

AQA : GCSE specification 4461 or 4462

Science A or Science B

First certification Summer 2008

Please ensure that you have selected the correct specification
(available from www.physicsforyou.co.uk and www.physics4u.co.uk).

Name : _____

10.2 Fundamental ideas

<p>FT & HT</p>	<p>Evidence must be approached with a critical eye. It is necessary to look closely at how measurements have been made and what links have been established. Scientific evidence provides a powerful means of forming opinions. These ideas pervade all of 'How Science Works'.</p> <p>Candidates should know and understand:</p> <ul style="list-style-type: none"> • It is necessary to distinguish between opinion based on valid and reliable evidence and opinion based on non-scientific ideas (prejudices, whim or hearsay). • Continuous variables (any numerical values, eg weight, length or force) give more information than ordered variables (eg small, medium or large lumps) which are more informative than categoric variables (eg names of metals). A variable may also be discrete, that is, restricted to whole numbers (eg the number of layers of insulation). • Scientific investigations often seek to identify links between two or more variables. These links may be: <ul style="list-style-type: none"> - causal, in that a change in one variable causes a change in another - due to association, in that changes in one variable and a second variable are linked by a third variable (eg an association noted between soil acidity and crop growth may be the effect of a third variable, fertiliser type and quantity, on both) - due to chance occurrence (eg increase in the early 20th century in radio use was accompanied by an increase in mental illness). <p>Evidence must be looked at carefully to make sure that it is:</p> <ul style="list-style-type: none"> - reliable, ie it can be reproduced by others - valid, ie it is reliable <i>and</i> answers the original question. 	<p>6</p> <p>360</p> <p>361</p> <p>7, 359</p>
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10.3 Observation as a stimulus to investigation

FT & HT

Observation is the link between the real world and scientific ideas. When we observe objects, organisms or events we do so using existing knowledge. Observations may suggest hypotheses and lead to predictions that can be tested.

Candidates should know and understand:

Observing phenomena can lead to the start of an investigation, experiment or survey. Existing theories and models can be used creatively to suggest explanations for phenomena (hypotheses). Careful observation is necessary before deciding which are the most important variables. Hypotheses can then be used to make predictions that can be tested. An example is the observation that shrimp only occur in parts of a stream. Knowledge about shrimp and water flow leads to a hypothesis relating the distribution to the stream flow rate. A prediction leads to a survey that looks at both variables.

Data from testing a prediction can support or refute the hypothesis or lead to a new hypothesis. For example, the data from the shrimp survey could suggest that, at slow flow rates, oxygen availability might determine abundance.

If the theories and models we have available to us do not completely match our data or observations, we need to check the validity of our observations or data, or amend the theories or models.

6, 360-1

10.4 Designing an investigation

<p>FT & HT</p>	<p>An investigation is an attempt to determine whether or not there is a relationship between variables. Therefore it is necessary to identify and understand the variables in an investigation. The design of an investigation should be scrutinised when evaluating the validity of the evidence it has produced.</p> <p>Candidates should know and understand:</p> <p>An independent variable is one that is changed or selected by the investigator. The dependent variable is measured for each change in the independent variable.</p> <p>Any measurement must be valid in that it measures only the appropriate variable, for instance colour change in a pH indicator to measure respiration in woodlice could be affected by their excretion.</p> <p>Fair Test It is important to isolate the effects of the independent variable on the dependent variable. This may be achieved more easily in a laboratory environment than in the field, where it is harder to control all variables.</p> <p>A fair test is one in which only the independent variable affects the dependent variable, as all other variables are kept the same.</p> <p>In field investigations it is necessary to ensure that variables that change their value do so in the same way for all measurements of the dependent variable (eg in a tomato growth trial, all plants are subject to the same weather conditions).</p> <p>When using large-scale survey results, it is necessary to select data from conditions that are similar (eg if a study is to survey the effect of age on blood pressure, a group of people with approximately the same diet or weight could be used).</p> <p>Control groups are often used in biological and medical research to ensure that observed effects are due to changes in the independent variable alone (eg in drug experiments, a placebo drug is used as a control).</p> <p>Choosing values of a variable Care is needed in selecting values of variables to be recorded in an investigation. A trial run will help identify appropriate values to be recorded, such as the number of repeated readings needed and their range and interval. For example, in an investigation of the effect of temperature on enzyme activity it is necessary to:</p> <ul style="list-style-type: none"> • use a sufficient amount of enzyme so that its activity can be detected • use a sensible range of temperatures • have readings closer together. (at smaller intervals) where a change in pattern is detected. 	<p>360</p> <p>360</p> <p>359</p> <p>360</p> <p>361</p> <p>361</p> <p>continued...</p>
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	<p>Accuracy and precision. Readings should be repeated to improve the reliability of the data. An accurate measurement is one which is close to the true value.</p> <p>The design of an investigation must provide data with sufficient accuracy. For example, measures of blood alcohol levels must be accurate enough to be able to determine whether the person is legally fit to drive.</p> <p>The design of an investigation must provide data with sufficient precision to form a valid conclusion. For example, in an investigation into the bounce of different balls, less precision is needed to tell if a tennis ball bounces higher than a squash ball than if you wanted to distinguish between the bounce of two very similar tennis balls.</p>	<p>361</p> <p>362</p>
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10.5 Making measurements

