Edexcel Specification 1549 : Physics B (Modular)

Please check that you have chosen the correct specification.

Specification content – Separate Sciences

The modules listed below, when taken in conjunction with the appropriate ones from the twelve previous modules (in Edexcel specification 1536, Double Award Science, Modular), will offer the opportunity to candidates to gain accreditation in:

- GCSE in Biology B
- GCSE in Chemistry B
- GCSE in Physics B

Module 13: Microorganisms and disease in humans

Module 14: Biotechnology

Module 15: Preparing and analysing

Module 16: Industrial and organic chemistry

Module 17: Communications

Module 18: Particles

Candidates may therefore wish to follow a modular pathway leading to an award in the single separate sciences as set out below:

	Modules
GCSE in Biology B	– 1, 2, 7, 8, 13 and 14
GCSE in Chemistry B	– 3, 4, 9, 10, 15 and 16
GCSE in Physics B	**– 5, 6, 11, 12, 17 and 18**

These are the 6 modules in this document.

Some of the content is designated for the **Higher Tier** candidates only. This content is printed in **bold**.	**Page numbers in Physics for You** (revised 2001 edition)
Module 5 : Energy and electricity **Physics for You**	
Units	
Candidates will be assessed on their ability to: • use the following units: – volt (V), ampere (A), ohm (Ω), watt (W), kilowatt-hour (kWh) (5.01)	p. 259, 266-7, 272
Circuits	**Chapter 31**
Candidates will be assessed on their ability to:	
• recall that cells and batteries supply direct current and understand that direct current (d.c.) passes in one direction only (5.02)	p. 254
• explain how changing the resistance in a circuit changes the current and how this can be achieved using a variable resistor (5.03)	p. 259-261
• describe how a voltmeter is placed in parallel with a component to measure the voltage (in volts) across it (5.04)	p. 258
• understand how the current in a series circuit depends on the voltage of the source (5.05)	p. 259
• recall and use the equation – voltage (V) = current (A) × resistance (Ω) – V = I × R (5.06)	p. 259
• describe how current varies with voltage for the following devices – fixed value resistors – filament lamps – diodes – and how this can be investigated experimentally (5.07)	p. 265, 322, 261
• describe how the resistance of a light-dependent resistor (LDR) changes with light intensity and the resistance of a thermistor changes with a change of temperature (5.08)	p. 265, 325
Mains electricity	**Chapter 32**
Candidates will be assessed on their ability to:	
• recall that the mains supply is alternating current and understand that alternating current (a.c.) changes direction (5.09)	p. 274, 305
• recall that the mains supply can provide dangerous currents which can cause serious injury, or death, to users (5.10)	p. 274

• recall the functions of live, neutral and earth wires – energy flows into a building or appliance through the live wire – the neutral wire is needed to make a complete circuit – the earth wire, together with the fuse, prevents electrocution (5.11)	p. 274-5
• identify the live, neutral and earth conductors in a correctly wired plug and recall the colour of the insulation used on each conductor (5.12)	p. 275
• recall that a fuse is placed in the live conductor and understand that the fuse protects the appliance, circuit and connecting wires from overheating (5.13)	p. 274
• understand the action of a fuse – a large current heats and melts a length of wire – the melting of the wire breaks the circuit – the correct choice of fuse depends on the current rating of an appliance (5.14)	p. 274-5
• **understand that a residual current circuit breaker (RCCB)** – **detects any difference in the currents in the live and neutral conductors** – **acts quickly to protect the user should a leak to earth occur** – **can be easily reset** (5.15)	345, Worksheet in the Teacher Support Pack
• explain the use of insulation and double insulation in terms of safety, eg hairdryer, drill, vacuum cleaner (5.16)	p. 275
• understand that when an electric current passes through a resistor there is an energy transfer and the resistor is heated (5.17)	p. 270
• describe how the heating effect of an electric current is used in a variety of appliances, such as – electric bar heaters – immersion heaters – kettles, cookers and irons (5.18)	p. 270-1
• understand that energy from the mains supply is measured in kilowatt-hours (5.19)	p. 273
• use the equation given below for calculating the cost of electricity – cost = power (kW) × time (h) × cost of 1 kWh – *(This equation will be provided if required)* (5.20)	p. 273
Energy resources and transfer	**Chapters 36, 2, 16**
Candidates will be assessed on their ability to:	
• explain that an electric current is generated by a magnet rotating inside a coil of wire – on a small scale, as in a bicycle dynamo – in the large-scale generation of electrical energy (5.21)	p. 303-4, 306

