Key Stage 4 Overview

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
Year 9	University Challenge: **DATA: importance and limitations** Context: C1 **• Which chemicals make up air, and which ones are pollutants? How do I make sense of data about air pollution?** **• What chemical reactions produce air pollutants?** **What happens to these pollutants in the atmosphere?** **• What choices can we make personally, locally, nationally or globally to improve air quality?**	University Challenge: **Cause and effect** Context: P1 **• What do we know about the place of the Earth in the Universe?** **• What do we know about the Earth and how it is changing?**	**University Challenge:** **Developing scientific explanations** Context: B1 **• What are genes and how do they affect the way that organisms develop?** **• Why can people look like their parents, brothers and sisters, but not be identical to them?** **• How can and should genetic information be used? How can we use our knowledge of genes to prevent disease?** **• How is a clone made?**	**University Challenge:** **The scientific community** Context: B2&3 **• How do our bodies resist infection?** **• What are vaccines and antibiotics and how do they work?** **• What factors increase the risk of heart disease?** **• How do our bodies keep a healthy water balance?** **• Systems in balance – how do different species depend on each other?** **• How has life on Earth evolved?** **• What is the importance of biodiversity?**	**University Challenge:** **Risk** Context**: P2&3** **• What types of electromagnetic radiation are there? What happens when radiation hits an object?** **• Which types of electromagnetic radiation harm living tissue and why?** **• What is the evidence for global warming, why might it be occurring, and how serious a threat is it?** **• How are electromagnetic waves used in communications?** **• How much energy do we use?** **• How can electricity be generated?** **• Which energy sources should we choose?**	**University Challenge:** **Making decisions about science and technology.** Context: C2&3 **• How do we measure the properties of materials and why are the results useful?** **• Why is crude oil important as a source of new materials such as plastics and fibres?** **• Why does it help to know about the molecular structure of materials such as plastics and fibres?** **• What is nanotechnology and why is it important?** **• What were the origins of minerals in Britain that contribute to our economic wealth?** **• Where does salt come from and why is it so important?** **• Why do we need chemicals such as alkalis and chlorine and how do we make them?**
	The quality of air is becoming a major world concern. In this module students learn about the gases that make up the Earth's atmosphere and how its composition has changed and is still changing. Students explore environmental and health consequences of certain air pollutants, and options for improving air quality in the future, such as the use of catalytic converters. The emphasis is on health issues arising from burning fuels rather than on global issues such as climate change **Skills:** Collecting data to test proposed explanations.	Scientific discoveries in the solar system and beyond continue to inspire popular culture and affect our understanding of our place in the Universe. In this module, students explore the scale of the Universe and its past, present and future, and consider the ideas scientists have and their evidence for them. Closer to home, students consider long-term and short-term changes in the Earth's crust, and how these changes impact on human life. In particular, they find out about earthquakes and volcanoes – explaining them, predicting them and coping with them. The module focuses on how we know the things we think we know about the Earth and its place in	The inheritance of detailed information from each generation to the next is a fundamental story in science. For each of us, inheritance also raises questions about our own development. In this module, students learn basic concepts of inheritance: genes as units of inheritance, the interplay between genes and environment and sexual reproduction as a source of variation. These concepts are sufficiently detailed for students to make sense of related ideas in other GCSE Science modules. More complex ideas, such as mechanisms for protein synthesis and cell division, are not required; these are covered in GCSE Additional Science A.	Keeping healthy involves maintaining a healthy lifestyle, avoiding infection, and using medication when necessary. This module illustrates these principles through prevention of infectious diseases and heart disease. Students learn about the immune system, and how vaccines work to prevent infection. They also learn about the increase of 'superbugs', and how correct use of antibiotics can help to reduce their prevalence. The module explores how new drugs are developed, including the stages of testing for safety and effectiveness. Students also consider the causes of heart disease, and how individuals	The possible health risks of radiation, both in nature and from technological devices, are becoming of increasing concern. In some cases, misunderstanding the term 'radiation' generates unnecessary alarm. By considering the need to protect the skin from sunlight, students are introduced to a general model of radiation travelling from the source to a receiver. They learn about the electromagnetic spectrum and the harmful effects of some radiation. The greenhouse effect and photosynthesis illustrate how radiation from the Sun is vital to life, whilst the ozone layer is shown to be a natural protection from harmful radiation. Students study evidence of global warming and its	Our way of life depends on a wide range of materials produced from natural resources. The Earth's crust provides us with crude oil, which is a source of fuel and raw material for producing synthetic polymers. Natural polymers can also be useful and can be obtained from living things. This module Considers how measurements of the properties of materials can inform the choice of material for a particular purpose. By taking their own measurements, students can explore some of the issues that arise when trying to establish accurate and meaningful data.

