SPECIFICATIONS FOR GCSE

GCSE

General Certificate

of

Secondary Education

SCIENCE (Physics)

Specification

200

2003

WJEC

CBAC

WELSH JOINT EDUCATION COMMITTEE

5 SPECIFICATION CONTENT

Subject content written in bold type will only be examined in the Higher tier paper.

The subject extension material is included in a box to distinguish it from the National Curriculum core material.

The Nature of Science

The Nature of Science strand of Scientific Enquiry will be developed through the context of Physical Processes (Sc4).

Where opportunities occur within the specification for the development of the Nature of Science, the specification contents has been highlighted using the following icon.

These icons will identify statements within the specification where it would be possible to assess candidates on:

Applying their knowledge, understanding and skills to solve problems, ask questions and offer explanations relating scientific ideas to the information about them;

- Evaluating a range of sources of information critically in arriving at conclusions;
- Recognising that scientific controversies arise from different interpretations and emphases placed on information;
- Considering the ways in which scientific ideas are affected by social, political and historical contexts in which they develop, and how these contexts may affect whether or not the ideas are accepted.

1. ELECTRICITY AND MAGNETISM

Topic	Candidates should:	pages in Physics for You
EM1. Circuits		Chapter 31
How to make simple measurements of voltage.	• Know that the voltage across a component is measured in volts (V) using a voltmeter connected in parallel with the component;	page 258
The quantitative relationship between resistance, voltage and current.	• Recall and use the equation: $\text{Resistance (ohms)} = \frac{\text{voltage (volts)}}{\text{current (amps)}}$ to calculate resistance, voltage or current;	p. 259-261, worksheet
The qualitative effect of changing resistance on the current in a circuit.	• State that an increase in resistance produces a decrease in current.	p. 259-261
	• Know that the longer the wire the greater the resistance, the thinner the wire the greater the resistance;	p. 260
How current varies with voltage in a range of devices, including resistors, filament bulbs, diodes.	• Describe how the current varies with voltage for a resistor at constant temperature, a filament lamp and a diode;	p. 265, 322, worksheet
	• Deduce a value of resistance from a graph of voltage against current;	p. 265, 391
The variation of resistance with ambient conditions for light-dependent resistors (LDRs) and thermistors.	• State that the resistance of a LDR decreases with increasing light intensity;	p. 325
	• State that the resistance of a thermistor decreases with increasing temperature;	p. 325
That resistors are heated when charge flows through them.	• Know that energy is transferred from batteries and other sources to other components in electrical circuits;	p. 266
	• State that a current is a flow of charge which is measured in amperes (A) by using an ammeter;	p. 256
	• Know that for a given current, the greater the resistance the greater the heat produced.	p. 270-2

Topic	Candidates should:	pages in Physics for You
About series and parallel circuits.	• Know that the current in a series circuit is the same everywhere in the circuit and the sum of the currents in the branches of a parallel circuit is equal to the current entering or leaving the parallel section;	pages 254-7
	• Know that in a series circuit the sum of the voltages across the components is equal to the supply voltage;	p. 262
	• Know that components in parallel have the same voltages across them;	p. 263
	• Calculate the resistance of combinations of resistors (series, parallel and mixed);	p. 262-3, 267 worksheet
	• Perform simple calculations based on the application of $V = I \times R$ to entire circuits involving combinations of resistors, neglecting internal resistance of cells;	p. 259, 262-3, 267
The quantitative relationship between power, voltage and current.	• Recall and use the equation: Electrical power (watts) = voltage (volts) x current (amps) to calculate power, voltage or current;	p. 272, worksheet

