

CCEA : GCSE Science (Single Award) specification

Science : Modules 5 & 6 (Physics)

First certification Summer 2008

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Name : _____

GCSE in Science (Single Award)	Page numbers in New Physics for You
Module 5 : Electricity, Waves and Communication	
<p>ICT In this module ICT is addressed in the following ways. Candidates should:</p> <ul style="list-style-type: none"> • interrogate a wide variety of CD Roms on constructing circuits, energy transfer and alternative energy sources in sections 5.1 and 5.4; • use data loggers in measuring voltage and current changes in circuits 5.1 and in determining the speed of sound in 5.10 • use databases and spreadsheets when comparing energy usage of household gadgets in section 5.3; • use data from internet to investigate effect of using alternative energy sources in section 5.7 • use modelling software in section 5.9 when looking at wave structure and vibrations and when looking at vision defects; • interrogate web sites when studying waves 5.9; communication using electromagnetic radiation 5.14 <p>Electrical Circuits <i>In this section candidates will investigate electrical circuits. They will examine series and parallel circuits and them, using the correct symbols. The rule for currents and voltages in each type of circuit will be investigated. Candidates will investigate resistance and how the heating effect of an electrical current depends on its resistance.</i></p> <p>Candidates should use their skills, knowledge and understanding of science works to:</p> <p>5.1 (i) plan and carry out investigations how current and voltages vary in simple series and parallel circuit; record above circuits diagrammatically using the appropriate circuit symbols.</p> <p>(ii) appreciate the convention that current flows from positive to negative potential while electrons flow in the opposite direction and the latter notion developed later as knowledge and understanding of the structure of the atom increased.</p>	<p style="text-align: center;">see the New Physics for You CD-ROM</p> <p>p. 248-251, worksheets</p> <p>p. 249, 375</p>

<p>5.2 (i) show that when electricity flows there is a heating effect, this heating effect is due to resistance: calculate resistance from measurements of current and voltage using the formula $V = IR$;</p> <p>(ii) show that this heating effect is used in kettles, fires and other household items.</p> <p>(iii) investigate how some materials eg nichrome and constantan, resist electricity limited to length and thickness of wires and examine how variable resistors can control current in a circuit.</p>	<p>p.264, 254-5</p> <p>264</p> <p>254-5</p>
<p>Household electricity</p>	
<p><i>In this section candidates are introduced to the concept of electrical power. The relationship between electrical power and the correct fuse rating is investigated. The kilowatt hour as the unit of electrical energy used to calculate bills is studied. Safety features when dealing with mains electricity will be examined. The location and nature of the various electrical generating plants in Northern Ireland is investigated as well as the principles involved in the generation of electricity. Renewable sources of energy and environmental implications are discussed and the concerns over nuclear electrical power generation are investigated.</i></p>	
<p>5.3 (i) apply knowledge of the formula Power = Voltage \times Current to choose the correct size of fuse;</p> <p>(ii) collect data on the power ratings of various domestic appliances and analyse data by drawing and interpreting energy consumption v time graphs;</p> <p>(iii) recognise the consequences of incorrect fuses in various electrical appliances;</p> <p>(iv) recall that the units of an electric meter are kWh ;</p> <p>(v) use meter readings to calculate the cost of using various appliances for varying amounts of time using the formula energy (kWh) = power (kw) \times time (hr);</p> <p>(vi) investigate factors which increase household electricity bills and how these bills can be reduced.</p>	<p>266, 270</p> <p>267</p> <p>269-270</p> <p>267</p> <p>267</p> <p>267</p>

<p>5.4 identify and explain the various measures used to protect users from electrical shock including:</p>	
<p>(i) the wiring and design features of the three pin plug.</p>	<p>p. 270</p>
<p>(ii) the importance of fitting the correct fuse</p>	<p>269-270</p>
<p>(iii) earthing</p>	<p>269</p>
<p>(iv) double insulation</p>	<p>269</p>
<p>(v) residual circuit breakers</p>	<p>269, 272</p>
<p>5.5 (i) describe the principle of electricity generation i.e. electricity is generated when a magnet is moved near conducting coils.</p>	<p>296-7</p>
<p>(ii) locate the various Northern Ireland power stations and understand the reasons for their positioning;</p>	<p>(104)</p>
<p>(iii) give the names of the fossil fuels used in these power stations;</p>	<p>13, 101, 106</p>
<p>(iv) interpret, in block diagram form, the component parts, and their functions, of power stations.</p>	<p>104, 349</p>
<p>5.6 apply their knowledge of energy transfers to those that take place within power stations.</p>	<p>101</p>
<p>5.7 (i) discuss and evaluate the environmental issues surrounding the use of renewable energy sources that can be used to directly drive turbine generators.</p>	<p>14-15, 105-6</p>
<p>(ii) explain why emphasis on developing alternative renewable fuels has risen in recent years.</p>	<p>13</p>
<p>5.8 Evaluate the advantages and disadvantages of having a nuclear power station in Northern Ireland and the ethical, social, economic and environmental issues relating to nuclear power in general.</p>	<p>105-7, 349</p>