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	we can never be sure that a measurement tells us the true value of the quantity being measured. taking several measurements of any quantity these are likely to vary. Working out the mean of several repeat measurements (to produce a good estimate of the true value of the quantity being measured) • estimating a a range from a set of repeated measurements of a quantity within which the true value probably lies. • Identifying anomalous results.	the Universe. Across the whole module, students encounter many examples showing relationships between data and explanations. Through these contexts they learn about the way scientists communicate and develop new explanations. **Skills:** • it is often useful to think about processes in terms of factors which may affect an outcome (or input variables which may affect an outcome variable). • to investigate the relationship between a factor and an outcome, it is important to control all the other factors which we think might affect the outcome (a so-called 'fair test'). • if an outcome occurs when a specific factor is present, but does not when it is absent, or if an outcome variable increases (or decreases) steadily as an input variable increases, we say that there is a correlation between the two. • a correlation between a factor and an outcome does not necessarily mean that the factor causes the outcome; both might, for example, be caused by some other factor. • in some situations, a factor alters the chance (or probability) of an outcome, but does not invariably lead to it. We also call this a correlation. • to investigate a claim that a factor increases the chance (or probability) of an outcome, scientists compare samples (e.g. groups of people) that are matched on as many other factors as possible, or are chosen randomly so that other factors are equally likely in both samples. The larger the samples, the more confident we can be about any conclusions drawn. • even when there is evidence that a factor is correlated with an outcome, scientists are unlikely to accept that it is a cause of the outcome, unless they can think of a plausible mechanism linking the two.	Throughout the module, students are introduced to genetic technologies that open up new possibilities for individuals and society. In doing so, they present significant ethical issues for citizens. Students explore some of the ideas people use to make ethical decisions. This enables them to engage with issues which regularly appear in the media, such as genetic testing and cloning research **Skills:** • scientific hypotheses, explanations and theories are not simply summaries of the available data. They are based on data but are distinct from them. • an explanation cannot simply be deduced from data, but has to be thought up creatively to account for the data. • a scientific explanation should account for most (ideally all) of the data already known. It may explain a range of phenomena not previously thought to be linked. It should also enable predictions to be made about new situations or examples. • scientific explanations are tested by comparing predictions based on them with data from observations or experiments.	can minimise this risk. They also learn about maintaining a constant internal environment, illustrated through how our body keeps a healthy water balance. In the contexts of vaccination policy and the study of clinical trials, students explore ideas of correlation and cause, and how peer review by the scientific community strengthens the confidence in scientific claims. They also consider particular ethical issues arising in modern medicine, for example the right of individual choice versus social policy, illustrated through vaccination policy. Debate about theories for the evolution of life on Earth often features in the media and popular culture. Students consider different explanations for evolution. These contexts illustrate how explanations arise and become accepted, and the role of the scientific community in this process. Natural selection is introduced as the mechanism for evolution. Biodiversity is recognised as an important natural resource, which is increasingly threatened by human activity. Students consider how ecosystems are in balance and how living organisms are dependent on their environment and each other for survival. The extinction of species is a growing concern often featured in the media. Students consider causes of extinction and whether extinctions should be a global concern. The need for sustainability is frequently referred to in the press. Students are introduced to what this really means and how maintaining biodiversity is one of the keys to sustainability. Specific examples are used to show how sustainability can be increased.	relationship to the carbon cycle. Possible consequences and preventative actions are explored. The importance of electromagnetic radiation for communication is explored with a consideration of how mobile phones are used to send digital images and sounds. Finally, through an investigation of evidence concerning the possible harmful effects of low intensity microwave radiation from devices such as mobile phones, students learn to evaluate reported health studies and interpret levels of risk. When considering the whole electromagnetic spectrum, it is sometimes more appropriate to use a photon model; at other times a wave model is considered. Energy supply is one of the major issues that society must address in the immediate future. Citizens are faced with complex choices and a variety of messages from energy supply companies, environmental groups, the media, scientists and politicians. Some maintain that renewable resources are capable of meeting our future needs, some advocate nuclear power, and some argue that drastic lifestyle changes are required. Decisions about energy use, whether at a personal or a national level, need to be informed by a quantitative understanding of the situation, and this is an underlying theme of the module. Students first survey the ways in which individuals and organisations use energy, and learn how energy demand and use can be measured. They explore the use of energy-efficient devices (e.g.	