Topic	Candidates should:	pages in Physics for You
EM2. Mains electricity		Chapter 32
The difference between steady direct current (d.c.) and alternating current (a.c.).	• Explain the terms direct current (d.c.) and alternating current (a.c.);	p. 254, 274
The functions of the live, neutral and earth wires in the domestic mains supply, and the use of insulation, earthing, fuses and circuit breakers to protect users of electrical equipment.	• Know the colour code of a three core cable;	p. 275 worksheet
	• Know the correct wiring of a three pin plug;	p. 275
	• Understand that live and neutral wires complete the circuit for the appliance;	p. 274-5
	• Explain the need for the use of insulation material around each wire;	p. 275
	• State the purpose and function of the earth wire;	p. 275
	• Understand that some appliances are not earthed but are double insulated.	p. 275
	• Explain the purpose and action of a fuse and state why it is located in the live wire;	p. 274-5
	• Understand that circuit breakers have been developed to provide quicker-acting, more reliable and reusable electrical safety devices;	p. 312 (270, 301, 345)
	• State that a miniature circuit breaker performs the same function as a fuse but has the advantage that it can be reset;	p. 312
	• State that earth leakage circuit breakers provide protection by disconnecting the live supply when it detects a difference between the live and neutral currents;	p. 345 worksheet
That electrical heating is used in a variety of ways in domestic contexts.	• Identify a number of domestic appliances in which electrical heating is utilised.	p. 270-1, 40

Topic	Candidates should:	pages in Physics for You
How measurements of energy transferred are used to calculate the costs of using common domestic appliances.	• Understand that the amount of electrical energy an appliance uses depends on (i) the time for which the appliance is used, (ii) the rate at which the appliance transfers energy (its power);	p. 272-3
	• Know that the power of an appliance is measured in watts (W) or kilowatts (kW) (1 kW = 1000 W);	p. 272-3
	• Use the following equations to calculate the cost of electricity. Number of units used (kWh) = power (kW) x time (h) cost = number of units x cost per time; *When needed, the equations will be provided for candidates.*	p. 273 worksheet

Topic	Candidates should:	pages in Physics for You
EM3. Electric charge		Chapter 30
The dangers and uses of electrostatic charges generated in everyday and industrial situations.	• Know that electrons are transferred when certain materials are rubbed, one against another, leaving one material negatively charged and the other positively charged;	p. 247-8
	• Know that materials which have a negative charge have an excess of electrons and materials which have a positive charge have a deficiency of electrons;	p. 248
	• Know that unlike charges attract each other and like charges repel each other;	p. 247
	• Explain how charged objects attract uncharged objects by electrostatic induction;	p. 248
	• Understand why ideas of electrostatic charge have been developed for use in everyday life and describe one example – precipitation, paint spraying, xerography etc;	p. 252, 321 worksheet
	• Describe a situation in which electrostatic charges are dangerous and explain how precautions can be taken to ensure that electrostatic charge is discharged safely;	p. 252
The quantitative relationship between steady current, charge and time.	• Recall and use the equation: Charge Q = current I x time t (coulombs) (amps) (s) to calculate charge, current or time;	p. 266 worksheet
About electric current as the flow of free electrons in metals or of ions during electrolysis.	• ★ Show the direction of conventional current in a circuit and understand that this convention arose because it was originally thought that current was a flow of positive charges;	p. 255
	• Know that the current through a metal is a flow of free electrons;	p. 251, 255, 266
	• Know that the current flow in an electrolyte is a flow of positive ions to the negative terminal and negative ions to the positive terminal;	p. 277-8

Topic	Candidates should:	pages in Physics for You
EM4. Electromagnetic forces		Chapter 35
That a force is exerted on a current-carrying wire in a magnetic field and the application of this effect in simple electric motors.	• Know that a current flowing through a wire or coil produces a magnetic field;	p. 292-3
	• Describe the effect of an external magnetic field on a current-carrying wire or coil;	p. 296
	• State the factors that affect the size of the force exerted on a current-carrying wire placed in a magnetic field;	p. 296
	• State Fleming's Left Hand Rule and apply it in the case of a simple electric motor;	p. 296-9

