GCSE
SCIENCE A, SCIENCE B, PHYSICS
UNIT P1 – Example 1
4461, 4462, 4451

Scheme of Work

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Introduction

This Outline Scheme of Work is one of a number of schemes prepared by practising teachers for the new AQA GCSE Sciences suite. It is hoped that other teachers will find them helpful as the basis for the fully detailed schemes prepared for teaching from September 2006. Each outline scheme covers one unit (B1, B2, B3, C1, C2, C3, P1, P2, P3) and for some units more than one outline scheme is available. This is because there are different, equally valid ways of approaching the teaching of the specifications and a single scheme would not show the range of possible approaches.

The AQA specifications are designed to be used with a wide range of resources, so this scheme does not assume the availability of any particular printed or electronic publications, or any special equipment. Teachers are enabled to use existing resources, including their own, together with resources specially purchased for the new specifications.

The outline scheme is arranged under the section headings of the relevant specification, for example, *13.1/11.1 How is heat (thermal energy) transferred and what factors affect the rate at which heat is transferred?* The content in the section is further subdivided with a brief statement given of the coverage of each subdivision, together with activities that relate to that content and an indication of the number of hours it is suggested are needed to deliver that part of the content.

Opportunities to deliver 'How Science Works' and to use ICT are highlighted using the same icons as used in the specifications.

This identifies parts of the content which lend themselves to extended investigative work of the type needed to explore Sections 10.3–10.7 of the specifications. These sections are about obtaining valid and reliable scientific evidence.

This identifies parts of the content which lend themselves to activities which allow Sections 10.2 and 10.8–10.9 to be considered. These sections are about using scientific evidence, for example, how scientific evidence can contribute to decision making and how scientific evidence is limited.

This identifies where there are opportunities to use ICT sources and tools in teaching the specifications.

UNIT PHYSICS 1			
Total hours: 5	**13.1/11.1 How is heat (thermal energy) transferred and what factors affect the rate at which heat is transferred?**		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Transmission of heat by: • conduction • convection • radiation		• Transmission of heat by the individual processes, including loss prevention. Integration of all three in normal situations to bring them altogether. • Concepts of thermal energy loss in a house	Energy transfer is generally by three processes. Treat as specific processes, but then state that each process is merely part of the overall process. Dull matt v shiny silver surface comparison. Spreadsheet and graphical package. This will add (1/2) lessons into the schedule lessons. PSA. Cooling curve of matt v shiny cans.
Effectiveness of insulation		• The converse of 'keeping materials cool' in hot environments	Build houses/paint test tubes. Heat using source – 24W/36W lamp. Thermometer inside building/test tube. Role of insulation – including fair tests. PSA. Use of data loggers for long term 24 hour experiment. Comparison of data obtained – re development of 'future home building'.

Total hours: 4	13.2/11.2 What is meant by the efficient use of energy?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Conversion of one energy to another form Energy cannot be created or destroyed		• Seven circles/diagrams of energy transfer. Link each form using a data chart. This can lead to some loss of energy; the full amount of energy is not transferred.	Energy types: heat, light, sound, chemical, mechanical (movement, kinetic, potential), electrical, nuclear. Eg electrical energy supplied to a lamp gives light (useful energy) and heat (wasted energy).
Energy cannot be created or destroyed. Representing energy transfers graphically		• Sankey diagrams for energy change • Note that the Specification distinguishes between energy transformation and energy transfer	Consider items such as : lamps/diesel/engines/steam engines.
Energy spreads out as it is used. This dissipation of energy makes it less useful		• Look at the energy flow through a power station	Construct Sankey diagram of energy flow. Alternatives could be: diesel energy/steam engine. Foundation level investigate energy flow in lamp.
Efficiency of a device		• Mathematical treatment of Sankey diagrams – calculation of energy efficiency	Use of 12V immersion heaters to warm oil/water. Data logger to evaluate energy flow.

Total hours: 6	13.3/11.3 Why are electrical devices so useful?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Electrical appliances are used to perform different applications		• Compare and contrast advantages/disadvantages of using a device for particular applications	Using a motor to lift an item – change V I characteristics to compare efficiency of device.
Calculation of energy transferred from the mains		• Energy transferred = power × time (J) (W) (s) • The amount of energy moved depends on time it is switched on and rate at which device transforms energy	Simple calculations – use lamps/hair drier/kettle to illustrate. Small electrical heaters: take temperature/time readings – plot graph: temperature (Energy supplied) v t (time). Comparison of different heater power inputs. (Suggest pooling of data; plot all data onto one graph for comparative purposes)
Calculation of energy transferred from the mains		• Energy transferred = power × time (kilowatt-hour, kWh) = (kilowatt, kW) × (hour, h) • Cost of running electrical devices: Total cost = number of kilowatt-hours × cost per kilowatt-hour	Include sub hour times, eg: ¼, ½, and ¾. (Links to mathematics conversion of minutes to hours.) Suitable examples of domestic usage.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Cost of using electrical equipment		• Cost of running electrical devices • Can extend to include general utility bill, with standing charge if required	Revisit energy circles. Demonstrate energy conversions made. Suitable examples of domestic usage available. Look at electrical devices in adverts.
The structure of the national power grid		• Use of transformers to transform voltages (potential differences) up/down • Construction of coils; to show coil numbers vary in primary and secondary coils • Use of low resistance coils to cut down on wasted energy • Increasing voltage reduces current in a circuit (power lines) but also reduces energy loss	Suitable demonstration using transformer kit – include V I meters in circuit. Be aware of potential hazards, observe HSE regulations.

