Year 9-11 Science - Rationale

Teaching in the sciences in key stage 4 continues with the process of building upon and deepening scientific knowledge and the understanding of ideas developed in earlier key stages in the subject disciplines of biology, chemistry, and physics. At Barnwood Park School, we introduce students to the fundamental concepts of each science discipline in year 9 in preparation for GCSE Science. This allows us to build on the ideas developed in years 7 and 8 and to ensure students understand the basic requirements across biology, chemistry and physics before facing the more demanding aspects of science introduced in the GCSEs.

We do this through the AQA specification for Combined Science Trilogy and includes the following topics:

- Atoms and the Periodic Table
- Particles of Matter and Atomic Structure
- Cell Structure and Cell Division
- Bonding and structure.

https://www.aqa.org.uk/subjects/science/gcse/combined-science-trilogy-8464/specification-at-a-glance

In year 10, students have the option of following the Separate Sciences route. The additional content is taught, once a week, after school. Topics covered in year 10 build on the fundamentals introduced in year 9 and include:

- Organisation
- Energy
- Infection and Response
- Electricity
- Quantitative Chemistry
- Bioenergetics
- Chemical and Energy Changes
- Homeostasis

Biology – https://www.aqa.org.uk/subjects/science/gcse/combined-science-trilogy-8464/specification-at-a-glance

Chemistry - https://www.aqa.org.uk/subjects/science/gcse/chemistry-8462/specification-at-a-glance

Physics - https://www.aqa.org.uk/subjects/science/gcse/physics-8463/specification-at-a-glance

For some students, we recognise that GCSE science is too demanding and as an alternative or a more gradual progression to GCSE, we follow the AQA specification for Entry Level Certificate. ELC Science prepares students for GCSE and can be used to monitor student progress. The component-based structure of the ELC provides students with the opportunity to work in short programmes and this gives the student a sense of achievement throughout the course and enables their progress to be monitored. It also enables us, as teachers to gauge whether an entry for both ELC Science and GCSE Combined Science is a reasonable expectation

- https://www.aqa.org.uk/subjects/science/elc/science-5960/specification-at-a-glance

In year 11, students continue with their chosen route through Combined or Separate Science. Topics covered include:

- Inheritance and Variation
- Forces
- Ecology
- Waves and Electromagnetism
- Rates of Reaction
- Organic Chemistry
- Chemical Analysis
- Chemistry of the atmosphere
- Using Resources
- Space (Physics Only)

Students who have followed the ELC specification will be assessed to determine whether an entry for both ELC Science and GCSE Combined Science is a reasonable expectation, and year 11 time is used to strength students understanding of the key areas being assessed

Extra–Curricular Opportunities

- Year 9 - Term 2 Gloucestershire Schools' Christmas Lectures, Dene Close School

Year 9 (6 lessons per fortnight)

	Autumn 1 Term 1	Autumn 2 Term 2	Spring 1 Term 3
Knowledge	**1. Atoms and the Periodic Table –** The periodic table provides chemists with a structured organisation of the known chemical elements from which they can make sense of their physical and chemical properties. The historical development of the periodic table and models of atomic structure provide good examples of how scientific ideas and explanations develop over time as new evidence emerges. The arrangement of elements in the modern periodic table can be explained in terms of atomic structure which provides evidence for the model of a nuclear atom with electrons in energy levels.	**1. Particle Model of Matter -** The particle model is widely used to predict the behaviour of solids, liquids and gases and this has many applications in everyday life. It 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. It also explains why it is difficult to make a good cup of tea high up a mountain! **2. End of Autumn Terms Assessment –** covers Atoms and the Periodic table, and the Particle Model	**1. Atomic Structure -** Ionising radiation is hazardous but can be very useful. 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. Early researchers suffered from their exposure to ionising radiation. Rules for radiological protection were first introduced in the 1930s and subsequently improved. Today radioactive materials are widely used in medicine, industry, agriculture and electrical power generation
	Spring 2 Term 4	**Summer 1 Term 5**	**Summer 2 Term 6**
	1. Cell Structure and Cell Division - Cells are the basic unit of all forms of life. In this section, we explore how structural differences between types of cells enable them to perform specific functions within the organism. These differences in cells are controlled by genes in the nucleus. For an organism to grow, cells must divide by mitosis producing two new identical cells. If cells are isolated at an early stage of growth before they have become too specialised, they can retain their ability to grow into a range of different types of cells. This phenomenon has led to the development of stem cell technology. This is a new branch of medicine that allows doctors to repair damaged organs by growing new tissue from stem cells.	**1. Bonding and Structure and the Properties of Matter -** 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.	**1. End of Year Assessment –** Covers all topics taught in terms 1-5 **2. Organisation (Digestive System) –** In this section, we will learn about the human digestive system which provides the body with nutrients. Digestion provides dissolved materials that need to be moved quickly around the body in the blood by the circulatory system.