Topic	Candidates should:	pages in Physics for You
EM5. Electromagnetic induction		Chapter 36
That a voltage is induced when a conductor cuts magnetic field lines and when the magnetic field through a coil changes.	• Know that a voltage is induced by changes in the magnetic field through a coil, or by cutting field lines and that this voltage drives a current in a complete circuit;	p. 302-3
	• State the factors which influence the magnitude of the induced voltage;	p. 302-3
	• Apply Fleming's Right Hand Rule in situations where the conductor, field and motion are mutually perpendicular;	p. 302
How simple a.c. generators and transformers work.	• Explain how an a.c. generator produces an alternating voltage, relating the coil position to the instantaneous voltage;	p. 304-6
	• Explain how a transformer works;	p. 307-9
	• Explain why a transformer will only work with a.c.;	p. 307-9
	• Understand that over time, the designs of the a.c. generator and transformer have changed to make them more effective e.g. multiple coils and radial field in the generator, and laminated core in the transformer to reduce energy loss;	p. 306, 308
The quantitative relationship between the voltage across the coils in a transformer and the numbers of turns in them.	• **Recall and use the equation:** $\frac{\text{Voltage across secondary}}{\text{voltage across primary}} = \frac{\text{number of turns in secondary}}{\text{number of turns in primary}}$ **for step up and step down transformers;**	p. 308 worksheet
	• **Perform calculations based $I_1 V_1 = I_2 V_2$ for a transformer of 100% efficiency;**	p. 308

Topic	Candidates should:	pages in Physics for You
How electricity is generated and transmitted.	• Describe the production of electrical energy at a power station, together with the energy changes involved;	p. 113-5 worksheet
	• Have an awareness of the financial and environmental costs of using various energy sources to generate electricity and an understanding of how social concerns have influenced the way in which electrical energy production is managed e.g. oil/coal versus nuclear fuel;	p. 114-5 worksheet
	• Give a brief description of the National Grid and know why it is more cost effective to transmit energy at high voltages;	p. 309
	• Account for the use of transformers in the National Grid;	p. 309
	• Have an understanding of the economic and environmental factors that have to be considered in transmitting electrical energy across the country (e.g. pylons versus underground cables).	p. 114-5

Topic	Candidates should:	pages in Physics for You
EM6. Electronic systems		Chapter 38
How switches, relays, variable resistors, sensors and logic gates can be used to solve simple problems.	• Know that all electronic systems have input sensors which detect changes in the environment; a processor which decides what action is needed; an output device which is controlled by the processor;	p. 327
	• Know that input sensors include: thermistors which detect changes in temperature; LDRs which detect changes in light; switches which respond to pressure, tilt or magnetic fields;	p. 325-6
	• Know that output devices include: lamps and LEDs which produce light; buzzers which produce sound; motors which produce movement, heaters which produce heat;	p. 324
	• Know that a relay can be used as a switch. A small current in the relay can switch on a circuit in which a larger current flows;	p. 326-7
	• Know that processors can be made using logic gates;	p. 336
	• Recognise and recall the symbols for AND, OR and NOT gates;	p. 336-7
	• Recognise and recall the truth tables for AND, OR and NOT gates;	p. 336-7
	• Interpret block and circuit diagrams;	p. 338-9 (328-331)
	• **Design and draw logic gate circuits from given information (limited to three logic gates).**	p. 338

