WJEC : GCSE Specification 1210

GCSE Physics

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 : ______________________________________

Page numbers in
New Physics for You
ISBN 07487-8328-8

Science **Physics 1 (P1)**	Page numbers in New Physics for You
Energy, Radiation and the Universe	
1. GENERATION OF ELECTRICITY	
What things influence the types of power stations we build? **Who decides on whether to build wind farms?** **Candidates should:**	
(a) discuss the factors which are involved in the decisions about the types of power stations, including commissioning and decommissioning costs, types of energy sources, fuel costs and environmental factors as well as personal views which are not scientifically based. (w(iv)a,b)	pages 104-106
(b) be aware of the planning processes involved in the development of power stations based upon renewable resources, e.g. wind and wave farms. (w(iv)b)	13-15, 106
2. TRANSMISSION OF ELECTRICITY	
Why do we have pylons and overhead power lines? **Why is power transmitted at high voltage, but used at low voltage?** **Candidates should:**	
(a) understand the need for an electricity distribution system	303
(b) select and use the equation: power = voltage x current	266
(c) describe the National Grid, including the use of ICT for monitoring power use and responding to changing demand. (w(iv)a,b)	303
(d) use physics knowledge to explain why electricity is transmitted at high voltages but used at low voltages in the home. (w(iv)a,b)	303
(e) understand the need for transformers in the transmission of electrical energy from the power station to the home. (w(iv)b)	303

ISBN 07487-8328-8

3. HEATING AND THE HOME	
How much electrical energy do we use in the home? **How much does it cost?** **What sort of heating is most economic to use?** **Is it worth installing alternative energy sources?**	
(a) distinguish between power and energy and select and use the equation: energy transfer = power x time	110, 266
(b) collect information, either directly or using secondary sources on the power ratings of domestic electrical appliances and use it to investigate the cost of using them. (w(i)a)	267
(c) select and use the equations: Units used = power (kW) x time (h) cost = units used x cost per unit	267
(d) use data to compare the cost of different sources of domestic energy, including electricity, gas, oil and coal. (w(i)a,b)	267
(e) use data to explore the cost-effectiveness of introducing domestic solar and wind energy equipment, including fuel-cost savings and payback time. (w(i)a,b;(iv)b)	105-6
4. ENERGY, TEMPERATURE AND THE TRANSFER OF HEAT ENERGY	
How does heat flow from place to place? **How can we help heat flow or keep the heat in?** **Is it worth getting double glazing or insulating the loft?** **Candidates should:**	
(a) explore, experimentally and using secondary sources, using ICT where appropriate, how temperature differences lead to the transfer of thermal energy by conduction, convection and radiation. (w(i)a-c)	42-7
(b) use data from investigations to make comparisons of heat transfer.	
(c) know the factors which affect the rate of heat transfer, including the use of insulators in reducing conduction and the nature of the surface in radiative transfer. (w(i)c)	42-3, 46-7
(d) use their understanding of heat transfer to analyse the processes involved in domestic situations and to suggest how the heat transfer can be promoted or restricted [e.g. by the use of insulation].	42-51
(e) use data to compare the cost-effectiveness of different methods of reducing heat loss from the home, including loft insulation, cavity wall insulation, double-glazing and draught excluders and discuss the ethical issues surrounding controlling heat loss from the home. (w(i)a,b,d;(iv)a,b)	43

5. ENERGY EFFICIENCY	
How much of the energy we use is wasted? **Can we use less energy by doing things in different ways?** **Candidates should:**	
(a) understand qualitatively the idea of energy efficiency in terms of input energy, useful output energy and wasted energy.	102-3
(b) select and use the equation: $\text{efficiency} = \dfrac{\text{useful energy transfer}}{\text{total energy input}} \times 100\%$	102-3
(c) plan and carry out investigations, experimentally or by using secondary sources, into the cost and efficiency of energy transfer in a variety of contexts, e.g. comparing an electric kettle with an electric cooker ring for boiling water.	264, worksheet
6. THE CHARACTERISTICS OF WAVES	
How can I measure waves? **Candidates should:**	
(a) characterise waves in terms of their wavelength, frequency, speed and amplitude.	167
(b) plan and carry out an investigation into waves e.g. investigating the factors which affect the speed of waves on water. (w(i)a)	167-8
(c) apply the equations wave speed = wavelength x frequency and $\text{speed} = \dfrac{\text{distance}}{\text{time}}$ to the motion of waves	167

