosphere **Waves 2:** The Solar System and Beyond **Health and Disease 1:** Lifestyle and Health	**Matter 2:** Having previously been introduced to the atom in Matter 1, students gain further knowledge into how atoms are rearranged in chemical reactions and that when this rearrangement occurs, mass is never lost or gained; the law of conservation of mass. This law is then applied to a series of chemical reactions in solutions and chemical reactions that involve a change of state. **Forces 2:** From Forces 1 we know forces make things change. Building on from an understanding of forces we can now look at how the forces acting on an object affect the objects motion in terms of speed, velocity and acceleration and how we can measure, calculate and present this as a distance-time graph. **Cells 2:** Now we know the structure and function of cells we begin to consider how things can move in and out of cells, are around the body. The process of diffusion is introduced, as is how this is central to supplying cells and organisms the substances they need to exist, and we will begin to look about how organ systems transfer those substances around the body. **Reactions 2:** Building on our knowledge of chemical reactions, the conservation of mass and the standard conventions of describing those reactions in word equations we begin to introduce the more technical process of writing chemical formula. Salts are widely used in the chemical industry to make lots of other useful products. In this topic students can gain an understanding of how these salts are produced by applying their existing knowledge of separating mixtures. **Energy 2:** Considering the underpinning knowledge of how waves transfer energy, students will learn to describe why temperature changes happen by convection, conduction and radiation. This allows us to understand why insulation in homes is important. Students will begin to explain how temperature is dependent on thermal energy, and the mass of an object and that different materials have different specific heat capacities. **Genes 2:** Students will discuss the growth and development of humans and other living things, including human reproduction. They will consider the changes humans go through during

			adolescence and the reasons behind those changes in term of physical sexual maturity. Pupils will discuss the important issue of contraception in the prevention of sexually transmitted diseases and unwanted pregnancy. Pupils will make links between how humans, other animals and plants reproduce. We felt the timing of this unit was suitable to ensure pupils had the emotional maturity to tackle these issues sensibly, without leaving some uninformed for too long. **Earth 2:** Gaining the knowledge of how the Earth's atmosphere has developed throughout history and evolved into its current composition enables students to understand how life has evolved and is able to be sustained on Earth. It is imperative for students to consider how human activity, has and will continue to impact the Earth and its atmosphere and to critically analyse the data which support this. This will give students awareness of the very current issue of the climate crisis. **Waves 2:** Understanding the uniqueness of the Earth and the vastness of space gives us perspective and awe. This will be a key point in introducing an understanding of orders of magnitude when we talk about things so very large, or so very small. At this point students will have a deep enough understanding of forces and light to understand how the solar system works. This topic is always popular and has been included in excess of the national curriculum to encourage awe and wonder. **Health and Disease 1** We look at what happens when living things begin to fail, either because of harmful interactions with other organisms (i.e. pathogens), or because of life choices; diet, exercise, smoking and drugs. Much of this unit builds on the knowledge of specialised cell and transport systems covered in Cells 1 and 2.
	9 (From September 2022)	**Term 1** **Matter 3;** Atomic Structure and the Periodic Table **Forces 3:** Mass and Density **Genes 3:** Inheritance and Evolution **Term 2** **Reactions 3;** Energy Change **Health and Disease 2:** Immunity and Respiration **Energy 3:** Magnetism **Term 3** **Earth and the Atmosphere 3;** Earth's Cycles **Ecosystems 2:** Biodiversity and Human impact	**Matter 3:** This unit enhances students understanding of the indivisible atom, to explain the existence of sub-atomic particles, enables us to continue to build on students' prior knowledge about elements with how they are arranged in the periodic table and the experimental evidence that led to the discovery of the sub-atomic particles and the development of early versions of the periodic table. Students are then able access study of the periodic table in greater depth to identify key chemical and physical trends and patterns in groups of elements. **Forces 3:** Students already know that forces can help us to predict and control physical change. This unit builds to apply how moments, pressure and density can be utilized to exert forces in excess of those we could physically create. Reviewing mass and weight allows us to remind students about the work done in Waves 3.