• recall how transformers are used in the transmission of electricity in the National Grid and explain the advantages and disadvantages of using overhead and underground cables (5.22)	p. 308-9
• understand a range of energy transfer chains illustrating the environmental implications of generating electricity – the use of wind and water in electricity generation – fossil fuel reserves and their use in electricity – solar heating systems and electricity production through solar cells (5.23)	p. 11-13, 110-15 p. 52, 113-14
• **describe the advantages and disadvantages of methods of large scale electricity production using a variety of renewable and non-renewable resources** (5.24)	p. 11-13, 113-15
• understand the benefits of the use of low energy appliances, eg low energy light bulbs (5.25)	p. 112, 226
• understand that insulation can reduce the transfer of energy between objects at different temperatures (5.26)	p. 43-5
• describe some examples where the use of insulation results in the reduction of energy transfer: – loft insulation – double glazing – cavity wall insulation (5.27)	p. 44-5
• **understand that many insulating materials make use of the insulating properties of air that is not free to form convection currents** (5.28)	p. 44-5, 53

Module 6 : Waves, atoms and space **Physics for You**	
Units	
Candidates will be assessed on their ability to: • Use the following units: – hertz (Hz), metre (m), newton per kilogram (N/kg) (6.01)	p. 139, 175
Waves	**Chapter 21, 28, 29**
Candidates will be assessed on their ability to:	
• describe longitudinal and transverse waves in terms of frequency, wavelength and amplitude (6.02)	p. 174-5
• recall that the electromagnetic spectrum includes radio waves, microwaves, infra-red (IR), visible, ultraviolet (UV), X-rays and gamma rays (6.03)	p. 218-19
• recall the order of the electromagnetic spectrum in decreasing wavelength and increasing frequency including the colours of the visible spectrum (6.04)	p. 216-19
• recall that the energy associated with an electromagnetic wave, and thus its potential danger, increases with increasing frequency (6.05)	p. 218-19
• recall that all electromagnetic waves are transverse and travel at the same speed in a vacuum (6.06)	p. 218-19
• understand the difference between analogue and digital signals (6.07)	p. 312, 332
• understand some uses of electromagnetic radiation including	
– radio waves: broadcasting and communications including satellite transmissions	p. 169, 177, 219, 221, 320, 335
– microwaves: cooking and communications including satellite transmissions	p. 169, 219, 221, 227, 320
– infra-red: grills, night vision, remote controls, security systems and treatment of muscular problems	p. 48-53, 219, 221, 227
– visible light: vision and photography	p. 206-11
– ultraviolet: sunbeds, security marking, fluorescent lamps and detecting forged bank notes	p. 218, 220, 226
– X-rays: observing the internal structure of objects and materials including the human body	p. 218, 220, 226, 318
– gamma rays: sterilising food and medical equipment, and treatment of cancers (6.08)	p. 218, 220, 356-7
• understand the detrimental effects of excessive exposure of the human body to	
– microwaves: internal heating of body tissue	p. 219, 227
– infra-red: skin burns	p. 219
– ultraviolet: damage to surface cells (including skin cancer) and eyes	p. 218, 220
– X-rays: damage to cells (6.09)	p. 218, 220