7. THE ELECTRO-MAGNETIC SPECTRUM	
What sorts of electromagnetic waves are there? **How do we use these waves and how are they dangerous?** **Is it better to use optical fibres or satellites for communication?** **How dangerous are mobile phone masts?**	
Candidates should: (a) distinguish between the different regions of the electromagnetic spectrum [radio waves, microwaves, infra red, visible light, ultra violet, X rays and gamma rays] in terms of their wavelength and frequency (with an awareness of how these wave properties are related) and appreciate that they all travel at the same speed in a vacuum.	208-9
(b) Investigate, using secondary sources (e.g. an internet search), and know the uses of microwaves, infrared and visible radiation in energy transfer, and the hazards associated with the high-energy ionizing radiations, ultra-violet, X-rays and gamma rays.	210-214
(c) investigate experimentally the conditions under which total internal reflection occurs within parallel-sided glass blocks and explain, **in terms of total internal reflection,** how optical fibres enable long distance communication (w(i)c)	187, 189, 192, 314
(d) Compare the use of microwaves and infra-red radiation in long distance communication, including a consideration of geosynchronous satellites, mobile phone technology and intercontinental optical fibre links. (w(iv)a,b)	211, 213, 216-7, 154-5, 314
(e) Investigate and make a report on or take part in a discussion on claimed health risks associated with mobile phone and Tetra communications and understand the planning requirements for the communication masts. (w(iv)a-c)	216-7

8. THE SOLAR SYSTEM	
What objects are in the Solar System and how do they move? **How did the Solar System form?**	
Candidates should: (a) know the theory of the origin of the Solar System in terms of the gravitational collapse of a cloud of gas (largely hydrogen and helium) and dust. (w(iv)c)	152
(b) describe the main features of the Solar System, including the Sun, the rocky and gas planets, moons, asteroids and comets, relating these features to the origin of the Solar System.	150-2
(c) interpret data on the orbits of planets and other bodies in the Solar System.	151, 162
(d) understand the effect of gravity on the orbital motion of planets, comets, moons and artificial satellites **and use a model of radiation pressure to account for cometary tails**. (w(i)c)	152-3
(e) know how new discoveries of solar system objects are made by the use of ICT to detect movement.	(151)

9. STARS	
What are stars made of and how do we know? **Where do the elements come from that make us up?** **How do stars form, get their energy and what will happen to them in the end?** **Candidates should:**	
(a) know that, in the 19th and early 20th centuries, the source of the Sun's energy became a problem as Geologists discovered that the Earth was millions of years old, and the model of the Sun's being powered by Chemical energy could not account for its shining for more than a few thousand years. (w(i)d;(iv)c)	
(b) know that studies of the light from stars, including our Sun, show that they are composed mainly of hydrogen and helium and that their energy is supplied by the fusion of hydrogen into helium, which is able to supply energy at the current rate for about 10 000 million years. (w(i)b,c)	156
(c) appreciate the role of previous generations of stars in the existence of elements heavier than helium in the Solar System and that the fraction of heavier elements in the universe is gradually increasing as a result of the processes in stars. (w(i)c)	156-7
(d) model the stability of stars in terms of the balance between gravitational force and gas/radiation pressure and describe the stages in the evolution of low and high mass stars. (w(i)c)	156-7
10. THE UNIVERSE	
How do we know that the universe is expanding? **How can we find out how old the universe is?** **Candidates should:**	
(a) know how studies of the electromagnetic radiation from distant galaxies lead to a model of an expanding universe **and that the further they are away, the bigger their speed**.	158
(b) know that Red Shift measurements provide evidence that the universe started with a hot Big Bang which, according to current measurements, occurred 12-15 thousand million years ago.	158, 373

Additional Science **Physics 2 (P2)**	**Page numbers in New Physics for You**
Radioactivity, Electricity, Forces and Motion ***Radioactivity***	
1. RADIOACTIVE EMISSIONS	
Where does radiation come from? **How dangerous is it?** **How can I protect myself?** **Candidates should:**	
(a) know that radioactive emissions from unstable atomic nuclei arise **because of an imbalance between the numbers of protons and neutrons.** (w(i)c)	(worksheet)
(b) use secondary sources, e.g. the website of the Health Protection Agency, to investigate the sources of background radiation.	340, 350
(c) be aware of the dangers associated with radon in the home and use secondary sources to investigate the geographical distribution of radon-affected houses, and the measures that can be taken against radon. (w(iv)a)	350
(d) investigate experimentally, or use secondary sources to investigate the penetrating power of nuclear radiation and to determine the types of radiation, α(alpha), β(beta) or γ(gamma) emitted by a radioactive material. (w(i)b)	340-1
(e) know how the different penetrating powers of α, β and γ radiation relate to the dangers of external and internal exposure to radioactive sources. (w(i)c)	346
(f) discuss the health risks associated with exposure to radioactive emissions, discuss the ethics of using radiation-based treatments and describe the precautions needed to protect medical staff and patients from over-exposure to radioactivity. (w(i)d;(iv)a,b)	346, 350, (357)