			Genes 3 Linking together the ideas of reproduction, inheritance and variation covered in Genes 1 and 2 students are introduced to Darwin's theory of evolution, which brings together concepts of heredity and adaptation to explain the existence of all living organisms on our planet. **Reactions 3** Students are now able to bring together all their prior knowledge and standard nomenclature of chemical reactions to consider the energy changes which take place within the reaction, enabling them to classify chemical reactions as exothermic and endothermic. Students will continue to see how these chemical reactions are applied and are useful in everyday life based on the energy changes that take place. **Health and Disease 2:** Students will apply and extend their knowledge of cells, health and the transport systems in the body to learn about how animals can fight disease and how humans have developed artificial immunity by vaccination. This important but technical issue will allow pupils to make informed decisions in their adult lives. **Energy 3:** The everyday world is largely a consequence of electrical change. Understanding electricity and magnetism helps us develop technology to improve lives. Building on from the fundamentals of electricity learned in Energy 1 this topic will enable students to look at how the properties of electricity and magnetism are similar and how they can be combined to create electromagnets. This will then give students a solid foundation to move forward to study electromagnetic waves at GCSE. **Earth 3** Students should now recall the processes studied to do with the Earth and its atmosphere to consider how these materials cycle. Rock cycle, carbon cycle, water cycle, Nitrogen cycle all contribute to the homeostasis of our planet. Students will have to apply knowledge from within the Earth, Reactions and Matter topics to describe these processes. **Ecosystems 2** Student will use their knowledge of living things, organ systems and transport systems to cover the integral topic of photosynthesis. To extend on the theme covered in Earth 3 we will look at the human impact on biodiversity.

			The remaining weeks of KS3 will be spent completing the first unit of each of the AQA GCSE Sciences B1 Cell Biology, C1 Atomic Structure and P3 Particle Model of Matter (see below.)

Key Stage 4 –Biology

	Year	What is taught? Overview of Topics	Why this? Why then?
KS4	10	1. **Cell Biology (B1)** 2. **Digestive System (B2)** 3. **Heart & Lungs (B2) and Non-communicable diseases (B3**) 4. **Infection, response & treatment (B3)** 5. **Photosynthesis (B4) and Plant Organisation (B2)** 6. **Respiration (B4**)	In Year 10, GCSE Combined Science and Biology follow the AQA Specification B1-B4 as a sequence of teaching, this content has been divided into 6 topics, each with its own End-Of-Topic-Assessment. This follows on from our BEST inspired KS3 curriculum, in which much GCSE content is introduced in Years 7 to 9. That said, there are two instances where we consider it beneficial to split up AQA specification sections and re-combined them into in-house topics. For example, we teach the heart and the lungs (B2) with non-communicable diseases (B3) as a single topic, and we teach photosynthesis (B4) with plant organisation (B2) as another topic. The rationale for this will be explained later. It must be pointed out that in many cases there are so many links between topics that there is no obvious sequence through GCSE. As an example, consider obesity, a non-communicable, lifestyle-related and genetically underpinned disease covered in B3. To fully understand obesity, students need a knowledge of fat cells (B1), diet and the digestive system (B2), respiration and exercise (B4), genetic predisposition (B6) and glucoregulation and the laying down of fat (B5). In other words, a holistic view of the whole specification is often needed to understand the current "powerful knowledge". Therefore, as well as Interleaving what has come before, our teaching routinely looks ahead to future knowledge, fostering an appreciation of "The Big Picture". In other words, our curriculum is spiralised: it revisits and builds on what has come before, while looking ahead to future learning, all the while increasing in difficulty. It must be pointed out that while this document illuminates some of the decisions we made when designing our curriculum, it cannot exhaustively detail all decisions. Our six topics in Year 10 are: **Cell Biology (B1)** – Students learn that cells are the fundamental units of life and that substances must pass into and out of them. This topic covers, for example, that we are made of many different cells, which can be observed with Microscopy (Required Practical – RP), and that all our cells require a supply of oxygen, and that anything that reduces this supply, such as poor gas exchange (e.g., asthma) or poor circulation (e.g. Coronary Heart Disease) will lead to ill health. The movement of water into and out of cells is also investigated in the Osmosis RP. This leads on from "Cells" taught in Year 7 and 8. Knowledge of cell biology is needed to understand "Organisation", "Infection and response", "Bioenergetics" (later in Year 10) and "Homeostasis" (Year 11). Earlier, students use microscopes in Year 7 and Year 8, in the prior teaching of "Cells". **Digestive System (B2)** - Students learn how the body works as a whole, e.g. the breathing, digestive and circulatory systems work together to supply cells with their requirements for life. This topic focuses on digestion, while introducing the other systems. Cells work together to form tissues and organs, so this builds on knowledge from "Cell Biology". This also leads on from the learning of organ systems, taught in Years 7 and 8 "Cells". An overview of the whole body, including digestion, is needed to appreciate "Bioenergetics" (Year 10) and "Homeostasis" (Year 11). This