FT & HT	When making measurements we must consider such issues as inherent variation due to variables that have not been controlled, human error and the characteristics of the instruments used. Evidence should be evaluated with the reliability and validity of the measurements that have been made in mind.	362
	<p>A single measurement</p> <p>There will always be some variation in the actual value of a variable no matter how hard we try to repeat an event. For instance, if a ball is dropped and doesn't land on exactly the same point on its surface there will be a slight difference in the rebound height.</p>	362
	When selecting an instrument, it is necessary to consider the accuracy inherent in the instrument and the way it has to be used. For example, expensive thermometers are likely to give a reading nearer to the true reading and to be more accurately calibrated.	362
	The sensitivity of an instrument refers to the smallest change in a value that can be detected. For example, bathroom scales are not sensitive enough to detect the weekly changes in the mass of a baby, whereas scales used by a midwife are sensitive enough to permit a growth chart to be plotted.	362
	Even when an instrument is used correctly, human error may occur which could produce random differences in repeated readings or a systematic shift from the true value which could, for instance, occur due to incorrect use or poor calibration.	362
	Random error can result from inconsistent application of a technique. Systematic error can result from consistent misapplication of a technique.	
Any anomalous values should be examined to try and identify the cause and, if a product of a poor measurement, ignored.	362	

10.6 Presenting data

FT & HT	To explain the relationship between two or more variables, data may be presented in such a way as to make the patterns more evident. There is a link between the type of graph used and the type of variable represented. The choice of graphical representation depends upon the type of variable they represent.	363
	Candidates should know and understand:	
	The range of the data refers to the maximum and minimum values.	361
	The mean (or average) of the data refers to the sum of all the measurements divided by the number of measurements taken.	361
	Tables are an effective means of displaying data but are limited in how they portray the design of an investigation.	363
	Bar charts can be used to display data in which the independent variable is categoric and the dependent variable continuous.	363
	Line graphs can be used to display data in which both the independent and dependent variables are continuous.	363
Scattergrams can be used to show an association between two variables (eg water content of soil and height of plants).		

10.7 Using data to draw conclusions

FT & HT	The patterns and relationships observed in data represent the behaviour of the variables in an investigation. However, it is necessary to look at patterns and relationships between variables with the limitations of the data in mind in order to draw conclusions.	364
	Candidates should know and understand:	
	Patterns in tables and graphs can be used to identify anomalous data that require further consideration.	364
	A line of best fit can be used to illustrate the underlying relationship between variables.	364
	The relationships that exist between variables can be linear (positive or negative, eg height of wax remaining in a candle and time it has been burning) or directly proportional (eg extension of a spring and applied force). On a graph, the relationship could show as a curve (eg velocity against time for a falling object).	364
	Conclusions must be limited by the data available and not go beyond them. For example, the beneficial effects of a new drug may be limited to the sample used in the tests (younger men perhaps) and not the entire population.	364
	Evaluation	364
	In evaluating a whole investigation the reliability and validity of the data obtained must be considered. The reliability of an investigation can be increased by looking at data obtained from secondary sources, through using an alternative method as a check and by requiring that the results are reproducible by others.	

