# OCR 21st Century GCSE Physics

## Physics Module P1

### The Earth in the Universe

#### P1.1 What do we know about the Earth and space?

| Syllabus point (text abridged) | Boardworks presentations: GCSE Science | Boardworks presentations: Additional Science | Boardworks presentations: Separate Sciences |
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| Rocks provide evidence for changes in the Earth (erosion and sedimentation, fossils, folding, radioactive dating, craters). | **Earth's Structure** *(GCSE Core Chemistry)* | **Radioactive Decay** | |
| Continents would be worn down to sea level, if mountains were not being continuously formed. | | | |
| The rock processes seen today can account for past changes. | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| The Earth must be older than its oldest rocks, **which are about 4 thousand million years old**. | | | |
| Label on a diagram of the Earth its crust, mantle and core. | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| The solar system was formed, over very long periods, from clouds of gases and dust in space, **about 5 thousand million years ago**. | **The Universe** | | |
| Distinguish between planets, moons, the Sun, comets, asteroids and be aware of their relative sizes and motions. | **The Universe** | | **Orbits** |
| Fusion of hydrogen **nuclei** is the source of the Sun's energy. | **The Universe** | **Nuclear Energy** | **Stars** |
| All chemical elements larger than helium were made in earlier stars. | **The Universe** | | **Stars** |
| Discuss the probability and possible consequences of an asteroid colliding with the Earth, including the extinction of the dinosaurs. | **Gravity and Space** | | |
| In relation to the above, or when provided with relevant additional information:<br>• can identify statements which are data and statements which are (all or part of) an explanation;<br>• can recognise data or observations that are accounted for by (or conflict with) an explanation;<br>• can identify imagination and creativity in the development of explanations;<br>• can justify accepting or rejecting a proposed explanation on the grounds that it:<br>o accounts for observations;<br>o **and/or provides an explanation that links things previously thought to be unrelated;**<br>o **and/or leads to predictions that are subsequently confirmed;** | | | |

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| | | Light travels at a high but finite speed, **300 000 km/s**. | | | **Reflection and Refraction** |
| | | Understand that the speed of light means distant objects are observed as younger than they are now. | | | |
| | | A light-year is the distance travelled by light in a year. | | | |
| | | Compare the relative ages of the Earth, the Sun, and the Universe. | | | |
| | | Compare the relative diameters of the Earth, the Sun and the Milky Way. | **The Universe** | | |
| | | Relate uncertainty in the distance of stars and galaxies to the difficulty of observations. | | | |

| The Earth in the Universe | Physics Module P1 | | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | P1.2 How have the Earth's continents moved, and with what consequences? | Wegener's theory of continental drift and his evidence for it (geometric fit of continents and their matching fossils, mountain chains, and rocks). | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| | | Wegener's theory accounted for mountain building. | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| | | Reasons for the rejection of Wegener's theory by geologists of his time (movement of continents not detectable, Wegener an outsider to the community of geologists, too big an idea from limited evidence, simpler explanations of the same evidence). | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| | | Seafloor spreading is a consequence of movement of the solid mantle. | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| | | **Seafloors spread by about 10 cm a year.** | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| | | **Understand how seafloor spreading produces a pattern in magnetism recorded in ocean floors, limited to reversals of the Earth's magnetic field and solidification of molten magma at oceanic ridges.** | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| | | Earthquakes, volcanoes and mountain building generally occur at the edges of tectonic plates. | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| | | **The movement of tectonic plates causes earthquakes, volcanoes, mountain building and contributes to the rock cycle.** | **Earth's Structure** *(GCSE Core Chemistry)* | | |
| | | Some actions that authorities can take to reduce damage caused by geohazards. | | | |

| Physics Module P1 | | | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| The Earth in the Universe | P1.3 What is known about stars and galaxies? | What we know about distant stars and galaxies comes from the radiation astronomers can detect. | Gravity and Space | | |
| | | Distance to stars can be measured using the relative brightness of stars or parallax (qualitative idea only). | | | |
| | | Light pollution interferes with observations of the night sky. | | | |
| | | The Sun is a star in the Milky Way galaxy. | The Universe | | |
| | | There are thousands of millions of galaxies, each containing thousands of millions of stars, and that all of these make up the Universe. | The Universe | | Stars |
| | | All stars have a life cycle. | | | Stars |
| | | Astronomers have detected planets around some nearby stars. | | | |
| | | If even a small proportion of stars have planets, many scientists think that it is likely that life exists elsewhere in the Universe. | | | |
| | | No evidence of alien life (at present or in the past) has so far been detected. | Gravity and Space | | |
| | | Distant galaxies are moving away from us. | The Universe | | |
| | | **Relate the distance of galaxies to the speed at which they are moving away (Hubble's law, but not redshift).** | The Universe | | |
| | | **Understand why the motions of galaxies suggests that Space itself is expanding.** | The Universe | | |
| | | The Universe began with a 'big bang' about 14 thousand million years ago. | The Universe | | Stars |
| | | Understand why the ultimate fate of the Universe is difficult to predict. | The Universe | | |

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| | **Physics Module P1** | | | | |
| | | **Syllabus point (text abridged)** | **Boardworks presentations** | | |
| | | | **GCSE Science** | **Additional Science** | **Separate Sciences** |
| **The Earth in the Universe** | **P1.4 How do scientists develop explanations of the Earth and Space?** | In relation to movements of the Earth's continents or what is known about stars and galaxies, or when provided with relevant additional information:<br>• can identify statements which are data and statements which are (all or part of) an explanation;<br>• can recognise data and observations that are accounted for by, (or conflict with), a given explanation;<br>• can identify imagination and creativity in the development of an explanation;<br>• can describe in broad outline the 'peer review' process, in which new scientific claims are evaluated by other scientists;<br>• can recognise that new scientific claims which have not yet been evaluated by the scientific community are less reliable than well established ones; | | | |
| | | In relation to movements of the Earth's continents (P1.2), or when provided with relevant additional information:<br>• can justify accepting or rejecting a proposed explanation on the grounds that it:<br>  ○ accounts for observations;<br>  ○ **and/or provides an explanation that links things previously thought to be unrelated;**<br>  ○ **and/or leads to predictions that are subsequently confirmed;**<br>• can draw valid conclusions about the implications of given data for a given explanation, e.g.<br>  ○ recognises that an observation that agrees with a prediction (derived from an explanation) increases confidence in the explanation **but does not prove it is correct**;<br>  ○ recognises that an observation that disagrees with a prediction (derived from an explanation) indicates that either the observation or the prediction is wrong, **and that this may decrease our confidence in the explanation;**<br>• can identify a scientific question for which there is not yet an agreed answer, **and suggest why**;<br>• can identify absence of replication as a reason for questioning a scientific claim;<br>• **can explain why scientists regard it as important that a scientific claim can be replicated by others;**<br>• can suggest plausible reasons why scientists involved in a scientific event or issue disagree(d);<br>• **can suggest reasons for scientists' reluctance to give up an accepted explanation when new data appear to conflict with it.** | | | |