			topic includes the required practicals on food tests and enzymes, and so it was considered large enough to warrant its own topic and summative assessment. **The Heart / The Lungs (B2) and Non-communicable diseases (B3**) - Here we combine two sections of the AQA specification into one topic, the rationale being that lifestyle choices such as diet, exercise and smoking can lead to diseases of the heart and lungs. For example, smoking can damage alveoli (emphysema) and so reduce the absorption of oxygen into the blood (hypoxia), and so cause the heart to have to beat quicker (tachycardia); also, a high fat diet and a lack of exercise can lead to fatty deposits in the coronary arteries (atheroma), these vessels possibly having also been damaged by smoking; and so lifestyle choices can work together, perhaps with genetic factors also, to cause coronary heart disease. These parts of B2 and B3 are intimately linked. This builds on Year 8, "What is health?" and looks forward to the "Response to exercise" (B4). There is the opportunity for practical work with a heart dissection. **Infection, Response and Treatment (B3)** – Students need to appreciate that we all have a responsibility to each other to maintain a healthy population. For example, there are currently two national crises, in Antibiotic resistance and Covid-19, both of which require social co-operation to control (vaccination & antibiotic use). This means that students need to understand infection and response. Knowledge of cell structure and the blood system, for example, are needed to understand pathogens and the immune response, and so its teaching must come after topics B1 and B2. Infection and response follows on from Year 8 topic "What is health?", and also in Year 9: "Health & disease 2". Later, in Year 11, students will study the evolution of antibiotic resistance in B6. There is practical work when Triple Science students learn aseptic technique and the growth of microbes. Also, "plant disease and defences" (Biology only) draws on knowledge learned in Year 7 ("Interdependence") and Year 9 ("Inheritance & evolution"), and looks forward to Plant Organisation (B2). **Photosynthesis (B4) and Plant Organisation (B2)** – Students need to understand photosynthesis because it helps us understand life on Earth and also where our food comes from (Plants are producers for our food chain); also, to fully understand how plants are adapted to maximise photosynthesis, a knowledge of leaf structure (Cell Biology), vascular transport systems and support in plants (Plant Organisation) is needed. This is the rational for pairing these topics, and for why they follow on from Cell Biology, B1. A knowledge of photosynthesis is needed for the teaching of Ecology (B7). There is a required practical on the rate of photosynthesis. Also, microscopes are used to view stomata, plant cells having been viewed through the microscope in Year 7 and Year 8, in the "Cells 1" and "Cells 2" topics. Photosynthesis is introduced in Year 9 ("Ecosystems 2") **Respiration (B4**) - A knowledge of respiration helps us understand health / fitness / exercise; also, together with diet, respiration teaches us that when the energy we consume is more than the energy we expend, we will eventually become ill with obesity. The learning of respiration is foreshadowed in Year 9: "Respiration & infection", and in Years 7 and 8, "Cells". Also, B1 and B2 explain that cells need oxygen and glucose (for respiration) and that the breathing, circulatory and digestive systems together provide these. In Year 11, a knowledge of respiration will help the teaching of homeostasis (e.g. glucoregulation / thermoregulation). The teaching of metabolism builds on knowledge learned about alcohol (non-communicable diseases, B3).

	11	1. **The Nervous System (B5)** 2. **Hormones (B5)** 3. **Kidney (B5) (Triple Science only)** 4. **Variation & Inheritance (B6)** 5. **Evolution & Classification (B6)** 6. **Ecosystems (B7)** 7. **Humans & Biodiversity (B7)**	As in Year 10, sections of the AQA specification are divided up into six in-house topics (seven for Triple Scientists). The only shuffling of topics, relative to the AQA specification, is seen in the assessment of The Kidney (Triple Science), which is added to the "Variation & Inheritance" end-of-topic-assessment. This is a practical, not an academic arrangement, and it is scheduled that way to allow Triple students more time to prepare for the Year 11 Mock, which falls at that time, rather than studying for a stand-alone Kidney test. **The Nervous System (B5) -** A knowledge of the nervous system is essential for students to understand how our bodies detect and respond to stimuli, such as external temperature, and so maintain a constant internal environment (Homeostasis). This topic begins with nerve cells (and so revisits B1, Cell Biology, and Cells in Years 7&8), before moving on to synapses (revisiting such ideas as diffusion, B1, and complementary shapes B2). There is a required practical on Reaction Times, and Triple students learn also about the brain and the eye and vision. Lastly, thermoregulation is covered, and this primes students for the concept of negative feedback, which is found in the next topic, Hormones. **Hormones (B5)** - This builds on ideas encountered in The Nervous System (homeostasis & negative feedback) and also in B2 (complementary shapes, circulatory system) and B3 (Non-communicable diseases) and B4 (Respiration). It starts with ThYear oxine and Adrenaline, before moving on to glucoregulation and its pathology, diabetes, and its treatment. Therefore, this topic builds on learning about health, lifestyle and non-communicable disease taught in Years 8, 9 and 10, and looks forward to the genetic engineering of insulin in B6. The huge increase in Type 2 diabetes, increasingly in younger people, is one obvious reason why a knowledge of diet and glucose homeostasis is essential. There is scope for a re-visiting of food tests, by performing Benedict's on pretend urine from a diabetic. Next, the teaching of reproductive hormones, contraception and IVF continues a learning journey begun in Years 8 and 9 (Genes), which will terminate in B6 (Inheritance). Lastly, students learn about plant hormones, which builds on a knowledge of photosynthesis gained in Year 9 (Ecosystems) and Year 10 (B4). There is a required practical on phototropism and the growth of seedlings. **The Kidney (B5) (Triple Science only)** - Learning about the kidney, as part of the osmoregulatory / excretory system, builds on knowledge gained in Year 7 (Cells to organisms) and Year 10 (B2, organisation). Also, understanding kidney disease and its treatment reminds students of the need to avoid the renal pathology concomitant with Type 2 diabetes, studied in the previous topic. The functioning of the kidney relies on diffusion, active transport and osmosis, all studied previously (Year 8, Cells, and Year 10, B1). Learning ADH is another opportunity to study hormones and negative feedback. Lastly, an understanding of hemodialysis and kidney transplants is an opportunity for students to fully appreciate the role of the NHS in our national health; it teaches also compassion, and is a chance to discuss an ethical issue such as the opting in or out with respect to organ donation. **Variation & Inheritance (B6) -** This topic answers such fundamental questions as: Why are we all different but similar? How can I prevent my children having a genetic disease? Students learn about DNA, protein synthesis, cloning, genetic engineering and inheritance. This is a culmination of much which has gone before in KS3, namely Genes 1 (Year 7), Genes 2 (Year 8) and Genes 3 (Year 9). From the point of view of GCSE, this topic can feel quite "stand-alone". However, this is a false perception because our genes are precursors to everything we are and everything we do, so really B6 explains Topics 1-5. It is correct to teach this in the middle of Year 11 because a greater degree of intellectual development and emotional maturity is required to understand that, for example, the unborn baby of