10.8 Societal aspects of scientific evidence

<p>FT & HT</p>	<p>A judgement or decision relating to social-scientific issues may not be based on evidence alone, as other societal factors may be relevant.</p> <p>Candidates should know and understand:</p> <p>The credibility of the evidence is increased if a balanced account of the data is used rather than a selection from it which supports a particular pre-determined stance.</p> <p>Evidence must be scrutinised for any potential bias of the experimenter, such as funding sources or allegiances.</p> <p>Evidence can be accorded undue weight, or dismissed too lightly, simply because of its political significance. If the consequences of the evidence might provoke public or political disquiet, the evidence may be downplayed.</p> <p>The status of the experimenter may influence the weight placed on evidence; for instance, academic or professional status, experience and authority. It is more likely that the advice of an eminent scientist will be sought to help provide a solution to a problem than that of a scientist with less experience.</p> <p>Scientific knowledge gained through investigations can be the basis for technological developments.</p> <p>Scientific and technological developments offer different opportunities for exploitation to different groups of people.</p> <p>The uses of science and technology developments can raise ethical, social, economic and environmental issues.</p> <p>Decisions are made by individuals and by society on issues relating to science and technology.</p>	<p>358-9</p> <p>359</p> <p>359</p> <p>359</p> <p>6, 107, 216-7, 359</p> <p>6, 358-9</p>
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10.9 Limitations of scientific evidence

FT & HT	<p>Science can help us in many ways but it cannot supply all the answers.</p> <p>We are still finding out about things and developing our scientific knowledge. There are some questions that we cannot answer, maybe because we do not have enough reliable and valid evidence. For example, it is generally accepted that the extra carbon dioxide in the air (from burning fossil fuels) is linked to global warming, but some scientists think there is not sufficient evidence and that there are other factors involved.</p> <p>And there are some questions that science cannot answer at all. These tend to be questions where beliefs and opinions are important or where we cannot collect reliable and valid scientific evidence. For example, science may be able to answer questions that start 'How can we'... such as 'How can we clone babies?' but questions starting 'Should we..' such as 'Should we clone babies?' are for society to answer.</p>	<p>6, 107, 359</p> <p>6, 359</p>
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Unit Physics 1		Page numbers in New Physics for You
11.1 How is heat (thermal energy) transferred and what factors affect the rate at which heat is transferred?		
Foundation Tier (FT) and Higher Tier (HT)	<p>Candidates should use their skills, knowledge and understanding of how science works:</p> <ul style="list-style-type: none"> to evaluate ways in which heat is transferred in and out of bodies and ways in which the rates of these transfers can be reduced. <p>Their skills, knowledge and understanding of how science works should be set in these substantive contexts:</p> <p>Thermal (infra red) radiation is the transfer of energy by electromagnetic waves.</p> <p>All bodies emit and absorb thermal radiation.</p> <p>The hotter a body is the more energy it radiates.</p> <p>Dark, matt surfaces are good absorbers and good emitters of radiation.</p> <p>Light, shiny surfaces are poor absorbers and poor emitters of radiation.</p> <p>The transfer of energy by conduction and convection involves particles and how this transfer takes place.</p> <p>Under similar conditions different materials transfer heat at different rates.</p> <p>The shape and dimensions of a body affect the rate at which it transfers heat.</p> <p>The bigger the temperature difference between a body and its surroundings, the faster the rate at which heat is transferred.</p>	<p>pages 43, 51</p> <p>43, 49, 51</p> <p>40, 46-51</p> <p>46</p> <p>41</p> <p>46-7</p> <p>46-7</p> <p>40-45</p> <p>41, 43</p> <p>41, 43</p> <p>43, 46</p>

11.2 What is meant by the efficient use of energy?

<p>FT & HT</p>	<p>Candidates should use their skills, knowledge and understanding of how science works:</p> <ul style="list-style-type: none"> to describe the intended energy transfers/transformations and the main energy wastages that occur with a range of devices to calculate the efficiency of a device using: $\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$ to evaluate the effectiveness and cost effectiveness of methods used to reduce energy consumption. <p>Their skills, knowledge and understanding of how science works should be set in these substantive contexts:</p> <p>Energy cannot be created or destroyed. It can only be transformed from one form to another form.</p> <p>When energy is transferred and/or transformed only part of it may be usefully transferred/transformed.</p> <p>Energy which is not transferred/transformed in a useful way is 'wasted'.</p> <p>Both wasted energy and the energy which is usefully transferred/transformed are eventually transferred to their surroundings which become warmer.</p> <p>Energy becomes increasingly spread out and becomes increasingly more difficult to use for further energy transformations.</p> <p>The greater the percentage of the energy that is usefully transformed in a device, the more efficient the device is.</p>	<p>100-103, 116</p> <p>102-3, 116</p> <p>43, 102</p> <p>10-11, 98-9</p> <p>100-1</p> <p>102</p> <p>102-3</p> <p>102</p> <p>102-3</p>
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11.3 Why are electrical devices so useful?