Total hours: 5	13.4/11.4 How should we generate the electricity we need?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Energy can be produced by a wide range of different energy sources		• Compare and contrast the energy types/production quota of electricity produced by: coal/oil/gas (classified as fossil fuel burners, non-renewable); uranium/plutonium (classified as nuclear, non-renewable); wind/wave/tidal/hydro/(classified as renewable); solar radiation (classified as renewable); geothermal energy (classified as renewable)	Use of internet to locate/retrieve and produce directed task (presentations) on each of the areas of production.
Advantage and disadvantages of using each energy source		• Costs benefit analysis of each type of energy production	To include: cost of building, start up time, reliability of source, the relative cost of production of a unit, location of energy consumption. Discussion of NIMBY – with different types of energy production. Local/national debate. Write newspaper article to discuss/put forward points of view.
The carbon dioxide debate		• Global warming and the effect on the world • Know the difference between global warming and ozone depletion in general terms	Use internet/newspapers/resources to compile a scientific response to statements that global warming is affecting our weather, effects on crops, pollution, atmosphere change etc. Write newspaper article based on scientific facts/data. Keep file of information.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Suggest an insertion of two blank lessons to give an opportunity to have a test/catch up time		• Open lessons	
Total hours: 6	**13.5/11.5 What are the uses and hazards of the waves that form the electromagnetic spectrum?**		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Be able to recall the full electromagnetic spectrum of waves; in terms of named components, approximate wavelengths, approximate frequencies and uses		• Construct a chart of the different constituents of the electromagnetic spectrum of waves with approximate frequencies, wavelengths and uses • Be able to calculate the wavelength or frequency of a wave, knowing the speed and frequency or wavelength • Appreciate that powers of ten are useful in writing down this information	Know the equation: speed = frequency × wavelength ($v = f\lambda$) Calculations of: frequency/wavelength given the other quantities.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Look at the hazards associated with each type of radiation		• Closely compare the effects of the hazards of using different electromagnetic waves, comparing them to the tasks that they do in society	Include: X-ray/gamma/UV/IR as the minimum. Treat this as a health and safety piece of research/discussion & evaluation. Research hazards on internet for different electromagnetic waves.
Electromagnetic radiation travels as waves		• Show that electromagnetic radiation obeys reflection rules – travels therefore like light • Show that the speed of the wave is constant in a vacuum: 3×10^8 ms^{-1}	Look at the best absorber/characteristics of a body. Heat body with suitable radiant heater. Use of test tubes/metal cans: silver & black. PSA
Properties and therefore uses of different electromagnetic radiations		• Different wavelengths are reflected, absorbed or transmitted differently by different substances. Uses should be broad-based and include: heating effect, cancer killing and communication, including satellite communication. • Infra red/visible light in optical fibres	Compare the refractive angle of coloured lights through a 60^o prism. PSA Use of optical fibres in different day to day instruments.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Different wavelengths of electromagnetic radiations have different effects on living cells		• Collect data on the different effects of electromagnetic radiations on cellular materials, including the biological effects of mutation of DNA, cancerous change, heating effect • That these are dependent on quantity and type of wave	Sensitivity issue with cancer/associated problems. Issues could be developed by debate/essay into areas such as: health physics and mobile telephones. Should we use nuclear materials to generate electrical energy? Research using suitable scientific forum news to put over biological effects and electromagnetic waves.
The difference between analogue and digital communication		• Develop an understanding of the two types of communication (analogue and digital) • The reasons for the change to digital TV in the next few years	The reasons for the change to digital TV – less interference in transmission reception quality are higher. Less risk of interference, and increased capacity of data transfer in digital systems. DAB radio broadcasting.