2. FORCES AND MOTION

Topic	Candidates should:	pages in Physics for You
FM1. Force and acceleration		Chapter 18
How distance, time and speed can be determined and represented graphically.	• Recall and use the equation: Speed (m/s) = distance (m) / time taken (s) to calculate speed, distance or time;	page 130
	• Construct a distance-time graph, speed-time graph from given data;	p. 131-4
	• Recognise a state of rest, constant speed, increasing speed, decreasing speed from distance-time and speed-time graphs;	p. 132-4 worksheet
	• Determine a speed from a linear portion of a distance-time graph;	p. 134
	• Determine average speed from a distance-time and a speed-time graph;	p. 134, 132
About factors affecting vehicle stopping distances.	• Describe the effect on stopping distance of each of the following: condition of the vehicle, condition of the road, condition of the driver;	p. 98
The difference between speed and velocity.	• Define speed as the distance travelled in unit time;	p. 130
	• Define velocity as the change of distance in unit time in a specific direction;	p. 130
	• **Distinguish between distance and displacement.**	p. 134
About acceleration as change in velocity per unit time.	• Define acceleration as the change of velocity in unit time; Recall and use the equation: Acceleration (m/s^2) = change in velocity (m/s) / time taken (s) to calculate acceleration, change in velocity, time taken;	p. 130 worksheet
	• Determine the gradient of a velocity-time graph and interpret this as acceleration;	p. 132-3 worksheet
	• Calculate the area under a velocity-time graph and determine the distance travelled;	p. 132-3
	• **Use the following equations of motion to solve problems:** $\mathbf{v = u + a\,t}$ $\mathbf{v^2 = u^2 + 2\,a\,s}$ $\mathbf{s = u\,t + \frac{1}{2}\,a\,t^2}$ $\mathbf{s = \frac{1}{2}\,(u + v)\,t;}$ *When needed, these equations will be provided for candidates with the symbols defined.*	p. 135

Topic	Candidates should:	pages in Physics for You
That balanced forces do not alter the velocity of a moving object.	• Explain that under the effect of balanced forces acting on an object it will remain stationary or, if it is already moving it will continue to move at that speed in the same direction;	p. 77, 138
The quantitative relationship between force, mass and acceleration.	• **Calculate the resultant of two or more forces in a straight line;**	p. 96
	• **Recall and use the equation:** **Resultant force (N) = mass (kg) x acceleration (m/s^2)** **to calculate resultant force, mass or acceleration;**	p. 138-9 worksheets
	• **Recall and use the equation** **Weight = mass (kg) x gravitational field strength (N/kg)** **to calculate weight or mass**	p. 139, 75
That when two bodies interact, the forces they exert on each other are equal and opposite.	• State that the force exerted by a body A upon a body B is equal in magnitude, opposite in direction and in the same straight line as the force exerted by B upon A;	p. 94-5
	• Apply an understanding of physical principles involved in the study of action and reaction to situations such as: rocket propulsion, gun recoil etc;	p. 95, 66, 146
That when two bodies interact momentum is conserved.	• Use the equation Momentum = mass x velocity (kg m/s) (kg) (m/s) to calculate momentum, mass or velocity; *When needed, the equation will be provided for candidates.*	p. 144
	• **Use the law of conservation of momentum to perform calculations involving collisions or explosions;**	p. 145-6

Topic	Candidates should:	pages in Physics for You
FM2. Force and non-uniform motion		
The forces acting on familiar moving objects, *e.g. cars, falling objects.*	• Explain how unbalanced forces affect the motion of an object;	p. 99, 136
	• Know that an object moving through the air experiences a resistive force which increases with the speed of the object;	p. 99 worksheet
	• Know that all falling bodies have the same uniform acceleration, *g*, in the absence of a resistive force;	p. 136-7
Why moving objects may reach a terminal velocity.	• Know that an object falls to the ground because the force of gravity acts on it and when the resistive force becomes equal to the gravity force there is no further increase in speed;	p. 99, 136
	• Know that for objects moving horizontally, when the resistive force becomes equal to the thrust/driving force, there is no further increase in speed;	(p. 99)

Topic	Candidates should:	pages in Physics for You
FM3. Force and rotation		Chapter 15
The quantitative relationship between the turning moment, the magnitude of the force and its distance from the pivot.	• Know that the moment of a force depends on the size of the force and its perpendicular distance from the pivot;	p. 100
	• Recall and use the equation: Moment (Nm) = Force (N) x perpendicular distance from pivot (m); to calculate moment, force or perpendicular distance from the pivot;	p. 100
The principle of moments and its application to situations involving one pivot.	• Know that if an object is not turning, the moments acting in an anticlockwise direction are balanced by moments acting in a clockwise direction;	p. 101 worksheet
	• Use the principle of moments in familiar situations;	p. 101