• describe the change of direction of light as it enters glass from air and as it leaves glass into air (eg, glass block, glass prism) (6.10)	p. 176, 192
• understand the refraction of light in terms of the change of speed when light crosses a boundary (6.11)	p. 176, 193
• recall that light and infra-red radiation pass through an optical fibre with very little energy loss (6.12)	p. 197, 200, 320, 332
• recall that sound is transmitted as a longitudinal wave (6.13)	p. 174, 229
• understand that sound with frequencies greater than 20,000 Hz is known as ultrasound and recall that human ears detect a limited range of frequencies (6.14)	p. 230, 232
• describe the use of ultrasound in medical imaging and echo sounding (6.15)	p. 230, 240-1
Space	**Chapter 20**
Candidates will be assessed on their ability to:	
• recall that the Moon orbits the Earth and that some other planets also have moons (NB names of moons are not required) (6.16)	p. 159-161
• understand gravitational field strength, *g*, and recall that it is different on other planets and the Moon to that on Earth (6.17)	p. 136, 139, 159, 161
• explain that gravitational force – causes the planets to orbit the Sun – causes the Moon and artificial satellites to orbit the Earth – causes comets to orbit the Sun (6.18)	p. 158, 159, 163
• describe how the orbit of a comet differs from that of a planet (6.19)	p. 163
• recall that the solar system is part of the Milky Way galaxy – describe a galaxy as a large collection of millions of stars – state that the Universe is a large collection of galaxies (6.20)	p. 165-6
• describe the methods used to gather evidence for life elsewhere – soil experiments on landers (eg Viking) – listening on radio wavelengths (SETI) (6.21)	p. 167
• describe the evolution of small stars like our Sun through stages from nebula to main sequence to red giant, white dwarf and black dwarf (6.22)	p. 165
• understand that gravitational forces cause a nebula to collapse to form a star (6.23)	p. 163-4
• describe the 'Big Bang' theory of the origin of the Universe and consider other theories such as the 'Steady State' theory (6.24)	p. 166, 369
• **outline the evidence in support of the current theory about the origin of the Universe** – **the 'Big Bang'** – **red shift gives evidence that the Universe is expanding** – **microwaves give evidence of the original explosion** (6.25)	p. 166-7
• explain how the future of the Universe depends on the amount of mass present (6.26)	p. 166, worksheet

Atoms	**Chapter 39**
Candidates will be assessed on their ability to:	
• understand the terms atomic (proton) number and mass (nucleon) number and explain the existence of isotopes (6.27)	p. 353
• use symbols such as $^{14}_{6}C$ to describe particular nuclei (6.28)	p. 353
• understand that radioactivity arises from the breakdown of an unstable nucleus of an atom and is a random process (6.29)	p. 354
• recall the three main types of radiation from radioactive sources and their comparative mass, charge and ionisation ability (6.30)	p. 350-1
• describe the properties of alpha and beta particles and gamma radiation, including their penetrating powers and their uses in smoke alarms, for controlling the thickness of sheet material and sterilising medical instruments (6.31)	p. 350-1, 356-7
• recall the existence of background radiation from the Earth and from space including the regional variations in the United Kingdom, eg because of radon gas released from rocks (6.32)	p. 360
• describe the dangers of ionising radiations including – radiation can cause mutations in living organisms – radiation can damage cells and tissue – the problems arising in the disposal of radioactive waste (6.33)	p. 360, worksheet
• describe the problems associated with the safe disposal of radioactive waste (6.34)	p. 359, 360, worksheet

Module 11 : Movement and change Physics for You	
Units	
Candidates will be assessed on their ability to:	
• use the following units – second (s), metre (m), metre per second (m/s), metre per second^2 (m/s^2), kilogram (kg), joule (J), newton (N), newton per kilogram (N/kg), watt (W), becquerel (Bq) (11.01)	p. 6-7, 107, 118, 130, 360
Forces and motion	**Chapters 18, 14**
Candidates will be assessed on their ability to:	
• interpret distance-time graphs including determination of speed from the gradient of a graph (11.02)	p. 134
• recall that velocity is speed in a stated direction (11.03)	p. 130
• recall and use the equation – acceleration (m/s^2) = change in velocity (m/s) ÷ time taken (s) $a = \frac{(v - u)}{t}$ (11.04)	p. 130
• interpret speed/time graphs – determine the acceleration from the gradient of the graph – **determine the distance travelled from the area between the curve and the time axis (11.05)**	p. 132-3
• understand that the stopping distance of a vehicle is made up of – thinking distance – braking distance (11.06)	p. 98
• understand the factors affecting the stopping distance of a vehicle, including – the mass of the vehicle – the speed of the vehicle – the driver's reaction time (11.07)	p. 98
• recall a brief history of our understanding of forces and how they affect motion in a straight line including – the Greek view – a simple force needed to sustain motion – Galileo and Newton – balanced forces allow an object to continue in uniform motion in a straight line or to remain at rest – Newton – gravitational attraction acts between all masses (11.08)	p. 368, 77, 139, 162
• understand that when object A pulls or pushes object B then object B pulls or pushes object A with a force that is equal in size and opposite in direction (11.09)	p. 94-5