2. THE HALF LIFE OF RADIOACTIVE MATERIALS	
How long does a radioactive material last? **Candidates should:** (a) investigate experimentally, or using an ICT simulation or secondary sources, the decay of a short-lived radioactive material and determine its half life. (w(i)a) (b) perform simple calculations involving the activity and half life of radioactive materials.	 344, worksheet 344, (352)
3. USES AND DANGERS OF RADIOACTIVITY	
How can we make use of radioactivity and what problems are there? (a) use physics knowledge to respond to information describing contemporary uses of radioactive materials, relating to the half life, penetrating power and biological effects of the radiation e.g. *radioactive tracers, carbon dating, thickness monitoring and cancer treatment.* (w(i)d) (b) discuss the scientific and ethical problems associated with the long-term disposal of radioactive waste materials and appreciate the problems posed by the uncertainties in the behaviour of these materials and their containers over thousands of year. (w(i)d;(iv)b,c)	 346-7, 352, (357) 350, worksheet
Electricity	
4. SIMPLE ELECTRICAL CIRCUITS	
How can we make control electricity and make measurements? **Candidates should:** (a) use voltmeters and ammeters to measure the voltage across and current through electrical components. (w(i)a) (b) understand qualitatively, the relationship between current, voltage and resistance. (c) select and use the equation: $\text{resistance} = \frac{\text{voltage}}{\text{current}}$ (d) use a circuit, which includes a variable resistor, to investigate how current changes with voltage for a resistor (or wire) at constant temperature, a filament lamp and a diode. (w(i)a)	 250, 252 253 253 255, 259

5. SAFETY FEATURES USED IN MAINS CIRCUITS	
How do we protect ourselves from the dangers of electricity? **Candidates should:**	
(a) understand the roles of the live, neutral and earth leads and insulation in domestic electrical circuits.	268
(b) know how the earth lead and fuse operate to protect consumers against fire and electrical shocks. (w(iv)a)	269
(c) select and use the equation: $\text{current} = \frac{\text{power of appliance}}{\text{voltage}}$ to calculate the current taken by the appliance in normal use and hence the correct fuse required to protect the cable to the appliance.	270
(d) explain the roles of miniature circuit breakers (m.c.b.) and residual current devices (r.c.d.) and compare their actions to those of fuses. (w(iv)b)	269, 272
(e) discuss how ideas of risk and cost play a part in deciding what voltage domestic electricity supplies should use and appreciate that different countries have adopted different voltages. (w(i)d;(iv)b)	(303)
Forces and Motion	
6. DISTANCE, SPEED AND ACCELERATION	
How can we measure and display motion? **Candidates should:**	
(a) describe motion using speed, acceleration, speed-time and distance-time graphs.	122-6
(b) select and use the equations: $\text{speed} = \frac{\text{distance}}{\text{time}}$ and $\text{acceleration [or deceleration]} = \frac{\text{change in speed}}{\text{time}}$ in the context of the motion of objects.	122, 126 122, 125

7. THE EFFECT OF FORCES	
How do forces affect the movement of objects? **Why do things reach a steady speed?**	
Candidates should: (a) investigate experimentally, e.g. using an air track and data logger, or computer simulation, the effect of balanced and unbalanced forces on an object. (w(i)a,b)	(87)
(b) select and use the equation: resultant force = mass x acceleration	130-1
(c) distinguish between the weight and mass of an object **and use the approximation that the weight of an object of mass 1 kg is 10 N.**	67, 131
(d) use knowledge of forces and their effects to explain the behaviour of objects moving through the air, including the concept of terminal speed. (w(i)c)	89, 128