FM4. Force and pressure on materials		Chapters 11, 6
How extension varies with applied force for familiar materials, *e.g. steel springs, rubber bands.*	• Be able to plot, explain and interpret line graphs showing how extension varies with applied force;	p. 74, 379-380 worksheet
	• State Hooke's law;	p. 74
	• Perform simple ratio and graphical calculations using Hooke's law;	p. 74, (380, 390-1)
The quantitative relationship between the volume of a fixed mass of gas at constant temperature and its pressure.	• **State that when the pressure on a gas increases and its temperature stays the same, its volume decreases;**	p. 31
	• **State that the volume of a fixed mass of gas is inversely proportional to its pressure;**	p. 31
	• **Use the equation:** $P_1 V_1 = P_2 V_2$ **to find the final conditions of a fixed mass of gas when either a change of pressure or a change in volume occurs;** *When needed, the equation will be provided for candidates.*	p. 31, 35 worksheet

3. WAVES

Topic	Candidates should:	pages in Physics for You
W1. Characteristics of waves		Chapter 21
That waves can be reflected, refracted and diffracted.	• Describe the behaviour of waves in relation to the: (i) reflection of plane wavefronts at a plane surface, (ii) refraction of plane wavefronts at a plane boundary, (iii) diffraction of plane wavefronts passing through a narrow gap;	pages 176-7 worksheets
That waves can produce interference effects.	• **Explain the terms constructive and destructive interference;** • **State the conditions under which constructive and destructive interference occur;** • **Sketch diagrams to show interference of waves from two sources (accurate diagrams will not be required);**	worksheet
That waves transfer energy without transferring matter.	• Know that energy is transferred by vibrations without any transfer of matter;	p. 174
About longitudinal and transverse waves in ropes, springs and water.	• Know that waves are caused by vibrations;	p. 174, (228-9)
	• Know that the vibrations are parallel to the wave direction in longitudinal waves;	p. 174
	• Know that the vibrations are at right angle to the wave direction in transverse waves;	p. 174
The meaning of frequency, wavelength and amplitude of a wave.	• Define the terms amplitude, wavelength and frequency of a wave;	p. 175 (234)
	• Use a graphical representation of a wave to mark or deduce amplitude and wavelength;	p. 175 (234)
The quantitative relationship between the speed, frequency and wavelength of a wave.	• Recall and use the equation: Wave speed (m/s) = frequency (Hz) x wavelength (m) to calculate the wave speed, frequency or wavelength;	p. 175 (229)

Topic	Candidates should:	pages in Physics for You
W2. The electromagnetic spectrum		Chapter 28
That all electromagnetic waves travel at the same speed in free space.	• Know that the electromagnetic spectrum includes radio waves, microwaves, infra-red, visible light, ultra violet, X-rays and gamma rays which all travel at the same speed in a vacuum;	p. 217-221 worksheets
That the energy associated with an electromagnetic wave and thus its potential danger, varies with its frequency.	• Know their relative positions in terms of frequency; • Recall that the higher the frequency the more dangerous the electromagnetic wave;	p. 218-9
The benefits and potential dangers associated with the use of X-rays and gamma rays in medicine.	• Describe a medical use of X-rays and gamma rays; • Describe the precautions needed to protect medical staff and patients from over exposure to X-rays and gamma rays and explain why these precautions are necessary;	p. 220, 356
That electromagnetic waves can be used to carry large amounts of information.	• ★ Understand that the capacity and reliability of the communication network have been enhanced by developments in digital and optical fibre technology;	p. 320, 370, 332
	• Describe how radio waves, microwaves, infra-red and visible light may be used in communication;	p. 219, 221, 227, 320, 335
	• Know the difference between analogue and digital signals;	p. 312, 332 worksheet
	• Know that more information can be carried using a digital signal;	p. 332-3
That radio waves can carry information over long distances, and how satellites aid global communication.	• Know what is meant by a geostationary orbit; • Explain the need for satellites in geostationary orbits to aid global communication.	p. 168-9, 221, (162) worksheet
The principles involved in the transmission of waves along optical fibres.	• Know that when light reflects from a surface the angle of reflection equals the angle of incidence;	p. 184-6 worksheet
	• Know that when light passes into an optically denser medium, it refracts towards the normal;	p. 192-3
	• Know that when light passes into a less optically dense medium, it refracts away from the normal;	p. 192-3
	• Understand the term critical angle;	p. 195
	• Understand the term total internal reflection and the conditions under which it occurs;	p. 195 worksheet
	• Describe how an optical fibre transmits information.	p. 197, 200, (320, 332)