Year 10 (11 lessons per fortnight)

	Autumn 1 Term 1	Autumn 2 Term 2	Spring 1 Term 3
Knowledge	**1. Organisation (Animals and Plants) –** In this section, we will learn about the respiratory system that provides oxygen and removes carbon dioxide. This system moves dissolved materials quickly around the body in the blood by the circulatory system. Damage to this system can be debilitating if not fatal. Although there has been huge progress in surgical techniques, especially with regard to coronary heart disease, many interventions would not be necessary if individuals reduce their risks through improved diet and lifestyle. We will also learn how the plant's transport system is dependent on environmental conditions to ensure that leaf cells are provided with the water and carbon dioxide that they need for photosynthesis. **2. Energy -** The concept of energy emerged in the 19th century. The idea was used to explain the work output of steam engines and then generalised to understand other heat engines. It also became a key tool for understanding chemical reactions and biological systems. Limits to the use of fossil fuels and global warming are critical problems for this century. Physicists and engineers are working hard to identify ways to reduce our energy usage.	**1. Infection and Response -** Pathogens are microorganisms such as viruses and bacteria that cause infectious diseases in animals and plants. They depend on their host to provide the conditions and nutrients that they need to grow and reproduce. They frequently produce toxins that damage tissues and make us feel ill. This section will explore how we can avoid diseases by reducing contact with them, as well as how the body uses barriers against pathogens. Once inside the body, our immune system is triggered which is usually strong enough to destroy the pathogen and prevent disease. When at risk from unusual or dangerous diseases our body's natural system can be enhanced by the use of vaccination. Since the 1940s a range of antibiotics have been developed which have proved successful against a number of lethal diseases caused by bacteria. Unfortunately, many groups of bacteria have now become resistant to these antibiotics. The race is now on to develop a new set of antibiotics **2. End of Autumn Terms Assessment –** covers Organisation, Energy, and Infection and Response	**1. Electricity -** Electric charge is a fundamental property of matter everywhere. Understanding the difference in the microstructure of conductors, semiconductors and insulators make it possible to design components and build electric circuits. Many circuits are powered with mains electricity, but portable electrical devices must use batteries of some kind. Electrical power fills the modern world with artificial light and sound, information and entertainment, remote sensing and control. The fundamentals of electromagnetism were worked out by scientists of the 19th century. However, power stations, like all machines, have a limited lifetime. If we all continue to demand more electricity this means building new power stations in every generation – but what mix of power stations can promise a sustainable future? **2. Quantitative Chemistry -** 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.

	Spring 2 Term 4	Summer 1 Term 5	Summer 2 Term 6
	1. Bioenergetics - In this section we will explore how plants harness the Sun's energy in photosynthesis in order to make food. This process liberates oxygen which has built up over millions of years in the Earth's atmosphere. 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. Conversely, anaerobic respiration does not require oxygen to transfer energy. During vigorous exercise, the human body is unable to supply the cells with sufficient oxygen and it switches to anaerobic respiration. This process will supply energy but also causes the build-up of lactic acid in muscles which causes fatigue. **2. Chemical Changes –** Understanding of chemical changes began when people began experimenting with chemical reactions in a systematic way and organizing their results logically. Knowing about these different chemical changes meant that scientists could begin to predict exactly what new substances would be formed and use this knowledge to develop a wide range of different materials and processes. It also helped biochemists to understand the complex reactions that take place in living organisms. 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'.	**1. Chemical Changes (Continued)** **2. End of Year Assessment –** Covers all paper 1 topics across 3 past exam papers (1 x biology, 1 x chemistry, 1 x physics)	**1. Energy Changes –** 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. 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. **2. Homeostasis and Response -** Cells in the body can only survive within narrow physical and chemical limits. They require a constant temperature and pH as well as a constant supply of dissolved food and water. In order to 42 Visit aqa.org.uk/8464 for the most up-to-date specification, resources, support and administration do this the body requires control systems that constantly monitor and adjust the composition of the blood and tissues. These control systems include receptors which sense changes and effectors that bring about changes. In this section we will explore the structure and function of the nervous system and how it can bring about fast responses. We will also explore the hormonal system which usually brings about much slower changes. Hormonal coordination is particularly important in reproduction since it controls the menstrual cycle. An understanding of the role of hormones in reproduction has allowed scientists to develop not only contraceptive drugs but also drugs which can increase fertility