<p>Waves</p> <p><i>In this section candidates examine the two types of waves and what waves do. The echo method for the measurement of speed of sound is examined. Ultrasound and its medical use is studied. The dispersion of white light is investigated and the electromagnetic spectrum discussed and the uses and dangers of the various regions of the spectrum examined. Health issues are evaluated and discussed; such as the possible adverse effects of microwaves (mobile phone communications) and the harmful effect of sun tanning on the skin and its link to the depletion of the ozone layer.</i></p> <p>5.9 (i) show that waves are caused by vibrations and that waves transport energy and investigate the difference between transverse and longitudinal waves;</p> <p>(ii) understand the main features (amplitude, frequency and wavelength) of a transverse wave and explain transverse wave propagation in terms of particle movement.</p> <p>5.10 (i) investigate how to measure the speed of sound using the flash-bang method and also by using microphones connected to a timer. A comparison of the two methods should be made in relation to the accuracy of the measurement;</p> <p>(ii) explain how sound can be reflected and this is known as an echo and what steps are taken in auditoria to counteract this problem;</p> <p>(iii) carry out simple calculations involving the echo method, on the speed of sound.</p> <p>5.11 (i) recall the audible range of humans i.e. 20 Hz to 20kHz.;</p> <p>(ii) recall that ultrasound has a frequency greater than 20 kHz;</p> <p>(iii) explain how ultrasound can be used for depth measurement, locating fish, and used in medicine to scan the internal structure of the body and that ultrasound scanning is safer than X rays;</p> <p>(iv) investigate factors which affect the audible range in humans eg age, birth defects, ear drum damage, noisy environments. (and safety factors taken to prevent ear damage).</p>	<p>p.166-7</p> <p>167</p> <p>227</p> <p>226</p> <p>226, 228</p> <p>230</p> <p>226, 229</p> <p>226, 229</p> <p>230, 234</p>
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<p>5.12 (i) recognise that electromagnetic radiation travels as waves, and that such waves travel at the same speed in a vacuum;</p>	<p>p. 208-9</p>
<p>(ii) investigate the make up of the electromagnetic spectrum from gamma rays to radio waves.</p>	<p>208-213</p>
<p>5.13 appreciate that different wavelengths of electromagnetic radiation have different effects on living cells <i>explain these effects in terms of an increasing frequency</i> and explore the dangers associated with;</p>	
<p>(i) over exposure to sunlight (ultra violet)</p>	<p>214</p>
<p>(ii) the damaging effect on tissues of X-rays</p>	<p>312</p>
<p>(iii) using gamma rays in industry and medicine</p>	<p>210, 214, 346-7</p>
<p>(iv) explain the microwave heating effect in terms of energy absorption and molecular behaviour.</p>	<p>213</p>
<p>Communications</p>	
<p><i>The use of electromagnetic waves in communications is studied and the technology associated with mobile phone networks examined. Health issues should be examined and discussed; such as the possible adverse effects on health of microwaves (mobile phone communications). The reflection and refraction of light investigated, leading to an examination of critical angle and total internal reflection.</i></p>	
<p>5.14 explore and discuss the use of electromagnetic waves in communications, radio waves for television and radio, microwaves for satellite and mobile phones, infra red and visible light in telephone networks using optical fibres..</p>	<p>208-9, 211, 213, 314, 331</p>
<p>5.15 (i) describe how mobile phones work by passing messages from one cell to another and that this requires phone masts to act as repeater stations and telephone messages may also be sent across wires or through fibre optic cables.</p>	<p>216-7</p>
<p>(ii) investigate the use of microwaves in mobile phone communications with regard to possible health risks.</p>	<p>216-7</p>
<p>(iii) recall the difference between analogue and digital signals and that digital signals are less likely to be affected by interference and can be processed by computers.</p>	<p>218-9</p>