Topic	Candidates should:	pages in Physics for You
W3. Seismic waves		Chapter 20
That longitudinal and transverse waves are transmitted through the Earth, producing wave records that provide evidence for the Earth's layered structure.	• **Know that earthquakes generate two types of vibration;**	p. 154 worksheet
	• **Know that primary (P) waves are longitudinal and pass through liquids and solids;**	p. 154
	• **Know that secondary (S) waves are transverse and pass through solids but not liquids;**	p. 154
	• **Know that primary waves travel faster than secondary waves;**	p. 154
	• **Know that the time lag between the arrival of these waves provides information about the distance they have travelled;**	p. 155
	• **Know that seismic records provide evidence for the layered structure of the Earth.**	p. 155 worksheet

Topic	Candidates should:	pages in Physics for You
W4. Colour		Chapter 28
About the primary and secondary colours of light	• Know that the primary colours of light are red, blue and green**;**	p. 224
	• Know that the secondary colours of light are yellow, magenta and cyan;	p. 224
	• Understand the difference between primary and secondary colours;	p. 224
	• Know that to get coloured light, white light can be passed through a coloured filter;	p. 222-3
	• Predict the effects of mixing together the primary colours of light;	p. 224
	• Know that surfaces look coloured because they reflect some of the colours of the spectrum and absorb others;	p. 222-3
	• Know that coloured filters allow some of the colours of the spectrum to pass through and absorb others;	p. 222-3
	• Know that white surfaces are good reflectors of all colours of light and that black surfaces are good absorbers of all colours of light;	p. 187, 222-3
	• Predict the colour of light passing through a pair of coloured filters (the filters may be primary or secondary coloured);	p. 222-3
	• Predict the appearance of coloured objects in coloured lights.	p. 222-3

4. THE EARTH AND BEYOND

Topic	Candidates should:	pages in Physics for You
EB1. The solar system and the wider universe		Chapter 20
The relative positions of the Earth, Moon, Sun planets and other bodies in the Universe.	• ★ Understand that over time, the model of the 'solar' system changed from being Earth-centred to Sun-centred;	p. 369, 372 worksheet
	• State that the Sun is the centre of our solar system;	p. 158, 160-1
	• State that all of the planets orbit the Sun in the same sense of rotation;	p. 160-1
	• State the order of planets in the solar system;	p. 160-1
	• State that the Moon is our natural satellite and is our closest heavenly body;	p. 159
	• State that the Sun is just one of many millions of stars in our galaxy – the Milky Way, and that our galaxy is only one of a billion galaxies which comprise the Universe;	p. 165-6
That gravitational forces determine the movements of bodies in the Universe and play a part in the evolution of stars.	• ★ State that the Earth, Sun, Moon, and all other bodies attract each other with a force called gravity and that this force pulls on the mass of each of them;	p. 158, 159, 160, 162
	• State that the greater the distance between the bodies, the smaller the force of gravity between them;	p. 162
	• Know that a small body will stay in orbit around a more massive (larger) one because of the combination of its high speed and the force of gravity between the two bodies;	p. 162, 168
	• ★ Know that most bodies, especially the majority of planets, orbit the Sun in nearly circular orbits, but comets have extremely elliptical orbits and pass well outside our solar system;	p. 163
	• State that stars, including our Sun, form when dust and gas from space is pulled together by gravitational attraction and that their life time is finite;	p. 163