8. INTERACTIONS BETWEEN OBJECTS	
Where do forces come from? **How do objects gain or lose energy?** **How do we keep ourselves safe in and around cars?**	
Candidates should: (a) appreciate that forces arise between objects and that the forces on the two objects are equal and opposite	82, 84-5
(b) know that when a force acts on a moving body, energy is transferred although the total amount of energy remains constant.	
(c) select and use the equation: work = Force x distance to calculate work / energy transfer, force or distance.	97
(d) **select and use the equations:** **kinetic energy** $= \frac{\textbf{mass x speed}^2}{\textbf{2}}$ **and**	109
change in potential energy = mass x gravitational field strength x change in height	108
(f) apply the principles of forces and motion to the safe stopping of vehicles, including knowledge of the terms reaction time, thinking distance, braking distance and overall stopping distance and discuss the factors which effect these distances. (w(i)c;(iv)a)	83
(g) apply the principles of forces and motion to an analysis of safety features of modern cars: air bags and crumple zones. (w(i)c;(iv)a)	69, 139
(h) discuss the reasons for introducing speed restrictions and speed cameras to promote road safety. (w(i)d;(iv)b)	

Separate Sciences **Physics 3 (P3)**	**Page numbers in New Physics for You**
Electromagnetic Induction, Waves, Motion & Nuclear Physics ***Electromagnetic Induction***	
1. ELECTROMAGNETIC INDUCTION AND GENERATORS	
How is electricity generated? **Candidates should:**	
(a) investigate the conditions in which a current is induced in circuits by changes in magnetic fields and the position of wires. (w(i)a-c)	296-7
(b) consider the benefits of a pictorial model of electromagnetic induction in terms of cutting or changing flux. (w(i)b)	(296)
(c) use knowledge of electromagnetic induction to explain the operation of a simple a.c. electric generator including the factors upon which its output depends.	298, 300
(d) apply Fleming's Right Hand Rule to the situation where a coil rotates in a magnetic field. (w(i)c)	296
(e) understand how the use of a radial field, multiple coils and electromagnets improves the effectiveness of modern generators. (w(iv)a)	(300)
2. TRANSFORMERS	
How can we increase or decrease the voltage? **Candidates should:**	
(a) investigate model transformers experimentally, e.g. using linked C-cores or demountable transformers, know qualitatively how the output voltage depends upon the number of turns on the coils and explain their operation qualitatively by reference to electromagnetic induction.	301-3
(b) **select and use the equation:** $\frac{V_1}{V_2} = \frac{N_1}{N_2}$ **in the context of 100% efficient step-up and step-down transformers.**	302

Waves	
3. REFRACTION OF PLANE WAVES	
Why does refraction occur? **Candidates should:** (a) distinguish between transverse and longitudinal waves.	166
(b) explain refraction in terms of the speed of waves on either side of a refracting boundary. (w(i)c)	168, 184-5
(c) draw and interpret diagrams of plane waves being reflected or refracted at plane boundaries, *e.g. as shown in the ripple tank*. (w(i)b)	168
4. ULTRASONIC WAVES	
How do ultra scans work? **What can ultrasound be used for?** **Candidates should:** (a) understand the nature of ultrasonic waves.	225-6
(b) understand the conditions under which the reflection of ultrasonic waves occurs, the wavelength requirements for a useful image and the consequence for the useful frequencies for ultrasonic waves.	228-9
(c) **select and use the equation:** **wave speed = frequency x wavelength** **in the context of ultrasonic waves**	(167), 225
(d) use physics knowledge to respond to information describing contemporary uses of ultrasound including cleaning, medical and industrial scanning, *e.g. fault finding in castings*. (w(iv)a)	228-9
5. SEISMIC WAVES	
What are seismic waves? **How can scientists use them to probe the structure of the Earth?** **Candidates should:** (a) understand the properties of seismic P-waves, S-waves and surface waves, in terms of their nature, speed and ability to penetrate different materials.	146-7
(b) **select and use the equation:** **speed = distance / time** **in the context of seismic waves.**	122, 147
(c) interpret the information on simplified seismic records, including the lag time and the presence or not of S-waves to reveal information about the location of an earthquake. (w(i)b)	147
(d) know how the study of seismic records, including the identification of an S-wave shadow zone, has enabled geo-physicists to investigate the structure of the earth, leading to a model of a solid mantle and a liquid core. (w(i)c)	147