| | | | Physics Module P2 | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| Radiation and Life | P2.1 What types of electromagnetic radiation are there? What happens when radiation hits an object? | Light is one of a family of radiations, the electromagnetic spectrum. | **Electromagnetic Waves** | | |
| | | A beam of electromagnetic radiation delivers energy in 'packets' called photons. | | | |
| | | The electromagnetic radiations in order of the energy delivered by each photon – radio waves, microwaves, infrared, light, ultraviolet, X-rays, gamma rays. | **Electromagnetic Waves** | | |
| | | Interpret a situation in which one object affects another some distance away in terms of the general model of electromagnetic radiation:<br>• one object (a source) emits radiation;<br>• the radiation travels from the source and can be reflected, transmitted or absorbed by materials on its journey;<br>• radiation may absorbed by another object (a detector) some distance away. | | | |
| | | The energy deposited by a beam of electromagnetic radiation depends on both the number of photons arriving and the energy that each photon delivers. | | | |
| | | Intensity of electromagnetic radiation is the energy arriving at a surface each second. | | | |
| | | The intensity of a beam of electromagnetic radiation decreases with distance **and be able to explain why.** | | | |
| | | Ionising radiation is able to break molecules into bits (called ions), **which can then take part in other chemical reactions.** | **Ionizing Radiation** | | |
| | | Ionising radiation includes:<br>• ultraviolet radiation;<br>• X-rays;<br>• gamma rays. | **Ionizing Radiation** | | |
| | | Microwaves heat materials containing particles that the microwaves can vibrate; | **Radio Waves and Microwaves** | | |
| | | Link the heating effect of non-ionising radiation to its intensity **and duration.** | | | |
| | | An example of the way in which each of infrared, microwaves and radio waves are used for transmitting information. | **Radio Waves and Microwaves, Infrared and Visible Waves** | | |

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| | **Physics Module P2** | | | | |
| | | **Syllabus point (text abridged)** | **Boardworks presentations** | | |
| | | | **GCSE Science** | **Additional Science** | **Separate Sciences** |
| **Radiation and Life** | **P2.2 Which types of electromagnetic radiation harm living tissue?** | The heating effect of absorbed radiation can damage living cells. | **Electromagnetic Waves** | | |
| | | Low intensity microwave radiation, for example from mobile phone hand sets and masts, may be a health risk, but this is disputed. | **Radio Waves and Microwaves** | | |
| | | Ionising radiation can damage living cells. | **Ionizing Radiation** | | |
| | | Examples of how exposure to different amounts of ionising radiation can affect living cells. | **Ionizing Radiation** | | |
| | | The metal cases and door screens of microwave ovens protect users from the radiation. | **Radio Waves and Microwaves** | | |
| | | Physical barriers protect people from ionising radiation, for example, sun-screens and clothing can be used to absorb most of the ultraviolet radiation from the Sun. | **Ionizing Radiation** | | |

| Physics Module P2 | | | | | |
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| | | **Syllabus point (text abridged)** | **Boardworks presentations** | | |
| | | | **GCSE Science** | **Additional Science** | **Separate Sciences** |
| **Radiation and Life** | **P2.3 How does electromagnetic radiation make life on Earth possible?** | The Earth is surrounded by an atmosphere which allows light radiated from the Sun to pass through. | **Climate Change** *(GCSE Core Chemistry)* | | |
| | | This radiation provides the energy for photosynthesis and warms the Earth's surface. | | **Animal and Plant Cells** *(GCSE Additional Biology)* | |
| | | Photosynthesis removes carbon dioxide from the atmosphere and adds oxygen, and that this reverses the effect of respiration. | | **Animal and Plant Cells** *(GCSE Additional Biology)* | |
| | | The Earth emits electromagnetic radiation that is absorbed by some gases in the atmosphere, so keeping the Earth warmer than it would otherwise be. This is called the greenhouse effect. | **Climate Change** *(GCSE Core Chemistry)* | | |
| | | The ozone layer absorbs ultraviolet radiation, **producing reversible chemical changes in that part of the atmosphere**. | **Climate Change** *(GCSE Core Chemistry)* | | |
| | | The ozone layer protects living organisms, especially animals, from the harmful effects ultraviolet radiation. | **Climate Change** *(GCSE Core Chemistry)* | | |

| Physics Module P2 | | | | | |
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| | | **Syllabus point (text abridged)** | **Boardworks presentations** | | |
| | | | **GCSE Science** | **Additional Science** | **Separate Sciences** |
| **Radiation and Life** | **P2.4 What is the evidence for global warming, why might it be occurring, and how serious a threat is it?** | One of the greenhouse gases in the Earth's atmosphere is carbon dioxide, present in small amounts. | **Climate Change** *(GCSE Core Chemistry)* | | |
| | | **Other greenhouse gases include methane, present in trace amounts, and water vapour.** | **Climate Change** *(GCSE Core Chemistry)* | | |
| | | Interpret simple diagrams representing the carbon cycle. | **Climate Change** *(GCSE Core Chemistry)* | | |
| | | Use the carbon cycle to explain:<br>• why for thousands of years the amount of carbon dioxide in the Earth's atmosphere was constant<br>• how decomposers play an important part in the recycling of carbon<br>• that during the past two hundred years, the amount of carbon dioxide in the atmosphere has been steadily rising<br>• that the rise in atmospheric carbon dioxide is largely the result of:<br>  ○ burning increased amounts of fossil fuels as an energy source<br>  ○ burning forests to clear land. | **Climate Change** *(GCSE Core Chemistry)* | | |
| | | **Computer climate models provide evidence that human activities are causing global warming.** | **Climate Change** *(GCSE Core Chemistry)* | | |
| | | Global warming could result in:<br>• climate change and this could make it impossible to continue growing some food crops in particular regions<br>• extreme weather conditions in some regions<br>• rising sea levels, due to melting continental ice and expansion of water in the oceans, which would cause flooding of low-lying land. | **Climate Change** *(GCSE Core Chemistry)* | | |