Key ideas in this module are illustrated through polymers. Students learn how the molecules that make up a polymer fit together and how strongly they are bonded to each other, providing an explanation of the properties of materials. This provides an example of a scientific explanation that makes sense of a wide range of observations. Students also learn how polymers can be modified to give them more desirable properties by the introduction of nanoparticles, which have different properties when compared with larger particles of the same material. Thanks to its geological history, Britain is a country that has large deposits of valuable resources including salt and limestone as well as coal, gas and oil. These raw materials have been the basis of a chemical industry for over 200 years. At first many of the industrial processes were highly polluting. This led to new laws and the establishment of regulatory organisations to control the industry. Today the industry is under great pressure to operate processes that are efficient in their use of energy and which do minimal harm to health and the environment. Salt is particularly important. Salt is necessary in the diet but is hazardous if eaten to excess. Chemists have learnt to convert salt to alkalis and to chlorine, chemicals that are used to make many

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				Skills: • scientists report their claims to other scientists through conferences and journals. Scientific claims are only accepted once they have been evaluated critically by other scientists. • scientists are usually sceptical about claims that cannot be repeated by anyone else, and about unexpected findings until they have been replicated (by themselves) or reproduced (by someone else). • if explanations cannot be deduced from the available data, two (or more) scientists may legitimately draw different conclusions about the same data. A scientist's personal background, experience or interests may influence his/her judgments. • an accepted scientific explanation is rarely abandoned just because some new data disagree with its predictions. It usually survives until a better explanation is available.	light bulbs) and consider the quantitative consequences of various lifestyle choices (e.g. relating to transport and the use of electrical equipment). National data on energy sources introduce a study of electricity generation and distribution; nuclear power generation, the burning of fossil fuels, and renewable resources are compared and contrasted. Finally, students review the energy choices available to individuals, organisations and society. **Skills:** • everything we do carries a certain risk of accident or harm. Nothing is risk free. New technologies and processes based on scientific advances often introduce new risks. • we can sometimes assess the size of a risk by measuring its chance of occurring in a large sample, over a given period of time. • to make a decision about a particular risk, we need to take account both of the chance of it happening and the consequences if it did. • to make a decision about a course of action, we need to take account of both its risks and benefits, to the different individuals or groups involved. • people are generally more willing to accept the risk associated with something they choose to do than something that is imposed, and to accept risks that have short-lived effects rather than long-lasting ones. • people's perception of the size of a particular risk may be different from the statistically estimated risk. People tend to over-estimate the risk of unfamiliar things (like flying as compared with cycling), and of things whose effect is invisible or longterm (like ionising radiation).	valuable products. The use of manufactured chemicals has brought both benefits and risks. Society has become increasingly concerned that there are many chemicals that are used in large amounts, but which have never been thoroughly tested to evaluate their effects on people and the environment. The data from Life Cycle Assessments shows that in selecting a product for a particular job we should assess not only its 'fitness for purpose' but also the total effects of using the materials that make up the product over its complete life cycle, from its production using raw materials to its disposal. **Skills:** • science-based technology provides people with many things that they value, and which enhance the quality of life. Some applications of science can, however, have unintended and undesirable impacts on the quality of life or the environment. Benefits need to be weighed against costs. • scientists may identify unintended impacts of human activity (including population growth) on the environment. They can sometimes help us to devise ways of mitigating this impact and of using natural resources in a more sustainable way. • in many areas of scientific work, the development and application of scientific knowledge are subject to official regulations. • some questions, such as those involving values, cannot be answered by science. • some forms of scientific research, and some applications of scientific knowledge, have ethical implications.

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					• governments and public bodies may have to assess what level of risk is acceptable in a particular situation. This decision may be controversial, especially if those most at risk are not those who benefit.	People may disagree about what should be done (or permitted). • in discussions of ethical issues, one common argument is that the right decision is one which leads to the best outcome for the greatest number of people involved. Another is that certain actions are considered right or wrong whatever the consequences.