Total hours: 14	13.6/11.6 What are the uses and dangers of emissions from radioactive substances?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
The basic structure of an atom			Concept of small central nucleus containing protons and neutrons and space occupied by electrons.
The Rutherford model		• Rutherford's 'plumb pudding' model • Charge on proton, neutron and electron – their configuration and placement	Develop into conventional model of P + N and e in orbits. Proton & electron numbers equal in neutral atom, neutron number approximately same but can vary.
Effect of changing numbers of protons and neutrons		• Looking at examples of an atom in Periodic table, determining the P, N and e for individual atoms • Comparing them to common isotopes; hydrogen, deuterium, tritium; ^{35}Cl	Know that the individual atoms of the isotopes are chemically identical, but physically they can/are different.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Looking at decay: Beta		• That there are a number of isotopes that are unstable, and as a result, this can cause energy to be emitted in the form of a beta particle (an electron from the nucleus) • Properties and uses of beta decay, including; relative ionizing power, penetration through materials, range in air, dangers associated with the decay	Typical beta decay emissions – can give nuclear breakdown of nuclei, but do not go into a chain sequence. Research on use of beta radiation (i-data).
Looking at decay: Alpha		• That occasionally the nuclei is too massive and it will throw out of its nuclei chunks of matter that we call alpha particles • Properties and uses of alpha decay, including; relative ionizing power, penetration through materials, range in air, dangers associated with the decay	Alpha decay results in mass reduction of the nuclei. Simulation of alpha, beta and gamma radiation available on commercial software. Research on use of alpha radiation (i-data).
Looking at decay: Gamma		• No change in mass, merely a change in the internal energy of the nuclei • Properties/uses of gamma emission including relative ionizing power, penetration through materials, range in air, dangers associated with the decay, sterilisation of food materials	Research on use of gamma radiation (i-data) and societal aspects.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Collecting together the data on alpha, beta and gamma radiations		• Chart comparing the properties of each radioactive type. Charge on radioactive type has a fundamental effect on movement in electric and magnetic fields	Comparative chart of fundamental characteristics of alpha, beta and gamma radiation.
		• Class demonstration of 'classic penetrative experiment' to show the distance travelled by alpha, beta and gamma radiation, through paper, lead and aluminium	Develop into 'use of', in terms of nuclear protective issues, around examples of radioactive usage.
Half-life		• Half-life calculation of protactinium/radon etc	Respect and observe current HSE regulations.
		• Formal definition of half-life	Show that as the number of radioactive particles decreases, the number of daughter atoms increases.
		• Find half-life of suitable source - protactinium	Plot graph to demonstrate this.
		• Plot graph of half-life	
		• What are the problems associated with half-life? Examine the effects of radio nuclear decay and half-life – Chernobyl, Windscale, nuclear accidents	Research into accidents of nuclear type such as Chernobyl power station.
		• Estimating by numerical methods the amount of radioactivity remaining after a set time, with known half-life	Practical use of ^{14}C, ^{24}Na etc to obtain archaeological data.
		• Data analysis from graphical work	

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Commercial uses of radioactive materials		• Development into uses of radioactive materials from paint mixing (short half life beta) to medicinal work (any dependant on use) to gamma – food preservation	The rights and wrongs of using radioactive nuclides in society. Possible visit by local nuclide expert from hospital/industry. Research project on radionuclide.
Suggest an insertion of two blank lessons to give an opportunity to have a test/catch-up time		• Open lessons	
The nuclear energy debate		• Should nuclear energy contribute towards our energy need?	Discussion/debate on topical lines. Research essay? Local area to be used for new nuclear reactor? Debate/issue person cards – everyone in class to contribute.

Total hours: 7	13.7/11.7 What do we know about the origins of the Universe and how it continues to change?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
The different types of telescope that are available for us to use		• Optical lens refractors/reflectors (radio/X-ray). Advantages and disadvantages of their use on Earth and in space (near and far) for observations	Library/internet/book activity – better groups could develop ray diagrams to show how the relative telescopes work. Use of NASA website for pictures.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Red shift		• Red shift with reference to the movement of distant galaxies. Blue = towards, red = away, proof of by use of Doppler ball	Movement of source relative to observer only required.
The Big Bang concept		• Universe is expanding – supportive data is available. Link this to the observed red shift of distant galaxies.	Internet activity - sites have excellent photographs at good resolution. Google Earth (http://earth.google.com/) is a good starter for finding your school – then develop on.
Observations from Earth are useful		• Uses of satellite imagery: military (spying), food production, ocean watching, crop development, mapping, mineral finding, pollution watching etc	Discovery of the pulsar – two rotating close proximity starts around a common central axis. 'Spy' style images on internet – resolution is adequate to see cars. Google Earth suitable in some areas.
Observations from Earth are useful		• Use of visible light, electromagnetic radiations such as radio waves and X-rays	Comparing our activity to others in the world. This will be dependent on the relative activity of everyone globally. An excellent opportunity to closely examine our developments in the space race.
Topic revision			