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<tr><th colspan="6">Physics Module P2</th></tr>
<tr><th rowspan="2"></th><th rowspan="2"></th><th rowspan="2">Syllabus point (text abridged)</th><th colspan="3">Boardworks presentations</th></tr>
<tr><th>GCSE Science</th><th>Additional Science</th><th>Separate Sciences</th></tr>
<tr><td>Radiation and Life</td><td>P2.5 What ideas do citizens and scientist have about risk?</td><td>When provided with necessary additional information about alleged health risks due to radiation or global warming can:<br>• identify examples of risk which arise from new scientific or technological advances;<br>• suggest ways of reducing specific risks;<br>• interpret and discuss information on the size of risks, presented in different ways;<br>• discuss a given risk, taking account of both the chance of it occurring and the consequences;<br>• identify, or propose, an argument based on the precautionary principle;<br>• use the ideas of correlation and cause appropriately when discussing historical events or topical issues<br>• explain why a correlation between a factor and an outcome does not necessarily mean that one causes the other, and give an example to illustrate this;<br>• suggest factors that might increase the chance of an outcome, but not invariably lead to it;<br>• explain that individual cases do not provide convincing evidence for or against a correlation;<br>• use data to develop an argument that a factor does/does not increase the chance of an outcome;<br>• identify the presence (or absence) of a plausible mechanism as significant for the acceptance (or rejection) of a claimed causal link.</td><td>Climate Change<br>(GCSE Core Chemistry)</td><td></td><td></td></tr>
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| | | When provided with necessary additional information about alleged health risks due to radiation emitted from technological devices, UV radiation from the Sun, can:<br>• explain why it is impossible for anything to be completely safe;<br>• suggest benefits of activities with known risk;<br>• offer reasons for peoples willingness (or reluctance) to accept the risk of a given activity;<br>• discuss personal and social choices in terms of a balance of risk and benefit;<br>• **distinguish between actual and perceived risk, when discussing personal and social choices;**<br>• **suggest reasons for given examples of differences between actual and perceived risk;**<br>• **explain what the ALARA (as low as reasonably achievable) principle means, and how it applies in a given situation;**<br>• identify the outcome and the factors that may affect it;<br>• suggest how an outcome might be affected when a factor is changed;<br>• give an example from everyday life of a correlation between a factor and an outcome;<br>• evaluate the design for a study to test whether or not a factor increases the chance of an outcome, by commenting on sample size and how well the samples are matched. | **Radio Waves and Microwaves**<br><br>**Ionizing Radiation** | | |

# Physics Module P2

| | | Syllabus point (text abridged) | Boardworks presentations | | |
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| | | | GCSE Science | Additional Science | Separate Sciences |
| Radiation and Life | P2.4 What is the evidence for global warming, why might it be occurring, and how serious a threat is it? | Some elements emit ionising radiation all the time and are called radioactive. | Radioactivity | Radioactive Decay | |
| | | Radioactive elements are naturally found in the environment, emitting background radiation. | Radioactivity | | |
| | | Recognise, in given text, the terms electron, proton, neutron and nucleus. | Radioactivity | | |
| | | **An atom has a nucleus, made of protons and neutrons.** | Radioactivity | | |
| | | **Every atom of any element has the same number of protons but the number of neutrons may differ.** | | Radioactive Decay | |
| | | The behaviour of radioactive materials cannot be changed by chemical or physical processes. | Radioactivity | | |
| | | Recall three types of ionising radiation (alpha, beta and gamma) emitted by radioactive materials. | Radioactivity | | |
| | | Recall the penetration properties of each type of radiation. | Radioactivity | | |
| | | **Describe radioactive materials in terms of the instability of the nucleus, radiation emitted and the element left behind.** | Radioactivity | Radioactive Decay | |
| | | Over time, the activity of radioactive sources decreases. | | Radioactive Decay | |
| | | Understand the meaning of the term half-life. | | Radioactive Decay | |
| | | Radioactive elements have a wide range of half-life values. | | Radioactive Decay | |
| | | **Carry out simple calculations involving half-life.** | | Radioactive Decay | |

| Physics Module P3 | | | | | |
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| | | **Syllabus point (text abridged)** | **Boardworks presentations** | | |
| | | | **GCSE Science** | **Additional Science** | **Separate Sciences** |
| **Radioactive materials** | **P3.2 How can radioactive materials be used and handled safely, including wastes?** | Ionising radiation can damage living cells. | **Ionizing Radiation** | | |
| | | Ionising radiation is able to break molecules into bits (called ions), **which can then take part in other chemical reactions;** | **Ionizing Radiation** | | |
| | | When ionising radiation strikes living cells these may be killed or may become cancerous; | **Ionizing Radiation** | | |
| | | Ionising radiation can be used to:<br>• treat cancer<br>• sterilise surgical instruments<br>• sterilise food. | **Ionizing Radiation** | | |
| | | Radiation dose (in sievert) (based on both amount and type of radiation) is a measure of the possible harm done to your body. | | | |
| | | Interpret given data on risk related to radiation dose. | | | |
| | | Radioactive materials expose people to risk by irradiation and contamination. | **Radioactivity** | | |
| | | We are irradiated and contaminated all the time and name some sources of this background radiation. | **Radioactivity** | | |
| | | Relate ideas about half life and background radiation to the time taken for a radioactive source to become safe. | | | |
| | | Categories of people who are regularly exposed to risk of radiation and that their exposure is carefully monitored. | **Radioactivity** | | |

| | | Physics Module P3 | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| Radioactive materials | P3.3 How can electricity be generated? What can be done with nuclear wastes? | Why electricity is called a secondary energy source. | | | |
| | | Electricity is convenient because it is easily transmitted over distances and can be used in many ways. | | | |
| | | Label a block diagram showing the basic steps by which electricity is generated. | **Non-renewable Energy Resources** | | |
| | | Interpret a Sankey diagram of electricity generation and distribution to include the efficiency of energy transfers; | | | |
| | | Two examples to show that we can use renewable energy sources instead of fuels to generate electricity; | **Renewable Energy: Solar and Thermal, Renewable Energy: Wind and Water** | | |
| | | Power stations which burn carbon fuels will produce carbon dioxide. | **Non-renewable Energy Resources** | | |
| | | A nuclear fuel is one where energy is released from changes in the nucleus. | **Non-renewable Energy Resources** | **Nuclear Energy** | |
| | | **In nuclear fission a neutron splits a large and unstable nucleus (limited to uranium) into two smaller parts, roughly equal in size, releasing more neutrons.** | | **Nuclear Energy** | |
| | | **Compare the amount of energy released during nuclear fission with that released in a chemical reaction.** | | **Nuclear Energy** | |
| | | **How the nuclear fission process in nuclear power stations is controlled, and use the terms chain reaction, fuel rod, control rod and coolant;** | | **Nuclear Energy** | |
| | | Nuclear power stations produce radioactive waste; | **Non-renewable Energy Resources** | **Nuclear Energy** | |
| | | Nuclear wastes are categorised as high level, intermediate level and low level, and relate this to disposal methods. | | | |