<p>5.16 explain what is meant by critical angle and total internal reflection and their application to optical fibres, car and bicycle rear reflectors.</p>	<p>p. 187, 189, 192</p>
<p>Vision <i>In this section lenses are investigated and the use of different lenses in the correction of long sight and short sight examined.</i></p>	
<p>5.17 show with the use of triangular prisms that a lens is shaped so as to refract light in a particular way and draw ray diagrams to illustrate the different ways in which converging and diverging lenses refract rays of light parallel to the principal axis.</p>	<p>197, 194-6, worksheets</p>
<p>5.18 (i) describe the part refraction of light plays in the formation of an image on the retina, that most of the refraction takes place as the light passes from air through the cornea;</p>	<p>200</p>
<p>(ii) explain the function of the lens in the human eye i.e. to further converge light rays on to the retina to produce a sharp image and that in long sight a person's lens is too weak to converge the light and the image is formed behind the retina. Recognise that in short sight a person's lens is too strong and the image is formed in front of the retina.</p>	<p>200-3</p>
<p>5.19 explain how short sight and long sight are corrected and be able to draw ray diagrams to show how long sight is corrected with a converging lens and short sight is corrected with a diverging lens.</p>	<p>202-3</p>
<p>5.20 <i>explain what astigmatism is.</i></p>	
<p>Links In this module there is reference to fossil fuels which are also studied in Module 3. Knowledge of atomic structure mentioned in 5.2 is covered in detail in Module 3. The increase in CO₂ levels and greenhouse effect as a result of burning of fossil fuels are dealt with in Module 2.11, 2.12 and 2.14. The effect of exposure to UV during tanning sessions is also mentioned in Module 2.2.</p>	

Module 6 : Road Safety, Radioactivity and Earth in Space

ICT In this module ICT is addressed in the following ways. Candidates should:

- use the internet to research information on world energy resources and the development of new technologies for road transport 6.3 and 6.4.
- use spreadsheets and graph plotting packages to construct pie charts and bar graphs in section 6.1 and 6.7 dealing with fossil fuels and stopping distances.
- interrogate web sites on lobby organisations such as Greenpeace and Friends of the Earth when looking at using energy resources efficiently in section 6.1, 6.3 and 6.4.
- use datalogging when measuring speed and reaction time in section 6.7, and 6.10 and when measuring acceleration in 6.11.
- interrogate web sources to investigate ideas in crash barrier design and safety features in 6.13, 6.14

Road Safety

In this section candidates examine the importance fossil fuels play in transport and the consequences that increasing use of such fuels have on our planet. Candidates have the opportunity to investigate the factors governing the stopping distances of road vehicles. The meaning of speed and acceleration are studied and linked to graphical methods to display motion data. Candidates explore the dangers involved in road transport and how they can be reduced. The concepts of thinking distance, braking distance and stopping distances are explored in the context of road accidents. Candidates are also introduced to the idea of momentum.

6.1 (i) recall that fossil fuels are the dead remains of plant and animal matter buried in the Earth for millions of years and that the major world energy resources are oil, gas and coal. Investigate past and future estimates of rates of usage of fuels in UK and RoI;

(ii) recognise that peat and lignite are found locally and understand why Northern Ireland's vast reserves of lignite have not yet been exploited commercially;

(p. 13, 107)

<p>(ii) suggest why the most useful energy resources for transport are oil and its derivatives, petrol and diesel.</p>	
<p>6.2 (i) discuss and evaluate the differences between external and internal combustion engines giving rise to the use of oil based products for the latter.</p>	(p. 114)
<p>(ii) understand that oil based fuels have a high energy density and can be made to burn rapidly and are therefore most appropriate for road transport;</p>	
<p>(iii) know that global reserves of all fossil fuels are limited and appreciate why energy resources should be used efficiently;</p>	13
<p>6.3 Collect data on the use of fossil fuels and discuss and evaluate the consequences of the increasing use of fossil fuels, including global warming and research the ways that attempts are being made to minimise reliance on fossil fuels by the use of substitutes such as biodiesel from oil bearing seeds, hydrogen, and extenders such as alcohol.</p>	107
<p>6.4 explore strategies that car manufacturers are currently developing to save reliance on fossil fuels (such as the use of regenerative, hybrid systems as in the Toyota Prius) and <i>fuel cells based on methanol (under research by Mercedes).</i></p>	115
<p>6.5 (i) appreciate the role of prices in controlling the demand for oil and understand why limited supplies are likely to cause increased prices;</p>	
<p>(ii) <i>discuss and evaluate the economic arguments for and against the use of fiscal measures to control the consumption of fossil fuels, particularly petrol and diesel.</i></p>	
<p>6.6 recall and use the equation below to calculate the efficiency of a device:</p>	
<p>efficiency = useful work output /total energy input</p>	102-3, 116
<p>6.7 (i) apply the terms <i>thinking distance, braking distance and stopping distance</i> as applied to the drivers of road vehicles;</p>	83