			two carriers of cystic fibrosis has a 25% chance of inheriting CF, and so the decision to undergo amniocentesis and then consider a termination is a reality. Genetic Engineering is exemplified with insulin, and so reference is made to Hormones (B5) **Evolution and classification (B6)** - This topic goes right to the heart of what it means to be human and considers where we as a species sit in relation to all our other cousin species, here on Earth. This follows on from Genes 1 and 3 in Years 7 and 9 respectively. Also, the teaching here of extinction foreshadows Human effects on the environment, which is covered in Humans and Biodiversity (B7). Antibiotic resistance, and how to slow its emergence, is also taught, and so reference is made back to Infection, response and treatment (B3). **Ecosystems (B7)** - This deepens students' knowledge of interdependence, a topic first encountered in Year 7 (Ecosystems). This, and the teaching of material cycling, revisits much of what has gone before, namely Photosynthesis (Year 9, Year 10), Respiration (Year 9, Year 10) and Plant leaves and roots (Organisation, Year 10). There are two required practicals, on distribution sampling and decomposition. Triple students learn about Biogas generators, and so learn about other societies around the world where these are commonplace. **Humans and biodiversity (B7)** - In view of the climate emergency and a growing population, perhaps this is the most important topic of all? As stated previously, the teaching of extinction in B6 foreshadowed this current topic; this is because we are in the midst of a slow but seemingly inevitable, anthropogenic mass extinction event; this topic is therefore an essential part of any child's education. Improving biodiversity is covered in detail. Triple students learn much about farming, food production and energy transfers, learning why, for example, on a planet with unsustainable food production a vegetarian diet could potentially save humankind. This is truly powerful knowledge as it empowers our students to make decisions that are right for our species, and our planet. This is the end of a learning journey begun in Year 9 with Ecosystems 2.