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| | | Interpret and evaluate information about different energy sources for generating electricity, considering efficiency, economic and environmental costs, **power output and lifetime.** | **Non-renewable Energy Resources** | | |

| Physics Module P3 | | | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| Radioactive materials | P3.4 What are the health risks from radioactive materials? | When provided with additional information on the health risks associated with radioactive materials, and the steps taken to limit these:<br>• can explain why it is impossible for anything to be completely safe;<br>• can identify examples of risks which arise from new scientific or technological advances;<br>• can suggest ways of reducing specific risks;<br>• can interpret and discuss information on the size of risks, presented in different ways;<br>• **can discuss a given risk, taking account of both the chance of it occurring and the consequences if it did;**<br>• can suggest benefits of activities with known risk;<br>• can offer reasons for people's willingness (or reluctance) to accept the risk of a given activity;<br>• can discuss personal and social choices in terms of a balance of risk and benefit;<br>• **can identify, or propose, an argument based on the 'precautionary principle';**<br>• **can distinguish between actual risk and perceived risk, when discussing personal and social choices;**<br>• **can suggest reasons for given examples of differences between actual and perceived risk;**<br>• **can explain what the ALARA (as low as reasonably achievable) principle means and how it applies to the issue in question;** | | | |
| | | In the context of health risks associated with radioactive materials:<br>• can identify the groups affected and the main benefits and costs of a course of action for each group;<br>• can explain the idea of sustainable development, and apply it to specific situations;<br>• shows awareness that scientific research and applications are subject to official regulations and laws;<br>• **can distinguish what can be done (technical feasibility), from what should be done (values);**<br>• **can explain why different courses of action may be taken in different social and economic contexts.** | | | |

| Physics Module P4 | | | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| Explaining Motion | P4.1 How can we describe motion? | Apply the following equation to situations where an average speed is involved: speed (m/s) = distance travelled (m) / time taken (s). | | Speed and Acceleration | |
| | | Distinguish between average speed and instantaneous speed (in effect, an average over a short time interval) for examples of motion where speed is changing. | | Speed and Acceleration | |
| | | Draw and interpret the shape of a distance-time graph for an object that is:<br>• stationary<br>• moving at constant speed<br>**• moving with increasing or decreasing speed.** | | Speed and Acceleration | |
| | | Interpret a steeper gradient of a distance-time graph as a higher speed. | | Speed and Acceleration | |
| | | **Calculate a speed from the gradient of a straight section of a distance-time graph.** | | Speed and Acceleration | |
| | | The velocity of an object at any instant is its speed plus an indication of the direction. | | Speed and Acceleration | Forces and Motion |
| | | The velocity of an object moving in a straight line is positive if it is moving in one direction and negative if it is moving in the opposite direction. | | | Forces and Motion |
| | | Draw and interpret the shape of a velocity-time graph for an object that is:<br>• stationary;<br>• moving in a straight line with constant speed;<br>• moving in a straight line with steadily increasing or decreasing speed | | Speed and Acceleration | |
| | | Relate these ideas about recording motion to applications such as lorry tachographs. | | | |

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<tr><th></th><th></th><th>GCSE Science</th><th>Additional Science</th><th>Separate Sciences</th></tr>
<tr><td rowspan="7">Explaining Motion</td><td rowspan="7">P4.2 What are forces?</td><td>Recall that a force arises from an interaction between two objects.</td><td></td><td>Laws of Motion</td><td></td></tr>
<tr><td>When one object exerts a force on another, it always experiences a force in return.</td><td></td><td>Laws of Motion</td><td></td></tr>
<tr><td>In simple everyday situations:<br>• identify forces arising from an interaction between two objects<br>• identify the ‘partner’ of a given force (i.e. the other force of the interaction pair)<br>• specify, for each force, the object which exerts it, and the object on which it acts<br>• use arrows to show the sizes and directions of forces acting.</td><td></td><td>Laws of Motion</td><td></td></tr>
<tr><td>The two forces in an interaction pair are equal in size and opposite in direction; and that they act on different objects.</td><td></td><td>Laws of Motion</td><td></td></tr>
<tr><td>Some forces (such as friction, reaction of a surface) arise in response to the action of an applied force.</td><td></td><td>Laws of Motion</td><td></td></tr>
<tr><td>The interaction between an object and a surface it is resting on: the object pushes down on the surface; the surface pushes up on the object with an equal force. This is called the reaction of the surface.</td><td></td><td>Laws of Motion</td><td></td></tr>
<tr><td>Use the idea of a pair of equal and opposite forces to explain in outline how rockets and jet engines work.</td><td></td><td></td><td></td></tr>
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| Explaining Motion | P4.3 What is the connection between forces and motion? | Interpret situations in which several forces act on an object. | | Laws of Motion | |
| | | The resultant force on an object is the sum of all the individual forces acting on it, taking their directions into account. | | Laws of Motion | |
| | | If a resultant force acts on an object, it causes a change of momentum in the direction of the force. | | Momentum | |
| | | use the definition:<br>• momentum (kg m/s) = mass(kg) × velocity(m/s) | | Momentum | |
| | | The size of the change of momentum is related to the size of the resultant force, and the time for which it acts in the following way:<br>change of momentum (kg m/s) = resultant force (N) x time for which it acts (s) | | Momentum | |
| | | How the horizontal motion of objects (like cars and bicycles) can be analysed in terms of a driving force (produced by the engine or the cyclist), and a counter force (due to friction and air resistance). | | Laws of Motion | |
| | | For a moving object, if the driving force is:<br>• greater than the counter force, the vehicle will speed up<br>• equal to the counter force, the vehicle will move at constant speed in a straight line<br>• smaller than the counter force, the vehicle will slow down. | | Laws of Motion | |
| | | In situations involving a change in momentum (such as a collision), the longer the duration of the impact, the smaller the average force for a given change in momentum. | | Momentum | |
| | | Use this idea to discuss and explain the action of road safety measures, such as car seat-belts, crumple zones, air bags, cycle and motorcycle helmets. | | Momentum | |
| | | If the resultant force on an object is zero, its momentum does not change. | | Laws of Motion | |