• understand that falling objects are acted on by a downward force (weight) and an upward force (air resistance) and that at the start of the fall the forces are unbalanced and the object accelerates (11.10)	p. 99, 136
• understand that, when an object falls through the atmosphere, air resistance increases with increasing speed until it is equal in size to the weight of the falling object, when terminal speed (velocity) is reached (11.11)	p. 99, 136
• understand that in the absence of air, all falling bodies accelerate at the same rate (11.12)	p. 99, 136
• describe the forces acting on a car moving in a straight line on a horizontal surface – the driving force – the resistive force (11.13)	p. 139
• in the above example, understand how the balance of forces differs when the car is – accelerating – braking – moving at a constant speed (11.14)	p. 139
• understand that when an unbalanced force acts on an object, the acceleration depends on – the size of the unbalanced force – the mass of the object (11.15)	p. 138, worksheet
• **recall and use the equation** – **force (N) = mass (kg) × acceleration (m/s^2)** – $F = m \times a$ (11.16)	p. 138-9
Forces and energy	**Chapter 16**
Candidates will be assessed on their ability to:	
• recall and use the equation – work done (J) = force (N) × distance moved in the direction of the force (m) $W = F \times d$ (11.17)	p. 107
• understand that gravitational potential energy is stored positional energy, eg a swimmer on a diving board, a person lifting weights (11.18)	p. 108-9
• **recall and use the equation** – **gravitational potential energy (J) =** **mass (kg) × gravitational field strength (N/kg) × vertical height (m)** $GPE = m \times g \times h$ (11.19)	p. 116
• recognise the equivalence of work done and energy transfer and recall that energy transferred (J) = work done (J) (11.20)	p. 109
• understand that power is the rate of doing work and is measured in watts (joules per second) (11.21)	p. 118-9
• recall that kinetic energy is movement energy (11.22)	p. 8, 108-9, 117
• **recall and use the equation** – **kinetic energy (J) = ½ × mass (kg) × velocity^2 (m/s)^2** $KE = \frac{1}{2} \times m \times v^2$ (11.23)	p. 117

Earth waves	**Chapter 20**
Candidates will be assessed on their ability to:	
• recall that seismic waves are caused by earthquakes or 'underground explosions' (11.24)	p. 154-5
• **understand that longitudinal and transverse waves are transmitted through the Earth and that their paths and times of travel give information about the layered structure of the Earth: crust, mantle, outer (liquid) core and inner core** (11.25)	p. 154-5
• recall that the Earth's outermost layer, the lithosphere, is composed of plates in relative motion and that plate tectonic processes result in the formation, deformation and recycling of rocks (11.26)	p. 156-7
• understand that at plate boundaries, plates may – slide past each other, sometimes causing earthquakes – move towards each other, taking rock into the mantle – move away from each other, resulting in volcanoes and forming new rocks (11.27)	p. 157
Using half-life	**Chapter 39**
Candidates will be assessed on their ability to:	
• understand that the activity of a radioactive isotope decreases over a period of time and is measured in becquerels (11.28)	p. 354, 360
• recall that the half-life of a radioactive isotope is the time taken for half the undecayed nuclei to decay, and the consequent problems arising in the disposal of radioactive waste (11.29)	p. 354, 359, 360, worksheet
• use the concept of half-life to carry out simple calculations on the decay of a radioactive isotope (11.30)	p. 354
• describe the uses of radioactivity in the radioactive dating of archaeological specimens and rocks (11.31)	p. 357, 362