Topic	Candidates should:	pages in Physics for You
How stars evolve over a long time-scale.	• State that stars are very massive so that the force of gravity drawing together the matter from which they are made is very strong. The very high temperatures in stars create forces acting in the opposite direction. During the stable period of the life of a star, these forces are balanced. The Sun is at this stage in its life;	p. 164
	• State that, thereafter, the star then expands to become a red giant. At a larger in its history it contracts under its own gravity to become a white dwarf. The matter from which the star is made may then be millions of times denser than any matter on Earth. If the star is massive enough, it may then explode throwing dust and gas into space. A very dense neutron star or black hole could remain;	p. 165
About some ideas used to explain the evolution of the Universe into its present state.	• ★ Know that light from other galaxies is shifted to the red end of the visible spectrum;	p. 166
	• ★ Understand that a 'red shift' is produced by receding galaxies;	p. 166
	• ★ Know that the faster a galaxy is moving, the greater is the shift towards the red end of the spectrum;	p. 166
	• ★ Understand that these ideas support a model of an expanding universe which originated approximately 12 billion years ago with the 'BIG BANG'	p. 166 worksheets

5. ENERGY RESOURCES AND ENERGY TRANSFER

Topic	Candidates should:	pages in Physics for You
ERT1. Energy transfer		Chapter 7, 8
That differences in temperature can lead to transfer of energy.	• Explain how temperature is related to the energy of the particles making up the body;	page 28
	• **Know that the energy needed to raise the temperature of 1kg of a substance by 1°C is called the specific heat capacity of the substance (standard unit J/kg °C);**	p. 39
	• Explain how temperature differences lead to a transfer of energy;	p. 42
	• **Know that the energy transferred to, or from, a substance when its temperature changes can be calculated using the formula:** **Energy transferred (J) = mass (kg) x specific heat capacity (J/kg °C) x change in temperature (°C)** **to calculate energy transferred, mass, specific heat capacity or temperature change;** *When needed, the equation will be provided for candidates*	p. 39-40 worksheet
How energy is transferred by the movement of particles in conduction, and convection.	• Describe, in terms of particle vibration, how energy is transferred by the process of conduction;	p. 43
	• Give examples of good and bad conductors;	p. 43-5
	• Know that energy is transferred in liquids and gases by the process of convection;	p. 42, 46-7
	• Describe convection currents in terms of movement of the medium,	p. 46-7

Topic	Candidates should:	pages in Physics for You
That energy is transferred by electromagnetic radiation.	• Know that energy transfer by thermal radiation is in the form of an electromagnetic wave which transfers energy by vibrations without transfer of matter and can therefore travel through a vacuum;	p. 42, 48-51
	• Know that the dark surfaces are the best absorbers and emitters of radiation;	p. 48-9 worksheet
	• Know that shiny, silvered surfaces are the best reflectors of radiation;	p. 48-9
	• Know that the hotter the object the more energy is radiated;	p. 48-9
The meaning of energy efficiency and the need for economical use of energy resources.	• Understand the idea of energy efficiency in terms of input, useful output energy, and wasted energy;	p. 112-3, 122 worksheet
	• ★ Understand that because of decreasing reserves of fossil fuels, there is a need to become more efficient and economical in their use;	p. 11, 113-5 worksheet
That insulation can reduce transfer of energy from hotter to colder objects, and how insulation is used in domestic contexts.	• Understand why and explain how modern buildings are designed to minimise energy wastage; • Explain how the 'thermos' (vacuum) flask is designed to minimise energy transfer;	p. 45 worksheet p. 51 worksheet