| Physics Module P4 | | | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| Explaining Motion | P4.4 How can we describe motion in terms of energy changes? | The energy of a moving object is called kinetic energy. | | Energy and Movement | |
| | | As an object falls, its gravitational potential energy decreases. | | Energy and Movement | |
| | | When a force causes movement of an object work is done. | | Work and Power | |
| | | Use the equation:<br>• work done by a force (joule, J) = force (newton, N) × distance moved by the force (metre, m) | | Work and Power | |
| | | When work is done on an object, the energy of the object increases and when work is done by an object, the energy of the object decreases according to the relationship: change in energy (joule, J) = work done (joule, J) | | | |
| | | When an object is lifted to a higher position above the ground, work is done by the lifting force against the gravitational force acting on the object (its weight); this increases the object's gravitational potential energy (GPE). | | Energy and Movement | |
| | | use the equation:<br>• change in GPE (joule, J) = weight (newton, N) × vertical height difference (metre, m) | | Energy and Movement | |
| | | When a force acting on an object makes its velocity increase, the force does work on the object and this results in an increase in its kinetic energy. | | | |
| | | The greater the mass of an object and the faster it is moving, the more kinetic energy it has. | | Energy and Movement | |
| | | use the equation:<br>• kinetic energy (joule, J) = ½ × mass (kilogram, kg) × [velocity]2 (metre per second, m/s)2 | | Energy and Movement | |
| | | If friction and air resistance can be ignored, an object's kinetic energy increases by an amount equal to the work done on it by an applied force. | | | |
| | | Air resistance or friction will cause the gain in an object's kinetic energy to be less than the work done on it by an applied force, because some energy is dissipated through heating. | | | |
| | | Energy is always conserved. | | Energy and Movement | |
| | | Calculate the gain in kinetic energy, **and the speed**, of an object that has fallen through a given height. | | Energy and Movement | |

| | | Physics Module P5 | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| Electric Circuits | P5.1 Electric current – a flow of what? | Explain that when two objects are rubbed together and become charged, electrons are transferred from one object to the other. | | Static Electricity | |
| | | There are repulsive forces between objects with similar charges, and attractive forces between objects with opposite charges. | | Static Electricity | |
| | | Simple electrostatic effects in terms of attraction and repulsion between charges. | | Static Electricity | |
| | | Electrons are negatively charged. | | Static Electricity | |
| | | Electric current is a flow of charge. | | Electric Circuits | |
| | | Electric current is measured in amperes. | | Electric Circuits | |
| | | In an electric circuit the components and wires are full of charges that are free to move. | | Electric Circuits | |
| | | When a circuit is made the battery causes these free charges to move, and that they are not used up but flow in a continuous loop. | | Electric Circuits | |
| | | In metallic conductors an electric current is a movement of free electrons. | | Electric Circuits | |
| | | In metal conductors there are lots of charges free to move but in an insulator there are few charges free to move. | | Electric Circuits | |

# Physics Module P5

| | | Syllabus point (text abridged) | Boardworks presentations | | |
|---|---|---|---|---|---|
| | | | GCSE Science | Additional Science | Separate Sciences |
| Electric Circuits | P5.2 What determines the size of the current in an electric circuit? | The larger the voltage of the battery in a given circuit, the bigger the current. | | | |
| | | Components (for example resistors, lamps, motors) resist the flow of charge through them. | | Resistance and Resistors | |
| | | The larger the resistance in a given circuit, the smaller the current will be. | | Resistance and Resistors | |
| | | The resistance of connecting wires is so small that it can usually be ignored. | | | |
| | | Resistors get hotter when electric current passes through them, **and that this heating effect is caused by collisions between the moving charges and stationary atoms in the wire.** | | Resistance and Resistors | |
| | | This heating effect makes a lamp filament hot enough to glow. | | Resistance and Resistors | Controlling Current and Voltage |
| | | How the resistance of an LDR varies with light intensity. | | Resistance and Resistors | Controlling Current and Voltage |
| | | Describe how the resistance of a thermistor (ntc only) varies with temperature; | | Resistance and Resistors | Controlling Current and Voltage |
| | | Recognise and use the electrical symbols for a cell, power supply, filament lamp, switch, LDR, fixed and variable resistor, thermistor, ammeter and voltmeter; | | Electric Circuits, Resistance and Resistors | Controlling Current and Voltage |
| | | Two (or more) resistors in series have more resistance than one on its own, because the battery has to push charges through both of them. | | Resistance and Resistors | |
| | | Two (or more) resistors in parallel provide more paths for charges to flow along than one resistor on its own, so the total resistance is less and the current is bigger. | | Resistance and Resistors | |
| | | Use the equation:<br>resistance (ohm, Ω) = voltage (volt, V)/current (ampere, A) | | Resistance and Resistors | Controlling Current and Voltage |
| | | Describe in words, or using a sketch graph, how the current varies with voltage in components whose resistance stays constant. | | Resistance and Resistors | Controlling Current and Voltage |

# Physics Module P5

| | | Syllabus point (text abridged) | Boardworks presentations | | |
|---|---|---|---|---|---|
| | | | GCSE Science | Additional Science | Separate Sciences |
| Electric Circuits | P5.3 How do parallel and series circuits work? | How a voltmeter should be connected to measure the potential difference between any two chosen points. | | Electric Circuits | |
| | | The voltage of a battery (measured in V) provides a measure of the 'push' of the battery on the charges in the circuit. | | Electric Circuits | |
| | | Potential difference is another term for voltage. | | Electric Circuits | |
| | | Relate the potential difference between two points in the circuit to the energy transferred to, or from, a given amount of charge as it moves between these points. | | Electric Circuits | |
| | | Describe the effect on voltage and current of adding further batteries in series **and in parallel** with original one. | | Electric Circuits | |
| | | When several components are connected in series to a battery:<br>• the current through each component is the same<br>• the potential differences across the components add up to the potential difference across the battery **(because the total energy transferred to each unit of charge by the battery must equal the amount transferred from it to other components)**<br>• the potential difference is largest across the component with the greatest resistance, **because more energy is transferred by the charge passing through a large resistance than through a small one.** | | Electric Circuits<br><br>Resistance and Resistors | Controlling Current and Voltage |
| | | When several components are connected in parallel directly to a battery:<br>**• the potential difference (voltage) across each component is equal to the potential difference of the battery;**<br>**• the current through each component is the same as if it were the only component present;**<br>• the total current from (and back to) the battery is the sum of the currents through each of the parallel components;<br>• the current is largest through the component with the smallest resistance, **because the same battery voltage causes more current to flow through a smaller resistance than a bigger one.** | | Electric Circuits<br><br>Resistance and Resistors | |