<p>(ii) explain the meaning of reaction time and be able to describe a simple experiment to measure it;</p>	<p>p. 83, 132</p>
<p>(iii) investigate how thinking distance changes with speed and appreciate that it may increase when the driver has taken alcohol, prescribed medicines or illegal drugs;</p>	<p>83</p>
<p>(iv) describe how braking distance increases with speed and investigate factors which affect braking distance. (state of road surface, weather, condition of tyres and brakes)</p>	<p>83</p>
<p>6.8 (i) know that friction is the name given to the force which opposes motion and appreciate its role when a vehicle brakes; Investigate factors which can affect frictional force on a moving object;</p>	<p>82</p>
<p>(ii) <i>understand how the Newtonian model for constant motion differed from that of earlier scientists and the experimental evidence on which the Newtonian model is based;</i></p>	<p>(69), 372</p>
<p>(iii) know that energy is transferred from one vehicle to another in a road traffic accident.</p>	<p>(136)</p>
<p>6.9 (i) evaluate, how the use of seatbelts, airbags and crumple zones reduce the risk of serious injury to people and appreciate how speed restrictions, speed-bumps and traffic cameras contribute to road safety. Candidates should examine how safety features have become more important over the past 40 years as number of cars and accidents increased;</p>	<p>138</p>
<p>(ii) <i>understand the ethical issues raised by traffic cameras;</i></p>	
<p>(iii) appreciate social economic and environmental advantages of traffic calming measures (eg reduced speed of road users leading to fewer and less serious accidents) against their disadvantages; (eg increased time to provide emergency services).</p>	
<p>(iv) investigate what pedestrians can do to minimise the risks to themselves and others.</p>	
<p>6.10 (i) apply the equation for average speed as the total distance travelled divided by the time taken to do so; investigate motion on a trolley using dataloggers.</p>	<p>122, worksheets</p>

<p>(ii) interpret straight line graphs of distance against time;</p>	<p>p. 126</p>
<p>(iii) <i>understand the difference between instantaneous speed and average speed.</i></p>	<p>(122)</p>
<p>6.11 explain and apply the meaning of acceleration in the context of straight line motion. <i>Measure acceleration using dataloggers eg a trolley moving down a ramp.</i></p>	<p>122, worksheet</p>
<p>6.12 (i) describe momentum as the product of mass and velocity and recall that there is a momentum transfer in a collision and that this momentum transfer causes a force;</p>	<p>136</p>
<p>(ii) recall and apply that when forces on an object are balanced the object will move at a steady speed in a straight line or remain at rest;</p>	<p>69, 86-7, 89</p>
<p>(iii) explain the meaning of resultant force and appreciate that a resultant force will cause an acceleration.</p>	<p>86-7, 89</p>
<p>6.13 <i>explore crash barrier provision i.e. must be strong enough to prevent vehicles travelling from one carriageway to another, but weak enough to deform and absorb energy in a collision.</i></p>	
<p>6.14 investigate safety features which play an important role in the design of cars i.e. how a crumple zone and a rigid passenger cell in a car reduce the risk of serious passenger injuries.</p>	<p>69, 138, worksheet</p>
<p>Radioactivity</p>	
<p><i>In this section the particle structure of the nucleus is studied and radioactivity as a consequence of unstable nuclei studied. The nature and properties of alpha, beta and gamma radiation are studied. The terms background and half life are introduced. The damaging effect nuclear radiations have on our bodies is discussed.</i></p>	
<p>6.15 (i) recall the structure of atoms in terms of protons, neutrons and electrons;</p>	<p>342-3</p>
<p>(ii) recognise that some combinations of neutrons and protons are unstable and disintegrate and that such nuclei are described as radioactive;</p>	<p>340</p>