<p>FT & HT</p>	<p>Candidates should use their skills, knowledge and understanding of how science works:</p> <ul style="list-style-type: none"> to compare and contrast the particular advantages and disadvantages of using different electrical devices for a particular application to calculate the amount of energy transferred from the mains using: $\text{energy transferred} = \text{power} \times \text{time}$ (kilowatt-hour, kWh) (kilowatt, kW) (hour, h) to calculate the cost of energy transferred from the mains using: $\text{total cost} = \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour}$ <p>Their skills, knowledge and understanding of how science works should be set in these substantive contexts:</p> <p>Examples of energy transformations that everyday electrical devices are designed to bring about.</p> <p>Examples of everyday electrical devices designed to bring about particular energy transformations.</p> <p>The amount of electrical energy a device transforms depends on how long the appliance is switched on and the rate at which the device transforms energy.</p> <p>The power of an appliance is measured in watts (W) or kilowatts (kW).</p> <p>Energy is normally measured in joules (J).</p> <p>Electricity is transferred from power station to consumers along the National Grid.</p> <p>The uses of step-up and step-down transformers in the National Grid.</p> <p>Increasing voltage (potential difference) reduces current, and hence reduces energy losses in the cables.</p>	<p>264-5</p> <p>267</p> <p>267</p> <p>264-7, 11, 100</p> <p>264-7, 11, 100</p> <p>267</p> <p>266</p> <p>35, 97</p> <p>303</p> <p>303</p> <p>303</p>
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11.4 How should we generate the electricity we need?

<p>FT & HT</p>	<p>Candidates should use their skills, knowledge and understanding of how science works:</p> <ul style="list-style-type: none"> to compare and contrast the particular advantages and disadvantages of using different energy sources to generate electricity. <p>Their skills, knowledge and understanding of how science works should be set in these substantive contexts:</p> <p>In most power stations an energy source is used to heat water. The steam produced drives a turbine which is coupled to an electrical generator.</p> <p>Common energy sources include coal, oil and gas, which are burned to produce heat and uranium/plutonium, in which nuclear fission produces heat.</p> <p>Energy from renewable energy sources can be used to drive turbines directly.</p> <p>Renewable energy sources used in this way include wind, the rise and fall of water due to waves and tides, and the falling of water in hydroelectric schemes.</p> <p>Electricity can be produced directly from the Sun's radiation using solar cells.</p> <p>In some volcanic areas hot water and steam rise to the surface. The steam can be tapped and used to drive turbines. This is known as geothermal energy.</p> <p>Using different energy resources has different effects on the environment. These effects include the release of substances into the atmosphere, noise and visual pollution, and the destruction of wildlife habitats.</p> <p>The advantages and disadvantages of using fossil fuels, nuclear fuels and renewable energy sources to generate electricity. These include the cost of building power stations, the start-up time of power stations, the reliability of the energy source, the relative cost of energy generated and the location in which the energy is needed.</p>	<p>13-15, 104-6</p> <p>104</p> <p>104, 348-9</p> <p>14-15, 106</p> <p>14-15, 105-6</p> <p>14, 103-4, 115</p> <p>15</p> <p>104-6</p> <p>105-6</p>
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11.5 What are the uses and hazards of the waves that form the electromagnetic spectrum?