Topic	Candidates should:	pages in Physics for You
ERT2. Work, power and energy		Chapter 16
The quantitative relationship between force, distance and work.	• Define work done by a force; Recall and use the equation: Work done (J) = force (N) x distance moved in direction of force (m) To calculate work done, force or distance;	p. 107 worksheet
To calculate power in terms of the rate of working or of transferring energy.	• State that power is a measure of how fast energy is transferred; Recall and use the equation: Power (W) = work done or energy transferred (J) / time (s) To calculate power, work done (energy transferred) or time;	p. 118-9 worksheet
The quantitative links between kinetic energy, gravitational potential energy and work.	• Know that whenever energy is transferred the total amount of energy remains the same (conservation of energy);	p. 108, 9, 112
	• Recall and use the equations: Energy transferred = work done; Kinetic energy (J) = ½ x mass (kg) x speed^2 (m/s)^2 Change in potential energy (J) = mass (kg) x gravitational field strength (N/kg) x change in height (m)	p. 109, p. 117, p. 116 worksheet

6. RADIOACTIVITY

Topic	Candidates should:	pages in Physics for You
R1. Radioactivity		Chapter 39
About theories of the atom.	• ★ Know the differences between Thomson's plum pudding model and the nuclear model of the atom;	p. 352, 368 worksheet
	• Understand how Rutherford's alpha particle scattering experiment led to the rejection of the Thomson model;	p. 352, worksheet
	• Use the proton number and mass number to derive information about the particles making up an atom and vice versa;	p. 352-3
That radioactivity arises because of unstable nuclei	• Know that radioactive substances have atoms with unstable nuclei;	p. 353
	• Know that radiation is emitted when an unstable nucleus breaks down (disintegrates);	p. 350-1
That there is background radioactivity.	• Know that some common substances around us give out low level radiation and that radiation from these sources is called 'background' radiation;	p. 350, 360
That there are three main types of radioactive emissions, with different penetrating powers.	• Name the types of radioactive emissions; • Describe a simple experiment that demonstrates their different penetrating powers;	p. 350-1
The nature of alpha and beta particles and of gamma radiation.	• Know that: α particles are helium nuclei; β particles are fast moving electrons; γ rays are e.m. waves;	p. 350-1

Topic	Candidates should:	pages in Physics for You
	• Know and use the symbols $^{4}_{2}\alpha$, $^{4}_{2}He$, $^{0}_{-1}\beta$, $^{0}_{-1}e$;	p. 353, 355
	• State the properties of alpha, beta and gamma radiations with respect to: relative mass; relative charge, relative ionising powers;	p. 350-1
	• **Describe and explain how charged particles behave in electric and magnetic fields;**	p. 350, 315
	• **Describe the effect on the nucleus of alpha, beta and gamma radiations by using a decay equation;**	p. 355
The meaning of the term 'half-life'	• Understand that half-life is (i) the time taken for half the radioactive atoms of an element to disintegrate; (ii) the time it takes the radiation from an element to fall to half its original level;	p. 354
	• perform simple calculations on half-life given numerical or graphical data;	p. 354, (362) worksheet
The beneficial and harmful effects of radiation on matter and living organisms.	• Understand that relatively small doses of radiation can cause damage to living cells – the damage is caused by ionising the molecules of the cell;	p. 356
	• Know that (i) the larger the dose the greater the damage; (ii) the more easily absorbed the radiation the greater the damage;	p. 356, 360
	• know that controlled high doses can be used to kill cancer cells and harmful micro organisms;	p. 357, 220
	• describe the precautions needed to protect medical staff and patients from over exposure to radioactivity and explain why these precautions are needed;	p. 356, 360, worksheet
	• ★ have an understanding of the need to dispose of radioactive waste safely.	p. 360, worksheet
Some uses of radioactivity, including the radioactive dating of rocks.	• ★ know and describe some applications of radioactivity, e.g. tracers, measuring thickness, sterilising equipment, carbon dating;	p. 356-7
	• ★ understand how radioactivity can be used to find the age of rocks;	p. 362

end of subject content