Module 12 : Energy, force and communication **Physics for You**	
Units	
Candidates will be assessed on their ability to:	
• use the following units: – coulomb (C), ampere (A), volt (V), power (W), second (s), metre (m), hertz (Hz), metre per second (m/s), newton (N), newton metre (Nm) (12.01)	p. 130, 175, 266, 267, 272
Charge and energy	**Chapters 30, 31, 32, 36**
Candidates will be assessed on their ability to:	
• describe common materials which are electrical conductors or insulators including metals and plastics (12.02)	p. 249
• describe how an insulator can be charged by friction, resulting in the transfer of electrons (12.03)	p. 247-8
• recall that like charges repel and unlike charges attract (12.04)	p. 247
• describe common electrostatic phenomena in terms of movement of electrons, for example – shocks from car doors – charges on synthetic fabrics – lightning (12.05)	p. 248, 251, 252
• describe some of the uses and dangers of electrostatic charges in everyday situations, eg fuelling aircraft and tankers, photocopiers and inkjet printers (12.06)	p. 252, 321
• **explain how earthing removes the excess charge on a body, with reference to the movement of electrons** (12.07)	p. 251
• understand that current is rate of flow of charge (12.08)	p. 255, 256, 266, 278
• recall and use the equation – charge (C) = current (A) × time (s) $Q = I \times t$ (12.09)	p. 266
• **understand that electric current in metals is a flow of negatively charged electrons (12.10)**	p. 255, 256, 266
• **understand that electric current in molten or dissolved electrolytes is a movement of both positive and negative ions (12.11)**	p. 278
• recall and use the equation – electrical power (W) = current (A) × voltage (V) $P = I \times V$ (12.12)	p. 272
• **use the quantitative relationship between energy transferred, current, voltage and time** – **energy transferred = current × voltage × time** $E = I \times V \times t$ (*This will be provided if required*) (12.13)	p. 272

• **understand that voltage is the energy transferred per unit charge passed; the volt as a joule per coulomb** (12.14)	p. 267
• recall that a force is exerted on a current-carrying wire in a magnetic field and understand how this is used in a simple d.c. motor (12.15)	p. 296-9
• understand that when a wire carrying a current is perpendicular to a magnetic field, the resulting force is perpendicular to both (12.16)	p. 296
• recall the structure of a transformer and understand that a transformer changes the size of an alternating voltage by having different numbers of turns on the input and output sides (12.17)	p. 307-9
• **recall and use the quantitative relationship between input (primary) and output (secondary) voltages and the turns ratio for a transformer** $\frac{\text{voltage (primary)}}{\text{voltage (secondary)}} = \frac{\text{turns (primary)}}{\text{turns (secondary)}}$ $\frac{V_P}{V_S} = \frac{n_P}{n_S}$ (12.18)	p. 308
• explain the use of step-up and step-down transformers in transmitting electricity (12.19)	p. 309
• understand that transmitting electrical power at high voltages reduces the current required, and this reduces power losses caused by heating (12.20)	p. 309
Waves and communication	**Chapters 21, 25**
Candidates will be assessed on their ability to:	
• recall that waves transfer energy and information without transferring matter (12.21)	p. 174, 219
• recall and use the equation for all waves: – wave speed (m/s) = frequency (Hz) × wavelength (m) $v = f \times \lambda$ (12.22)	p. 175, 229
• understand the condition for total internal reflection to take place and how this is used in optical fibres and in reflecting prisms (12.23)	p. 195-7, 200
• **understand that digital signals can carry more information than analogue signals (12.24)**	p. 332-3
• recall that waves spread out when they pass through a narrow gap or past an edge and that this is called diffraction (12.25)	p. 177
• understand that sound and light show diffraction effects (12.26)	p. 177
• describe and interpret some examples of diffraction, eg – of sound by large building/doorways – of water waves by harbours – of light by a single narrow slit (12.27)	p. 177
• understand how reflection and diffraction affect the quality of received radio signals (12.28)	p. 177

Forces and shape	
Candidates following the Welsh National Curriculum should be taught the principle of moments and its application to situations involving one pivot in order to meet statutory requirements.	
Candidates will be assessed on their ability to:	
• understand that the upward forces on a light beam supported at its ends vary with the position of a heavy object placed on the beam (12.29)	p. 100
• describe how extension varies with applied force for a range of materials including springs and rubber bands (12.30)	p. 74
• recall that particles in a gas have random motion and that they exert a force on the walls of the container (12.31)	p. 14-16
• **understand the relationship between the pressure and volume of a fixed mass of gas at constant temperature and use the quantitative relationship** – $P_1 \times V_1 = P_2 \times V_2$ (12.32)	p. 31, 35, 36