Key Stage 4 Chemistry

	Year	What is taught? Overview of Topics	Why this? Why then?
KS4	**10**	**C1 – Atomic structure and the periodic table** **C4.1 – Chemical Changes; Reactivity of metals** **C7 – Organic Chemistry** **C6 – The rate and extent of chemical changes** **C10 – Using resources** **C9 – Chemistry of the Atmosphere** **C8 – Chemical Analysis**	**Atomic Structure and the Periodic Table (C1)** Atomic structure and the periodic table give students the knowledge and understanding of the basic principles of chemistry, why some elements react and others don't, what atoms are and how our current understanding of the atom has developed throughout time. This then enables students to build their chemistry knowledge from these basic concepts. Following on from this paper 2 content is taught first, in Year 10, as this gives the students the foundation knowledge in order to complete the paper 1 content in Year 11. These topics are more accessible to students within Year 10 giving them the opportunity to build up their confidence with chemistry principles. Many of these topics provide students with the basic understanding that can then be revisited and applied in Year 11 when being taught more complex chemistry content. These topics also introduce many of the practical skills that are required within the required practical guidance from AQA. This enables students to build in their confidence of completing practical tasks in a safe manner. Furthermore, these topics require a lower demand in terms of mathematical skills needed by students and therefore are more accessible to students in Year 10 than the mathematical demands of paper 1. **Chemical Changes; Reactivity of metals (C4.1)** Knowing about these chemical changes mean that students can start to predict new substances that are formed during chemical reactions and use this knowledge to apply to various chemical reactions they will come across throughout subsequent GCSE topics. Students also learn about how the extraction of important resources from the earth makes use of the way that some elements and compounds react with each other and how easily they can be 'pulled apart'. **Organic Chemistry (C7)** The chemistry of carbon compounds is so important that it forms a separate branch of chemistry. This branch of chemistry gets its name from the fact that the main sources of organic compounds are living, or once-living materials from plants and animals. These sources include fossil fuels which are a major source of feedstock for the petrochemical industry. In this topic students will look at how scientists take organic molecules and modify them in many ways to make new and useful materials such as polymers, pharmaceuticals, perfumes and flavourings, dyes and detergents. Students will also look at how the use of fossil fuels as fuels has impacted the atmosphere. **The Rate and Extent of Chemical Change (C6)**

			Chemical reactions can occur at vastly different rates. Whilst the reactivity of chemicals is a significant factor in how fast chemical reactions proceed, there are many variables that can be manipulated in order to speed them up or slow them down. Chemical reactions may also be reversible and therefore the effect of different variables needs to be established in order to identify how to maximise the yield of desired product. Understanding energy changes that accompany chemical reactions is important for this process. In industry, chemists and chemical engineers determine the effect of different variables on reaction rate and yield of product. Whilst there may be compromises to be made, they carry out optimisation processes to ensure that enough product is produced within a sufficient time, and in an energy-efficient way. **Using Resources (C10)** Industries use the Earth's natural resources to manufacture useful products. In order to operate sustainably, chemists seek to minimise the use of limited resources, use of energy, waste and environmental impact in the manufacture of these products. Chemists also aim to develop ways of disposing of products at the end of their useful life in ways that ensure that materials and stored energy are utilised. Pollution, disposal of waste products and changing land use has a significant effect on the environment, and environmental chemists study how human activity has affected the Earth's natural cycles, and how damaging effects can be minimised. **Chemistry of the atmosphere (C9)** The Earth's atmosphere is dynamic and forever changing. The causes of these changes are sometimes man-made and sometimes part of many natural cycles. Scientists use very complex software to predict weather and climate change as there are many variables that can influence this. The problems caused by increased levels of air pollutants require scientists and engineers to develop solutions that help to reduce the impact of human activity **Chemical Analysis (C8)** Analysts have developed a range of qualitative tests to detect specific chemicals. The tests are based on reactions that produce a gas with distinctive properties, or a colour change or an insoluble solid that appears as a precipitate. Instrumental methods provide fast, sensitive and accurate means of analysing chemicals, and are particularly useful when the amount of chemical being analysed is small. Forensic scientists and drug control scientists rely on such instrumental methods in their work.
	11	**C2 – Structure, bonding and properties** **C3 – Quantitative chemistry** **C4.2 and C4.3 – Chemical Changes; Salts and electrolysis** **C5 – Energy changes**	With the exception of C1 - Atomic Structure, which is necessary to underpin understanding of the fundamentals in all later units, Paper 1 content is taught in Year 11, the concepts in these topics are significantly harder to understand, and the basics need to be in place so that students can expand on the foundations they have created from Year 10, apply their understanding and start to understand why reactions happen, why energy changes take place in reactions and why different types of chemical bonding occur. In addition, topic C3 requires students to have a significantly higher level of mathematical skills, where students are expected to carry out complex calculations in application to chemical