# Physics Module P5

| | | Syllabus point (text abridged) | Boardworks presentations | | |
|---|---|---|---|---|---|
| | | | GCSE Science | Additional Science | Separate Sciences |
| Electric Circuits | P5.4 How is mains electricity produced? How are voltages and currents induced? | Mains electricity is produced by generators. | Mains Electricity | Motors and Generators | |
| | | Generators produce a voltage by a process called electromagnetic induction. | Electricity to the Home | Motors and Generators | Transformers |
| | | When a magnet is moving into a coil of wire a voltage is induced across the ends of the coil. | Electricity to the Home | Motors and Generators | Transformers |
| | | If the ends of the coil are connected to make a closed circuit, a current will flow round the circuit. | | Motors and Generators | |
| | | If the magnet is moving out of the coil, or the other pole of the magnet is moving into it, there is a voltage induced in the opposite direction. | Electricity to the Home | Motors and Generators | Transformers |
| | | A changing magnetic field caused by changes in the current in one coil of wire can induce a voltage in a neighbouring coil. | | | Transformers |
| | | Describe the construction of a transformer as two coils of wire wound on an iron core. | Mains Electricity | | Transformers |
| | | A transformer can change the size of an alternating voltage. | | | Transformers |
| | | **Use the equation**: $\frac{V_P}{V_s} = \frac{N_P}{N_s}$ | | | Transformers |
| | | In a generator, a magnet or electromagnet is rotated within a coil of wire to induce a voltage across the ends of coil. | | Motors and Generators | |
| | | The size of this induced voltage can be increased by:<br>• increasing the speed of rotation of the magnet or electromagnet;<br>• increasing the strength of its magnetic field;<br>• increasing the number of turns on the coil;<br>• placing an iron core inside the coil. | | Motors and Generators | |
| | | **The induced voltage across the coil of a generator changes during each revolution of the magnet or electromagnet. The current produced in an external circuit is an alternating current (a.c.).** | | Motors and Generators | |
| | | Understand that the current from a battery is always in the same direction: it is a direct current (d.c.). | Mains Electricity | | |
| | | Mains electricity is an a.c. supply. | Mains Electricity | | |

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| | | **Explain that a.c. is used because it is easier to generate than d.c., and can be distributed more efficiently.** | **Mains Electricity** | | |
| | | The mains supply voltage to our homes is 230 volts. | **Mains Electricity** | | |

| | | Physics Module P5 | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| Electric Circuits | P5.5 How much electrical energy do we use at home? | When electric charge flows through a component (or device), energy is transferred to the component. | Energy Efficiency | | |
| | | The power (in watts, W) is a measure of the rate at which an appliance or device transfers energy. | Electricity to the Home | | |
| | | Use the following equation to calculate energy transfer in joules and kilowatt-hours:<br>• energy transferred (joule, J or kilowatt hour, kWh) = power(watt, W or kilowatt, kW) × time(second, s or hour, h) | Electricity to the Home | | |
| | | Use the equation:<br>• power (watt, W) = potential difference (voltage (volt, V)) × current (ampere, A)<br>**Transformation of these equations is only required on the higher tier.** | Electricity to the Home | | |
| | | A joule is a very small amount of energy, so a domestic electricity meter measures the energy transfer in kilowatt hours. | Electricity to the Home | | |
| | | Calculate the cost of electrical energy given the power, the time and the cost per kilowatt hour. | Electricity to the Home | | |
| | | Use the following equation in the context of different electrical appliances:<br>efficiency = $\frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100$ | Energy Efficiency | | |

| Physics Module P6 | | | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| The Wave Model of Radiation | P6.1 The wave model of radiation. | A wave consists of disturbances that transfer energy in the direction that the wave travels, without transferring matter. | | | Waves |
| | | Describe the differences between a transverse and a longitudinal wave. | Wave Properties | | |
| | | The frequency of the waves, in hertz (Hz), is the number of waves each second that are made by the source, or that pass through any particular point in the medium. | Wave Properties | | |
| | | The wavelength of waves is the distance between the same point on two adjacent disturbances. | Wave Properties | | |
| | | The amplitude of waves is the distance from the top of the crest or bottom of the trough to the undisturbed position. | Wave Properties | | |
| | | Interpret diagrams showing the amplitude and the wavelength of waves. | Wave Properties | | |
| | | Use the equation:<br>• wave speed (metre per second m/s) = frequency (hertz, Hz) x wavelength (metre, m)<br>**Rearrangement of the equation is only expected on higher tier.** | Wave Properties | | |
| | | The speed of a wave is usually independent of its frequency or amplitude. | Wave Properties | | |

| The Wave Model of Radiation | Physics Module P6 | | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| The Wave Model of Radiation | P6.2 Why do scientists think that light and sound are waves? | Interpret diagrams showing the reflection of plane water waves and narrow beams of sound or light from a plane reflector. | | | Reflections and Refractions |
| | | Wave speed is affected by what waves are travelling along or through (the medium) and the speed will change if a wave moves from one medium into another. | | | Reflections and Refractions |
| | | Explain how a change in the speed of a wave causes a change in wavelength since the frequency of the waves cannot change, and that this may cause a change in direction. | | | Reflections and Refractions |
| | | Interpret diagrams showing the refraction of plane water waves, or beams of light or sound, when they cross a boundary between different media, relating the change of direction to the change in wave speed. | | | Reflections and Refractions |
| | | The refraction of light waves and sound waves can be explained by a change in their speed when they pass into a different medium. | | | Reflections and Refractions |
| | | Light rays for which the angle of refraction would be greater than 90 degrees cannot leave the medium they are in, and are reflected and that this is known as total internal reflection. | Infrared and Visible Waves | | Reflections and Refractions |
| | | Waves can spread out at a narrow gap and that this is called diffraction. | Radio Waves and Microwaves | | Waves |
| | | Interpret diagrams showing wave diffraction through gaps. | Radio Waves and Microwaves | | Waves |
| | | Light can be diffracted but needs a very small gap, comparable to the wavelength of the wave. | | | |
| | | Where two waves meet, their effects add and this is called interference. | Radio Waves and Microwaves | | Waves |
| | | Where two waves arrive in step they reinforce and where they arrive out of step they cancel out. | | | Waves |
| | | Two light beams can be shown to produce an interference pattern. | | | Waves |
| | | Explain interference patterns in terms of constructive and destructive interference. | | | Waves |
| | | Explain how the diffraction and interference of light and sound are evidence of their waves natures. | | | Waves |