Module 17 : Communications **Physics for You**	
Units	
Candidates will be assessed on their ability to:	
• use the following units – metre (m), second (s), metre/second (m/s), metre/second^2 (m/s^2), newton (N), hertz (Hz) (17.01)	p. 6-7, 130, 138, 175
Communications systems	**Chapter 38**
Candidates will be assessed on their ability to:	
• recall that communications systems can be broken down into a number of blocks, each having specific functions (17.02)	p. 332-3, 320, 335
• recall the terms used for the various building blocks and their associated functions, including – encoder – modulator – decoder – storage – transmitter – receiver – transducer – amplifier (17.03)	p. 332-3, 335
• recall how light can be encoded to transmit information via an optical fibre (17.04)	p. 332, 320
• describe the advantages of using digital signals over analogue signals (17.05)	p. 333
• recall the different methods of storage and retrieval of information, including – digital storage, as used with CD players – analogue storage, as used in record players – use of magnetic tape, photo-diode and diode-laser (17.06)	p. 312, p. 312, p. 312, 313, 332
• understand the physical principles of a variety of transducers, including – moving coil loudspeaker – moving coil microphone – erase, record and playback heads of a tape recorder (17.07)	p. 297, p. 334, p. 313
• understand the terms noise and attenuation and how these can affect the quality of the received signal (17.08)	p. 333
• recall the use of regenerators and repeaters in electrical cable and optical fibre communications (17.09)	p. 332

Transmitting and receiving radio waves	**Chapters 38, 28**
Candidates will be assessed on their ability to:	
• recall a brief history of the development of sending and receiving information including – communication by telegraph and telephone – wireless transmissions leading to radio and television – satellite communications (17.10)	p. 370
• **recall the nature of radio waves and understand how interference affects the quality of the received signals** (17.11)	p. 219, 221
• recall that transmitted radio waves can reach the receiver as ground, sky or space waves and recall the typical frequency ranges associated with these waves (17.12)	p. 221
• describe, by suitable diagrams, ground waves, sky waves and space waves (17.13)	p. 221
• recall the part played by the ionosphere in reflecting radio waves (17.14)	p. 221
• understand the importance of diffraction of radio waves, including by buildings, mountains, curvature of the Earth and transmission dishes (17.15)	p. 177, 169
• understand that the amount of diffraction depends upon wavelength and physical dimensions involved (17.16)	p. 177
• recall and use the relationships between wave speed (v), frequency (f) and wavelength (λ) – $v = f \times \lambda \qquad f = \frac{v}{\lambda} \qquad \lambda = \frac{v}{f}$ (17.17)	p. 175
• recall that amplitude modulation (AM) and frequency modulation (FM) are used in radio communications and understand the difference between them (17.18)	p. 335
• recall that AM signals have a greater range and are more susceptible to noise than FM signals (17.19)	p. 335
Satellites	**Chapter 20**
Candidates will be assessed on their ability to:	
• recall the difference between passive and active satellites (17.20)	p. 169
• describe the different uses for satellite communications systems including – telephone and television communications – surveillance and monitoring – navigation (17.21)	p. 169
• understand the features of a geostationary orbit and explain the importance to telecommunications of geostationary satellites (17.22)	p. 162, 168-9, 221, 320
• understand the connection between the Earth's spin and the use of monitoring satellites placed in low polar orbits (17.23)	p. 168

• use the quantitative relationship between orbital speed, orbital radius and time period – $orbital\ speed = \frac{2\pi \times orbital\ radius}{time\ period}$ $v = \frac{2 \times \pi \times r}{T}$ *(This equation will be provided if required)* (17.24)	p. 168
• understand the role of the gravitational force of the Earth as the centripetal force on the satellite (17.25)	p. 162
• use the quantitative relationship between the force acting on a satellite, mass (*m*), orbital speed (*v*) and radius (*r*) $\text{force} = \frac{\text{mass} \times (\text{orbital speed})^2}{\text{radius}} \quad F = \frac{m \times v^2}{r}$ (*This equation will be provided if required*) (17.26)	p. 78, 168, worksheet