		contexts. Students in Year 11 will have studied the majority of their maths GCSE course by this stage and therefore will have a better understanding of maths principles in order to apply them better to chemistry at this stage in Year 11. **Structure, bonding and properties (C2)** Chemists use theories of structure and bonding to explain the physical and chemical properties of materials. Analysis of structures shows that atoms can be arranged in a variety of ways, some of which are molecular while others are giant structures. Theories of bonding explain how atoms are held together in these structures. Scientists use this knowledge of structure and bonding to engineer new materials with desirable properties. The properties of these materials may offer new applications in a range of different technologies. **Quantitative Chemistry (C3)** Chemists use quantitative analysis to determine the formulae of compounds and the equations for reactions. Given this information, analysts can then use quantitative methods to determine the purity of chemical samples and to monitor the yield from chemical reactions. Chemical reactions can be classified in various ways. Identifying different types of chemical reaction allows chemists to make sense of how different chemicals react together, to establish patterns and to make predictions about the behaviour of other chemicals. Chemical equations provide a means of representing chemical reactions and are a key way for chemists to communicate chemical ideas. **Chemical Changes; Salts and Electrolysis (C4.2 and C4.3)** Students continue to learn about further chemical changes where they will further develop their skills in predicting new substances that are formed during chemical reactions with acids. Students use their knowledge of chemical reactions and their practical skills developed throughout their GCSE studies so far to be able to obtain samples of pure, dry, salt crystals. Students build on their knowledge of ionic substances from C2 and REDOX from C1 and C4.1 to apply to electrolysis used to split compounds. **Energy Changes (C5)** Energy changes are an important part of chemical reactions. The interaction of particles often involves transfers of energy due to the breaking and formation of bonds. This unit extends on the concepts covered at the end of C6 in Year 10. Reactions in which energy is released to the surroundings are exothermic reactions, while those that take in thermal energy are endothermic. These interactions between particles can produce heating or cooling effects that are used in a range of everyday applications. Some interactions between ions in an electrolyte result in the production of electricity. Cells and batteries use these chemical reactions to provide electricity. Electricity can also be used to decompose ionic substances and is a useful means of producing elements that are too expensive to extract any other way.

Physics - Key Stage 4

	Year	What is taught? Overview of Topics	Why this? Why then?
KS4	10	**Particle Model of Matter (YEAR 9)** **Atomic Structure & Radioactivity** **Electricity I** **Energy** **Electricity II** **Magnetism & Electromagnetism**	Paper 1 topics are taught first in Physics, as overall they are of lower mathematical demand than elements of paper 2. Completing all the topics on one paper before the end of Year 10 allows students to undertake a full past paper at the end of the Year with externally generated grade boundaries, and therefore acts as a more accurate metric of progress than an internally generated paper or grade boundaries. **Particle Model of Matter (P3)** Students are introduced to GCSE Physics with the topic Particle Model of Matter. This is a straightforward topic, of relatively low mathematical demand and directly links to KS3 topics on Matter and Kinetic Theory. Students are also introduced to the required practical elements of the GCSE course through a straightforward practical on finding the density of various bodies. This topic is then briefly revisited at the start of Year 10, and separate scientists cover the 'separate only' material on gas pressure and volume. **Atomic Structure and Radioactivity (P4)** Atomic Structure and Radioactivity is studied next as it neatly synergises and recaps elements of Chemistry on the structure of the atom taught in Year 9 while also introducing students to entirely new, engaging content on radioactivity. This is also a lower demand mathematical topic, and therefore suited to earlier in the course. Understanding the components of the atom and their charges is also a prerequisite for fully accessing elements of the Electricity topic, especially for Separate Scientists who learn about static and fields as part of this topic. **Electricity (P2)** Electricity is the longest paper 1 topic, and as such has been split into two sub-topics, **Electricity I (circuits)** and **Electricity II (using electricity)**. Electricity I is a practical heavy topic, including two required practicals that students can competently complete and analyse by the mid-point of Year 10. By interleaving Electricity I, Energy, and Electricity II students are able to revisit and reinforce key concepts from the earlier topics in Electricity II. **Energy (P1)** Energy, while a fundamental physical concept, is the most mathematically demanding of the paper 1 topics, and contains a complex required practical that necessitates students to apply practical skills gained during Electricity I. It also introduces students to concepts that will be revisited in Forces I in Year 11, and Electricity II.

			<u>Magnetism & Electromagnetism (P7)</u> Following the completion of paper 1, the first paper 2 topic started is Magnetism & Electromagnetism. While the latter part of this topic contains some demanding ideas on the motor effect and electromagnetic induction (separate only), the first half is highly practical and builds strongly on aspects on the KS3 Energy 3 topic, Later elements, though conceptually challenging, tend to maintain student engagement due to their direct applicability to devices students use every day, such as electric motors and loudspeakers. These can also be investigated practically but require students to utilise fine motor control and skills developed over the course of Year 10 to successfully execute.
	11	**Forces I** **Waves** **Forces II** **Space (Separate ONLY)**	**<u>Forces (P5)</u>** As with Electricity, the Forces topic has been split into two sections **Forces I (forces in equilibrium)** and **Forces II (forces and motion)**. Forces, a fundamental aspect of Physics, is the longest, and most mathematically taxing, topic within the Physics GCSE. It is therefore beneficial for students to be given the maximum time to develop their mathematical skills before undertaking it. Interspersing Forces I and Forces II with the Waves topic allows multiple aspects of the topic to be revisited, refreshed and revised before student's sit their final exam. The required practicals undertaken in Forces I (on elasticity and Hooke's Law) and Forces II (on Newton's second law) also lend themselves to higher level evaluation, which students are generally not ready to attempt before Year 11. **<u>Waves (P6)</u>** The Waves topic strongly links with strands of Magnetism & Electromagnetism, particularly with respect to conversion between sound waves and electrical signals (microphones and loudspeakers) and the nature of the electromagnetic spectrum (magnetic fields). This topic contains several required practicals of variable complexity, allowing students to consolidate skills covered earlier in the GCSE. **<u>Space (P8)</u>** Space is only covered on the Separate specification. It is syzygetic with numerous other topics, such as Atomic Structure and Radioactivity (emission and absorption lines, nuclear fusion), Waves (wave characteristics and the electromagnetic spectrum) and Forces (hydrostatic equilibria and balanced forces). This therefore makes it suitable to undertake near the end of the course, as it encourages students to revisit and revise these elements in preparation for their final exams.