(iii) recall that radioactive nuclei emit alpha, beta and gamma radiation.	p. 340-1
6.16 Investigate the properties of alpha, beta and gamma radiation limited to;	
(i) alpha radiation is stopped by a few centimetres of air or a sheet of paper;	340
(ii) that beta radiation is stopped by several metres of air or a thick sheet of aluminium;	340
(iii) gamma radiation easily passes through all of these but that lead is an effective shield;	341
(iv) evaluate background activity and its source;	340, 350
<i>(v) appreciate that emission of radiation is entirely random and that science cannot predict when a particular atom will disintegrate, however useful predictions can be made as to the probability of an atom decaying in a particular time.</i>	344
(vi) explain the meaning of the term <i>half-life</i> . <i>Carry out simple calculations involving half-life and be able to link the concepts of half-life and background activity to the time taken for a radioactive source to become safe;</i>	344
6.17 (i) describe radioactivity as the emission of ionizing radiation and that this ionizing radiation causes damage or can kill living cells or cause them to become cancerous;	350
(ii) give uses and reasons why ionizing radiation can be used to treat cancer and sterilise surgical instruments and extend the shelf life of perishable food.	347, 210
The Solar System <i>In this section candidates study the solar system. The Earth, the moon and the role of artificial satellites are examined. The discovery of planets in orbit around other stars is discussed and the search for extraterrestrial life introduced as an ongoing and serious scientific investigation. Star formation is outlined, galaxies and the expansion of the universe are examined and the difficulties of space travel discussed. The creation of the universe is discussed and the Big Bang model of its creation examined and evidence in support of it outlined.</i>	

<p>6.18 (i) recall that a solar system is a collection of planets, asteroids, comets and other smaller objects that orbit a star; that we live on a planet that is part of such a solar system;</p>	<p>p. 150-2</p>
<p>(ii) understand the meaning of retrograde motion as applied to Jupiter and how proponents of the heliocentric and geocentric models of our Solar System sought to explain it;</p>	<p>worksheet, 373</p>
<p>(iii) recall the names of the planets that make up our solar system and be able to list them in order of increasing distance from the Sun;</p>	<p>150-1</p>
<p>(iv) investigate how gravitational force varies on different planets and how this can affect weight.</p>	<p>151, 67, 131</p>
<p>(v) recognise that all the planets orbit the Sun in the same direction and in the same plane and that the gravitational attraction of the Sun on the planets keeps them moving in circular orbits;</p>	<p>151, 153</p>
<p>(vi) be aware that there is the possibility of the Earth being struck by an asteroid and that such events have taken place in the past and that evidence for this exists.</p>	<p>worksheet</p>
<p>6.19 (i) Examine previous theories of the Earth's place in space and how increased data brought about change in these theories;</p>	<p>(373)</p>
<p>(ii) recognise that planets have been detected orbiting other stars and there is a research program to search for extra terrestrial life.</p>	<p>159</p>
<p>6.20 know and understand that stars are formed from clouds of hydrogen gas; the processes that bring about star formation; that nuclear fusion is the energy source of a star.</p>	<p>152, 156</p>
<p>6.21 know that galaxies are huge collection of stars; that our galaxy is called the Milky Way; that the distance between the stars and the galaxies are enormous; that a <i>light year</i> is the distance light travels in a year; know that the galaxies are moving away from each other; understand the difficulties of space travel between the stars. <i>The further the galaxies are away the faster they are moving apart and that space is expanding.</i></p>	<p>157-8, 171, worksheet</p>

6.22 evaluate data suggesting the accepted explanation of this expanding Universe is that it began with 'Big Bang' some 10 billion years ago and be aware that other theories may exist or co-exist.

Links

Module 4.1 and 4.2 deal with the structure and combustion of alkanes as fossil fuels. The reference to reserves of fossil fuels occurs in Module 2.12. Road safety Officers may be consulted with regard to data on road accidents and their prevention. Car manufacturers promotion literature can be used when looking at safety features of cars. The planetarium in Armagh puts on many effective displays on space, origin of stars etc. Drug abuse and possible effects are also mentioned in section 2.10. Ionising radiations are met in section 2.2. The structure of the atom is dealt with in detail in section 3.17. The electromagnetic spectrum in Module 5 mentions gamma radiation. The Ecos Centre in Ballymena provides display of energy saving devices and alternative energy production.

p. 158, 373, worksheet