Module 18 : Particles **Physics for You**	
Units	
Candidates will be assessed on their ability to:	
• use the following units – kelvin (K), coulomb (C), ampere (A), volt (V), joule (J), pascal (Pa), speed (m/s) (18.01)	p. 29, 85, 107, 130, 266
Ideal gas molecules	**Chapter 6**
Candidates will be assessed on their ability to:	
• understand that there is an absolute zero of temperature which is -273 ^{o}C (18.02)	p. 29, 33
• describe the kelvin scale of temperature and be able to convert between the kelvin and Celsius scales (18.03)	p. 29, 33
• understand that an increase in temperature results in an increase in speed of gas particles and that the kelvin temperature of the gas is proportional to their average kinetic energy	p. 16, 36
• explain the pressure exerted by a gas in terms of the motion of its particles (18.05)	p. 14, 36, 89
• describe the qualitative relationship between pressure and kelvin temperature for a gas in a sealed container (18.06)	p. 34, 36
• **use the quantitative relationship between the pressure and the kelvin temperature** – $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (***This equation will be provided if required***) (18.07)	p. 34
Atoms and nuclei	**Chapter 39**
Candidates will be assessed on their ability to:	
• describe the results of Geiger and Marsden's experiments with gold foil and α-particles (18.08)	352, 368, worksheet
• describe Rutherford's nuclear model of the atom and how it accounts for the results of Geiger and Marsden's experiment and understand the factors (charge **and speed**) which affect the deflection of α-particles by a nucleus (18.09)	p. 352
• recall the qualitative features of the curve obtained when the number of neutrons (*N*) is plotted against the number of protons (Z) for stable isotopes (18.10)	Worksheet
• understand that if an isotope does not lie on this curve it will be unstable and radioactive	Worksheet
• recall that an isotope that lies above the curve has too many neutrons to be stable and will undergo β^- - decay (emit an electron) (18.12)	Worksheet
• understand that in the process of β^- - decay a neutron becomes a proton plus an electron	p. 355
• **recall that an isotope that lies below the curve has too few neutrons to be stable and will undergo β^+ - decay (emit a positron) (18.14)**	Worksheet
• **understand that in the process of β^+ - decay a proton becomes a neutron plus a positron (18.15)**	Worksheet
• **describe the effects on the proton (atomic) and mass numbers of a nucleus of β^- and β^+ - decay (18.16)**	p. 355

• recall that nuclei with greater than 82 protons usually undergo α - decay (18.17)	
• recall that as a result of β^- or β^+ - decay nuclei often undergo rearrangement with a loss of energy as γ-radiation (18.18)	p. 355
• understand that a nucleus of U-235 can be split (fission) by collision with a neutron and that this process releases energy in the form of kinetic energy of the fission products (18.19)	p. 358-9
• recall that the fission of U-235 produces two daughter nuclei and a small number of neutrons (18.20)	p. 358
• understand that a chain reaction can be set up if the neutrons produced by one fission strike other U-235 nuclei (18.21)	p. 358
• describe in outline how the fission process can be used as an energy source to generate electricity (18.22)	p. 358-9
• understand that the products of nuclear fission are radioactive and the implications this has for their safe storage over prolonged periods (18.23)	p. 360, worksheet
Electrons and other particles	**Chapter 37**
Candidates will be assessed on their ability to:	
• recall that the electron is a fundamental, negatively charged particle (18.24)	p. 314, 352
• recall that the proton and neutron are not fundamental particles but each contains three particles called quarks (18.25)	Worksheet
• **recall that the positron is a fundamental, positively charged particle with the same mass as the electron** (18.26)	worksheet
• **recall that there are two types of quark in protons and neutrons and that β decay occurs when one quark changes to the other type, which in turn causes the neutron to become a proton (β^- - decay) or the proton to become a neutron (β^+ - decay)** (18.27)	worksheet
• understand that electrons are 'boiled off' hot metal filaments and this is called thermionic emission (18.28)	p. 314
• understand the principles of a simple electron gun with a heated cathode and accelerating anode (18.29)	p. 314-5
• **use the quantitative relationship between kinetic energy gained, electronic charge and accelerating voltage** – **kinetic energy = electronic charge × accelerating voltage** $KE = e \times V$ – **(*This equation will be provided if required*)** (18.30)	worksheet
• recall that a beam of electrons is equivalent to an electric current **and perform simple calculations involving the rate of flow of electrons and the current, given the electronic charge** (18.31)	p. 266, worksheet
• understand that an electron beam, or a stream of charged ink drops, can be deflected by the electric field between parallel charged metal plates (18.32)	p. 315, 321
• understand the principal uses of electron beams, including TV picture tubes, computer monitors, oscilloscopes, the production of X-rays (18.33)	p. 315-318
• understand how an oscilloscope can be used to measure voltage and frequency (18.34)	p. 317