Key Stage 5 – Biology

	Year	What is taught? Overview of Topics	Why this? Why then?
KS5	**12**	AS content – 4 units as follows between Sept to start of May – 1. Biological Molecules – Chapters 1 and 2 (Teacher A) 2. Cells – Chapters 3, 4 and 5 (Teacher B) 3. Organisms exchange substances environment – Chapters 6 and 7 (Teacher A) 4. Genetic information- Chapters 8, 9 and 10 (Teacher B) During Term 3 of Y12, 7- Genetics, population, evolution and ecosystems – Chapter 19 ONLY (Teachers A and B). Plus Runswick Bay Fieldwork.	AS content – 4 units – taught in order split between two teachers as suggested by the AQA SOW and supported by the Kerboodle textbooks. This allows students to access home learning resources in the format available to them and follows the sequence of the specification. NB - All of the AS content needs to be covered by May Year 12 as some students take the AS exam. During Term 3 of Y12, we teach Chapter 19, Populations in Ecosystems (from A2 content) as this allows us to complete field work during the summer term when the weather conditions are suitable. Chapter 19 also follows on well from Chapter 10 on Biodiversity which is covered at the end of the Year 12 specification.
	13	A2 content – 4 units as follows between Sept to start of May – 5. Energy Transfer – Chapters 11 and 12 (Teacher A) 5. Energy Transfer – Chapter 13 ONLY (Teacher B) 6. Organisms respond to changes in their environment – Chapters 14, 15 and 16 (Teacher A) 7. Genetics, population, evolution and ecosystems – Chapters 17 and 18 (Teacher B) 8. Control of gene expression – Chapters 20 and 21 (Teacher B)	In Year 13, the order of teaching in the textbook is again followed according to the AQA SOW. This is for the same reasons as the order of teaching in Year 12. However, we propose that Chapter 13 Energy in Ecosystems is taught as the first topic by Teacher B (before Chapter 17). This allows teacher B to cover Chapters 17- 21 in sequence but allows more time to teacher A to cover Chapters 11, 12, and 14-16. Conceptually, Chapter 13 follows on from Chapter 19 which is taught at the end of Year 12. This change also takes into account that there are more required practicals for the content covered by teacher A.

Key Stage 5 – Chemistry

	Year	What is taught? Overview of Topics	Why this? Why then?
KS5	**12**	**3.1.1-3.1.7 Physical chemistry** **3.2.1-3.2.3 Inorganic chemistry** **3.3.1-3.3.6 Organic chemistry**	Students begin by refreshing and developing their understanding of the periodic table and atomic structure. They then go on to applying this developed knowledge to developing a greater understanding of the impact of periodicity and of group chemistry. Having finished exploring the fundamental ideas of chemistry and applying this, they go on to exploring schools of chemistry in a way they may not have done previously. This involves expanding their understanding of organic chemistry from GCSE as well as expanding their understanding of energetics. They then go on to apply this to equilibria. They explore organic chemistry in depth culminating in looking how we can use our chemical knowledge to probe organic functional groups. While they also continue to expand their understanding of physical chemistry through kinetics, having worked energetics previously.
	13	**3.1.8-3.1.12 Physical chemistry** **3.2.4-3.2.6 Inorganic chemistry** **3.3.7-3.3.16 Organic chemistry**	Students' knowledge of organic chemistry is expanded and enhanced. This is coupled with similar developments in thermodynamics and kinetics. The exploration of physical chemistry is completed through the study of the Arrhenius equation which unites these two aspects of it. Students' knowledge of organic chemistry is used to determine mechanistic routes for the synthesis of particular functional groups. Inorganic chemistry is developed through the learning of the transition metals having completed work on periodicity in AS and A2 (period 3). The completion of thermodynamics and equilibria is used to support students' understanding of acids, bases and buffers in order to understand pH as a concept. Thermodynamics is also applied in exploring electrochemistry, and this is supplemented with student's knowledge of the transition metals.