| Physics Module P6 | | | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| The Wave Model of Radiation | P6.3 Do all types of electromagnetic radiation behave in the same way? | The different colours of light in the spectrum have different frequencies (and therefore wavelengths). | Electromagnetic Waves | | |
| | | List the parts of the whole electromagnetic spectrum in order of frequency or wavelength (radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, gamma radiation). | Electromagnetic Waves | | |
| | | The energy delivered by each photon in a beam of electromagnetic radiation increases with the frequency of the electromagnetic waves. | Electromagnetic Waves | | |
| | | The intensity of a beam of electromagnetic radiation (the energy it delivers per second) depends on the number of photons arriving every second and the amount of energy carried by each photon. | | | |
| | | All types of electromagnetic radiation travel at exactly the same, very high, speed through space (a vacuum). | Electromagnetic Waves | | |
| | | An important difference between electromagnetic waves and sound waves is that electromagnetic waves can travel through empty space, but sound waves can only travel through a substance (solid, liquid or gas). | | | |
| | | Different frequencies of electromagnetic radiation are used for different purposes due to the difference in reflection, absorption, or transmission by different materials to include:<br>• radio waves are not strongly absorbed by the atmosphere so can be used to carry information for radio and TV programmes;<br>• some microwaves are strongly absorbed by water molecules and so can be used to heat objects containing water;<br>• satellite dishes are made of metal because metals reflect microwaves well;<br>• X-rays are absorbed by dense materials so can be used to produce shadow pictures of bones in our bodies or of objects in aircraft passengers' luggage;<br>• light and infrared radiation can be used to carry information along optical fibres because they travel through without becoming significantly weaker. | Electromagnetic Waves<br><br>Radio Waves and Microwaves<br><br>Infrared and Visible Waves | | |

| | | Physics Module P6 | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| The Wave Model of Radiation | P6.4 How is information added to a wave? | Signals can be carried not only by radio waves and microwaves through the Earth's atmosphere and through space but also by light waves and infrared waves through optical fibres. | Infrared and Visible Waves, Digital Communications | | |
| | | If a wave is to carry information, the waves must be made to vary in amplitude or frequency. The information is carried by the pattern of the variation. This process is called modulation. | | | Waves |
| | | Interpret diagrams showing how a sound wave can be used to vary the amplitude or frequency of a radio wave, with a pattern that matches its own frequency. | | | |
| | | A signal which varies continuously is called an analogue signal. | Digital Communications | | |
| | | The job of the receiver is to reproduce the original sound from the pattern of the variation. Details of any transmission or receiver systems are not required. | | | |
| | | Sound (or other information) can be transmitted digitally (digital signal). | Digital Communications | | |
| | | In digital transmission, the sound is often converted into a digital code made up from just two symbols (0 and 1). | Digital Communications | | |
| | | This coded information can be used to control the short bursts of waves (pulses) produced by a source (0 = no pulse, 1 = pulse). | Digital Communications | | |
| | | When the waves are received, the pulses are decoded to produce a copy of the original sound wave. | | | |
| | | An advantage of digital signals over analogue signals is that they transmit information with higher quality. | Digital Communications | | |
| | | All signals, as they travel, decrease in intensity, so they may have to be amplified. | | | |
| | | Random additions to the original signal (noise) may be picked up as a signal travels, reducing its quality; | | | |
| | | When a signal is amplified, any noise it has picked up is also amplified. | Digital Communications | | |
| | | With digital signals, 'on' and 'off' states can usually still be recognised despite any noise that is picked up. The signal can therefore be 'cleaned up' to remove the noise and restore the original pattern of 'on's and 'off's. | Digital Communications | | |

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| | | Use these ideas to interpret information about analogue and digital transmission **and to explain why information can be transmitted digitally with higher quality.** | Digital Communications | | |

| | Physics Module P7 | | | | |
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| | | **Syllabus point (text abridged)** | **Boardworks presentations** | | |
| | | | **GCSE Science** | **Additional Science** | **Separate Sciences** |
| Further Physics Observing the Universe | P7.1 Observing the sky with the naked eye. | The Sun appears to travel east-west across the sky once every 24 hours; the stars appear to travel east-west across the sky once in a very slightly shorter time period **(23 h 56 min);** the Moon appears to travel east-west across the sky once in a slightly longer time period **(about 25 hours)**, and the naked-eye planets (Mercury, Venus, Mars, Jupiter and Saturn) appear to move with the stars but change their positions in complicated patterns. | | | |
| | | Explain the apparent motions of Sun, stars, Moon **and planets** in terms of rotation of the Earth and the orbits of the Earth, Moon **and planets.** | | | |
| | | Explain the phases of the Moon in terms of the relative positions of the Sun, Moon and Earth. | | | |
| | | Explain eclipses in terms of the positions of the Sun and Moon **and explain the low frequency of eclipses in terms of the relative tilt of the orbits of the Moon about the Earth and the Earth about the Sun.** | | | |
| | | Explain that the positions of astronomical objects are measured in terms of angles as seen from Earth. | | | |
| | | Explain why a sidereal day, a rotation of 360° of the Earth, is different from a solar day due to the orbital movement of the Earth **and that a sidereal day is 4 minutes less than a solar day.** | | | |
| | | Explain why different stars are seen in the night sky at different times of the year, in terms of the movement of the Earth and the sun. | | | |
| | | Planets move in complicated patterns relative to the 'fixed' stars. | | | Orbits |

# Physics Module P7

| | | Syllabus point (text abridged) | Boardworks presentations | | |
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| | | | GCSE Science | Additional Science | Separate Sciences |
| Further Physics Observing the Universe | P7.2 How does a telescope work? | Convex/converging lenses bring parallel light to a focus. | | | Lenses |
| | | More powerful lenses of the same material have more curved surfaces. | | | Lenses |
| | | Calculate the power of a lens from: Power (dioptre) = $\frac{1}{\text{focal length (metre)}}$ | | | |
| | | Interpret diagrams showing the formation of a real image of a distant point source (off the principal axis of a lens) and of a distant extended source. | | | |
| | | Astronomical objects are so distant that light from them is effectively parallel. | | | Lenses |
| | | A simple telescope has two converging lenses of different powers, with the more powerful lens as the eyepiece. | | | Lenses |
| | | **Calculate the angular magnification of a telescope from the powers of the two lenses using: magnification =** $\frac{\text{focal length of objective lens}}{\text{focal length of eyepiece lens}}$ | | | Lenses |
| | | Most astronomical telescopes have concave mirrors, not convex lenses, as their objectives. | | | Lenses |
| | | Understand how concave mirrors bring parallel light to a focus. | | | Lenses |