Year 11 (10 lessons per fortnight)

	Autumn 1 Term 1	Autumn 2 Term 2	Spring 1 Term 3
Knowledge	**1. Inheritance and Variation –** In this section, we will discover how the number of chromosomes are halved during meiosis and then combined with new genes from the sexual partner to produce unique offspring. Gene mutations occur continuously and on rare occasions can affect the functioning of the animal or plant. These mutations may be damaging and lead to a number of genetic disorders or death. Very rarely a new mutation can be beneficial and consequently, lead to increased fitness in the individual. 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. Scientists have now discovered how to take genes from one species and introduce them in to 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. **2. Forces -** Engineers analyse forces when designing a great variety of machines and instruments, from road bridges and fairground rides to atomic force microscopes. Anything mechanical can be analysed in this way. Recent developments in artificial limbs use the analysis of forces to make movement possible. **3. Trial exams –** covers all paper 1 topics	**1. Trial exams –** continued **2. Ecology –** Engineers analyse forces when designing a great variety of machines and instruments, from road bridges and fairground rides to atomic force microscopes. Anything mechanical can be analysed in this way. Recent developments in artificial limbs use the analysis of forces to make movement possible. **2. Waves –** Wave behaviour is common in both natural and man-made systems. Waves carry energy from one place to another and can also carry information. Designing comfortable and safe structures such as bridges, houses and music performance halls requires an understanding of mechanical waves. Modern technologies such as imaging and communication systems show how we can make the most of electromagnetic waves. **3. Electromagnetism –** Electromagnetic effects are used in a wide variety of devices. 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. It means that systems that involve control or communications can take full advantage of this.	**1. The Rate and Extent of Chemical Change -** Electromagnetic effects are used in a wide variety of devices. 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. It means that systems that involve control or communications can take full advantage of this **2. Organic Chemistry -** The chemistry of carbon compounds is so important that it forms a separate branch of chemistry. A great variety of carbon compounds is possible because carbon atoms can form chains and rings linked by C-C bonds. 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. Chemists are able to 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. **3. Chemical Analysis -** 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. **4. Trial exams –** Biology and Physics paper 2 topics

	Spring 2 Term 4	Summer 1 Term 5	Summer 2 Term 6
	1. Trial exams – Continued **2. Chemistry of the Atmosphere -** 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. **3. Using Resources –** 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.	**1. Trial exams –** Chemistry paper 2 topics **2. Revision** **3. GCSE Exams**	**1. GCSE Exams Continued**

Skills	**Working Scientifically** https://filestore.aqa.org.uk/resources/science/specifications/AQA-8464-SP-2016.PDF Science is a set of ideas about the material world. We have included all the parts of what good science is at GCSE level: whether it be investigating, observing, experimenting, or testing out ideas and thinking about them. The way scientific ideas flow through the specification will support you in building a deep understanding of science with your students. We know this will involve talking about, reading and writing about science plus the actual doing, as well as representing science in its many forms both mathematically and visually through models. This specification encourages the development of knowledge and understanding in science through opportunities for working scientifically. Working scientifically is the sum of all the activities that scientists do. We feel it is so important that we have woven it throughout our specification and written papers. Our schemes of work will take this further for you and signpost a range of ways to navigate through this qualification, so your students are engaged and enthused. These free resources support the use of mathematics as a tool for thinking through the use of mathematical language in explanations, applications and evaluations. **Working Mathematically** Students will be required to demonstrate the following mathematics skills in GCSE Combined Science assessments. Questions will target maths skills at a level of demand appropriate to each subject. In Foundation Tier papers questions assessing maths requirements will not be lower than that expected at Key Stage 3 (as outlined in Mathematics programmes of study: Key Stage 3 by the DfE, document reference DFE-00179-2013). In Higher Tier papers questions assessing maths requirements will not be lower than that of questions and tasks in assessments for the Foundation Tier in a GCSE Qualification in Mathematics.
Assessment	**All Years** • Low stakes quizzes • Retrieval Practice activities • End of topic, self-assessed assessments **Year 9** • Carousel Learning Quizzes • End of term 2 assessment • End of year 9 assessment **Year 10** • Tassomai • End of term 2 assessment • End of year 10 assessment **Year 11** • Tassomai • Trial exams (End of term 1, beginning of term 2) • Trial exams (End of term 3, beginning of term 4)