Key Stage 5 – Physics

	Year	What is taught? Overview of Topics	Why this? Why then?
KS5	**12**	Teacher A: **Measurement, Errors & Practical Skills (Ch.14, 15, 16)** **Mechanics and Materials (Ch.6-11)** *Post AS exams:* ***Further Mechanics (Ch.17)*** Teacher B: **Particles, Radiation & Quantum Phenomena (Ch. 1-3)** **Waves & Optics (Ch. 4-5)** **Electricity (Ch. 12-13)** *Post AS exams:* ***Radioactivity (Ch.26)***	At A level, Physics teaching is split between two teachers and is ordered the divisions suggested by the Kerboodle textbooks and associated resources (students have electronic access to this textbook to further support independent learning). This gives a finer grade structure than that suggested by the AQA Specification, allowing students to maintain a better awareness of their progress through the course. Teacher A begins with a series of lessons on **Measurement, Errors & Practical Skills**, such as analysing uncertainties, that students will apply throughout the rest of both AS and A2, both within the formally assessed practicals, and during general classroom experimentation. These skills are directly tested in both the AS exams (for those who are only undertaking a one Year course) and A2 exams, at the end of Year 13. This is followed by the **Mechanics and Materials chapters (6-11)** the longest section of AS material, that allows students to develop their mathematical modelling of physical scenarios throughout the Year. There is significant correlation between this content and the 'Mechanics' section of AS Mathematics; studying the two subjects concurrently maximises students' opportunity for deliberate practise of skills learnt from either subject. This section of the course contains two assessed practicals that make use of the skills explicitly covered at the start of the Year, and allow students to revisit data-logging equipment first seen in the Forces II topic at GCSE. Following AS exams/ May half term, students then start A2 material with teacher A with the **Further Mechanics** chapter on circular motion. This is a natural progression from the earlier mechanics chapters, which primarily involve statics or linear motion. Teacher B starts the course with the **Particles, Radiation & Quantum Phenomena** chapters as these provide a new interest and knowledge dimension beyond GCSE. These are some of the more straightforward topics covered over the course of A level, and, additionally, do not contain any assessed practical work, giving students time to complete the Measurement, Errors & Practical Skills chapters with their other teacher before any significant experiments are undertaken.

			The **Waves & Optics** and **Electricity** chapters are somewhat stand alone and, in some Years, may be swapped in the order they are taught to best fit the calendar and specifics of that particular Year. The first half of **Waves & Optics** is a natural development of the Waves GCSE topic, while most of the optical material is new to students, and therefore best begun once they are settled into the rigours of A level study. It requires students to apply trigonometrical ideas to novel physical situations and aligns well with the development in mathematical skills students should be demonstrating by this point in the course. The **Electricity** chapters expand upon the foundations laid in the GCSE Electricity I topic, enhancing students knowledge of electrical circuits, while introducing new concepts such as emf and resistivity. The latter of these involves an assessed practical that directly builds on a required practical students completed at GCSE, on the resistance of a wire. Following AS exams/ May half term, students then start A2 material with teacher B with the **Radioactivity.** As with at GCSE, this is a topic with which students readily engage, allowing interest and enthusiasm to be maintained until the end of the Year.
	13	Teacher A: **Further Mechanics (Ch.18)** **Thermal Physics (Ch.19-20)** OPTIONAL MODULE: **Astrophysics (Ch. 28.1 -28.3)** Teacher B: **Radioactivity (Ch. 26-27)** **Fields (Ch. 21-25)**	Students start A2 with teacher A by completing the **Further Mechanics** chapters, looking at Simple Harmonic Motion. This revises and extends their learning on circular motion from the end of Year 12. This is followed by two chapters on **Thermal Physics.** These are short, straightforward chapters, that act a good counterpoint to the complexity of the material simultaneously seen in the Fields topic. Finally, after Christmas, students start the optional module, currently selected to be **Astrophysics**. This tends to be a popular topic of study for students, being an area of Physics often covered by the lay media. There is also a strong synoptic element as numerous points, for example work on lenses and telescopes relating to earlier AS work on Optics, supernova triggers relating to nuclear stability curves seen in Radioactivity and analysis of emission lines, first covered in Quantum Phenomena, to find galactic redshifts and exoplanets through radial velocity curves. There is a clear benefit to revisiting these earlier elements of the course prior to students' final A2 exams. Teacher B begins the A2 Year with the completion of the **Radioactivity** chapters, including if not completed in Year 12, an assessed practical where students use radioactive sources. They then spend the bulk of the Year completing the chapters on **Fields**, a fundamental Physical concept that underpins a significant fraction of our modern understanding of the Universe. These are challenging, and mathematically rigorous, chapters, that build on earlier topics, both at AS and GCSE.