Motion	
6. MOTION	
How can I find out the speed and position of objects which are accelerating? **What happens when objects collide?** **How do things change direction?** **Candidates should:** (a) develop their understanding of motion to include an appreciation of the importance of direction and to distinguish between speed and velocity.	122, 126
(b) develop their ability to use velocity-time and distance-time graphs in order to determine acceleration, mean velocity and distance travelled.	124-6
(c) appreciate that the motion of objects can be modelled using the equations $v = u + at$ $\mathbf{v^2 = u^2 + 2ax}$ $\mathbf{x = ut + \frac{1}{2} at^2}$ $x = \frac{1}{2}(u + v)t$ understand the condition under which these equations are valid and select and use these equations to solve problems. (w(i)c)	127
(d) explore experimentally, or using IT simulations, the collisions of objects under conditions in which externally applied forces are negligible, to develop an appreciation of the significance of the momentum of a body. (w(i)a-c)	136
(e) select and use the equation: momentum = mass x velocity	136
(f) understand qualitatively that change in momentum is related to the force and the time for which it acts and apply this in a given situation, *e.g. crumple zones, air bags*. (w(iv)a)	136, 138
(g) **use the law of conservation of momentum to perform calculations involving collisions or explosions, including selecting and use the equation.** (w(i)b) **kinetic energy** $= \mathbf{\dfrac{mv^2}{2}}$ **to compare the kinetic energy before and after a collision.**	137-8
(h) **know that change in momentum is related to the force and time according to the equation** **Force = $\dfrac{\text{change in momentum}}{\text{time}}$** **select and use the equation to calculate Force, change in momentum or time.**	136
(i) **know that changes in the direction of motion require a force to be applied and that, in the case of motion in a circle at a constant speed, the resultant force acts towards the centre of the circle.**	70-1
(j) **understand how space scientists use the concepts of conservation of energy and momentum in working out energy-saving sling-shot orbits in the exploration of the Solar System.**	

Nuclear Physics	
7. ATOMIC STRUCTURE	
How did scientists work out what atoms are like? **What happens to an atom when it decays?How can we use the decay of uranium to help us date rocks?** **Candidates should:**	
(a) know that Thomson developed the plum pudding model of the atom in an attempt to explain its properties, that the results of the α-particle scattering experiment were incompatible with this model and this led Rutherford to propose the nuclear model.	342, 372
(b) **appreciate qualitatively how the nuclear model was further developed by Bohr to explain atomic spectra.** (w(i)b,c)	(372)
(c) understand the terms *mass [or nucleon] number(A), atomic [or proton] number(Z)*and *isotope* and relate them to the number of protons, neutrons and electrons in a neutral atom.	342-3
(d) use nuclear symbols of the form $^{A}_{Z}X$ in the context of transformations including radioactive decay, nuclear fission and nuclear fusion, **and use them in producing nuclear equations from data and balancing them.**	343, 345
(e) recall and use the symbols $^{4}_{2}\alpha$, $^{4}_{2}He$, $^{0}_{-1}\beta$, $^{0}_{-1}e$ for alpha and beta particles.	345
(f) **use tables of isotopes to investigate nuclear decay series and appreciate the significance of these to investigations into the age of rocks and the age of the Earth and Solar System.** (w(i)c,d;(iv)c)	(352)
8. NUCLEAR FISSION	
How does nuclear fission work? **How can we control fission in nuclear reactors?** **Candidates should:**	
(a) know that processes which result in the splitting of heavy nuclei into lighter fragments (nuclear fission) release energy.	348
(b) recall that $^{235}_{92}U$ and $^{239}_{94}Pu$ undergo spontaneous fission with the emission of neutrons and that they also undergo induced fission when hit by neutrons.	348
(c) know how the induced fission of $^{235}_{92}U$ and $^{239}_{94}Pu$ can lead to an uncontrolled chain reaction releasing very large amounts of energy in a nuclear explosion and know how this is controlled in nuclear reactors. (w(iv)a)	348-9
(d) know that both controlled and uncontrolled fission reactions result in large quantities of unstable neutron-rich fission products, with a wide range of half lives. (w(iv)a)	

9. NUCLEAR FUSION	
How do stars obtain their energy? **Could we use the same process to provide energy on the Earth?** **Candidates should:** (a) understand that processes which combine light nuclei, such as hydrogen and helium, into heavier nuclei (nuclear fusion) release energy. (b) be able to provide a simple description of nuclear fusion in terms of combining hydrogen nuclei to produce helium nuclei under conditions of very high temperature and pressure such as those found in the Sun. (c) know why it has been difficult to replicate this under controlled conditions on the Earth, but that there is a very large potential fuel supply in the form of deuterium $\left({}^{2}_{1}H\right)$ in the oceans. (w(i)d) (d) recognise and discuss the following fusion reaction as a potential source of energy: $${}^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n$$ (w(iv)d)	 156 156