| | | | Boardworks presentations | | |
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| | | Syllabus point (text abridged) | GCSE Science | Additional Science | Separate Sciences |
| **Physics Module P7** | | | | | |
| Further Physics Observing the Universe | P7.3 What are the objects we see in the night sky and how far away are they? | Explain how parallax makes some stars seem to move relative to others over the course of a year. | | | |
| | | Define the parallax angle of a star as half the angle moved against a background of distant stars in 6 months. | | | |
| | | A smaller parallax angle means that a star is further away. | | | |
| | | Define a parsec (pc) as the distance to a star with a parallax angle of one second of arc. | | | |
| | | Calculate distances in parsecs for simple parallax angles expressed as fractions of a second of arc. | | | |
| | | A parsec is similar in magnitude to a light-year. | | | |
| | | Typical interstellar distances are a few parsecs. | | | |
| | | The intrinsic brightness of a star depends on its temperature and its size. | | | |
| | | Explain qualitatively why the observed brightness of a star (as seen on Earth) depends on its intrinsic brightness and its distance from Earth. | | | |
| | | Cepheid variable stars pulse in brightness, with a period related to their brightness. | | | |
| | | Explain qualitatively how this relationship enables us to estimate the distance to Cepheid variable stars. | | | |
| | | Understand the role of observations of Cepheid variable stars in establishing the scale of the Universe and the nature of most nebulas as distant galaxies. | | | |
| | | Telescopes revealed that the Milky Way consists of very many stars and led to the realisation that the Sun was a star in the Milky Way galaxy. | | | |
| | | Telescopes revealed the existence of many fuzzy objects in the night sky, and these were originally called nebulae. | | | |
| | | Recall the main issue in the Curtis-Shapley debate: whether nebulae were objects within the Milky Way or separate galaxies outside it. | | | |
| | | Hubble's observations of Cepheid variables in one nebula indicated that it was further away than any star in the Milky Way, and hence that this nebula was a separate galaxy. | | | |
| | | Intergalactic distances are typically measured in Mpc | | | |

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| | | Cepheid variable data in distant galaxies has given accurate values of the Hubble constant. | | | |
| | | Use the following equation to calculate, given appropriate data, the speed of recession, **the Hubble constant and the distance to distant galaxies:**<br>speed of recession (km/s) = Hubble constant × distance | | | |

| | | | Boardworks presentations | | |
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| **Physics Module P7** | | **Syllabus point (text abridged)** | **GCSE Science** | **Additional Science** | **Separate Sciences** |
| Further Physics Observing the Universe | P7.4 What are stars? | All hot objects (including stars) emit a continuous range of electromagnetic radiation, whose total intensity and peak frequency increases with temperature; | | | |
| | | The removal of electrons from atoms is called ionisation and that electron movement within atoms produces line spectra. | | | |
| | | The spectrum of a star also contains some specific spectral lines, and that these provide evidence of the chemical elements present in it. | | | |
| | | Use data on the spectrum of a star, together with data on the line spectra of elements, to identify elements present in it. | | | |
| | | When the volume of a gas is reduced its pressure increases and be able to explain this using a molecular model. | | | **Stars** |
| | | Explain why the pressure or volume of a gas varies with temperature and interpret absolute zero using a molecular model. | | | |
| | | The absolute zero of temperature is -273°C, be able to convert temperatures in K to temperatures in °C. | | | |
| | | Explain the formation of a protostar in terms of the effects of gravity compressing a cloud of gas. | | | **Stars** |
| | | Nuclear processes discovered in the early 20th Century provided a possible answer to the mystery of the Sun's energy source. | | | **Stars** |
| | | Explain that compressing the gas, e.g. in a protostar, will raise its temperature. | | | **Stars** |
| | | Describe the results of the Rutherford-Geiger-Marsden alpha particle scattering experiment as indicating that a gold atom contains a small, massive, positive region (the nucleus). | | | |
| | | The nucleus contains positive protons and neutral neutrons. | | **Radioactive Decay** | |
| | | Protons are held together in the nucleus by a strong force much greater than the repulsive electrical force between them. | | **Atomic Structure** *(GCSE Additional Chemistry)* | |
| | | Hydrogen nuclei can fuse into helium nuclei, releasing energy, if brought close together. | **The Universe** | **Nuclear Energy** | **Stars** |

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| | | A star contains: a hotter core, where fusion takes place; a convective zone, where energy is transported to the surface by convection; the photosphere, where energy is radiated into space. | | | **Stars** |
| | | All stars change when there is insufficient hydrogen in the core for fusion to continue. | | | **Stars** |
| | | Small stars like our Sun become red giants when the core hydrogen is depleted, while larger stars become red supergiants. | | | **Stars** |
| | | Red giants and red supergiants liberate energy by fusing helium into larger nuclei such as carbon, nitrogen and oxygen. | | | **Stars** |
| | | Red giants lack the mass to compress the core further at the end of the helium fusion, and they then shrink into hot white dwarfs, which gradually cool. | | | **Stars** |
| | | Fusion in red supergiants continues to larger nuclei due to the higher pressures in the core. | | | **Stars** |
| | | Fusion in large stars ceases when the core has been largely converted into iron, and the star then explodes in a supernova, leaving a dense neutron star or black hole. | | | **Stars** |

| Further Physics Observing the Universe | Physics Module P7 | | | | |
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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | P7.5 How do astronomers work together? | Recall two examples of the location of major astronomical observatories. | | | |
| | | Large telescopes are needed to collect the weak radiation from faint or very distant sources. | | | Lenses |
| | | **Radiation is diffracted by the aperture of a telescope, so the aperture must be very much larger than the wavelength of the radiation detected by the telescope to produce sharp images.** | | | |
| | | Describe two ways in which astronomers work with local or remote telescopes. | | | |
| | | Explain the advantages of computer control in remote telescopes. | | | |
| | | Explain the main advantages and disadvantages of using telescopes outside the Earth's atmosphere<br>• avoids absorption and refraction effects of atmosphere;<br>• can use parts of electromagnetic spectrum that the atmosphere absorbs;<br>• cost of setting up, maintaining and repairing;<br>• uncertainties of space programme. | | | |
| | | Understand the need for international collaboration in terms of economy and pooling of expertise; | | | |
| | | Describe one example showing how international cooperation is essential for progress in expensive 'big science' projects such as astronomy. | | | |
| | | Describe two astronomical factors that influence the choice of site for major astronomical observatories. | | | |
| | | Understand that non-astronomical factors:<br>• cost;<br>• environmental and social impact near the observatory;<br>• working conditions for employees;<br>are important considerations in planning, building, operating, and closing down an observatory. | | | |