<p>FT & HT</p>	<p>Candidates should use their skills, knowledge and understanding of how science works:</p> <ul style="list-style-type: none"> to evaluate the possible hazards associated with the use of different types of electromagnetic radiation to evaluate methods to reduce exposure to different types of electromagnetic radiation. <p>Set in these substantive contexts: Electromagnetic radiation travels as waves and moves energy from one place to another. All types of electromagnetic waves travel at the same speed through a vacuum (space).</p> <p>The electromagnetic spectrum is continuous but the wavelengths within it can be grouped into types of increasing wavelength and decreasing frequency: – gamma rays, X-rays, ultraviolet rays, visible light, infra red rays, microwaves and radio waves.</p> <p>Different wavelengths of electromagnetic radiation are reflected, absorbed or transmitted differently by different substances and types of surface.</p> <p>When radiation is absorbed the energy it carries makes the substance which absorbs it hotter and may create an alternating current with the same frequency as the radiation itself.</p> <p>Different wavelengths of electromagnetic radiation have different effects on living cells. Some radiations mostly pass through soft tissue without being absorbed, some produce heat, some may cause cancerous changes and some may kill cells. These effects depend on the type of radiation and the size of the dose.</p> <p>The uses and the hazards associated with the use of each type of radiation in the electromagnetic spectrum.</p> <p>Radio waves, microwaves, infra red and visible light can be used for communication.</p> <p>Microwaves can pass through the Earth’s atmosphere and are used to send information to and from satellites and within mobile phone networks.</p> <p>Infra red and visible light can be used to send signals along optical fibres and so travel in curved paths.</p> <p>Communication signals may be analogue (continuously varying) or digital (discrete values only, generally on and off). Digital signals are less prone to interference than analogue and can be easily processed by computers.</p> <p>Electromagnetic waves obey the wave formula: $\text{wave speed} = \text{frequency} \times \text{wavelength}$ (metre/second, m/s) (hertz, Hz) (metre, m)</p>	<p>208-214, 216-7 214, 216-7</p> <p>208-9 208-9</p> <p>208-9, 210-213</p> <p>208-9, 210-213</p> <p>47, 209, 211</p> <p>208-9, 214</p> <p>208-9</p> <p>211, 213, 314</p> <p>211, 314</p> <p>189, 192</p> <p>218-219</p> <p>167, 209</p>
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11.6 What are the uses and dangers of emissions from radioactive substances?

<p>FT & HT</p>	<p>Candidates should use their skills, knowledge and understanding of how science works:</p> <ul style="list-style-type: none"> to evaluate the possible hazards associated with the use of different types of nuclear radiation to evaluate measures that can be taken to reduce exposure to nuclear radiations to evaluate the appropriateness of radioactive sources for particular uses, including as tracers, in terms of the type(s) of radiation emitted and their half-lives. <p>Their skills, knowledge and understanding of how science works should be set in these substantive contexts:</p> <p>The basic structure of an atom is a small central nucleus composed of protons and neutrons surrounded by electrons.</p> <p>The atoms of an element always have the same number of protons, but have a different number of neutrons for each isotope.</p> <p>Some substances give out radiation from the nuclei of their atoms all the time, whatever is done to them. These substances are said to be radioactive.</p> <p>Identification of an alpha particle as a helium nucleus, a beta particle as an electron from the nucleus and gamma radiation as electromagnetic radiation.</p> <p>Properties of the alpha, beta and gamma radiations limited to their relative ionising power, their penetration through materials and their range in air.</p> <p>Alpha and beta radiations are deflected by both electric and magnetic fields but gamma radiation is not.</p> <p>The uses of and the dangers associated with each type of nuclear radiation.</p> <p>The half-life of a radioactive isotope is defined as the time it takes for the number of nuclei of the isotope in a sample to halve or the time it takes for the count rate from a sample containing the isotope to fall to half its initial level.</p>	<p>340-1, 350</p> <p>350</p> <p>346-7</p> <p>342-3</p> <p>343</p> <p>340</p> <p>340, 345</p> <p>340-1</p> <p>340-1</p> <p>346-7, 350</p> <p>344</p>
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11.7 What do we know about the origins of the Universe and how it continues to change?

FT & HT	<p>Candidates should use their skills, knowledge and understanding of how science works:</p> <ul style="list-style-type: none"> to compare and contrast the particular advantages and disadvantages of using different types of telescope on Earth and in space to make observations on and deductions about the universe. <p>Their skills, knowledge and understanding of how science works should be set in these substantive contexts:</p>	215
	<p>If a wave source is moving relative to an observer there will be a change in the observed wavelength and frequency.</p>	158
	<p>There is a red-shift in light observed from most distant galaxies. The further away galaxies are the bigger the red-shift.</p>	158
	<p>How the observed red-shift provides evidence that the universe is expanding and supports the 'big bang' theory (that the universe began from a very small initial point).</p>	158
	<p>Observations of the solar system and the galaxies in the universe can be carried out on the Earth or from space.</p>	155, 215
	<p>Observations are made with telescopes that may detect visible light or other electromagnetic radiations such as radio waves or X-rays.</p>	215