GCSE Specification 1536

Edexcel Science : Modular : Double Award

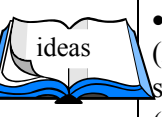
Please check that you have chosen the correct specification.

Some of the content is designated for the **Higher Tier** candidates only. This content is printed in **bold**.	
Module 1 : The human body – action and control pages in Biology for You	
The digestive system	
In order to meet statutory requirements, candidates following the Welsh National Curriculum should be taught how the presence of starch, sugar and protein in foods can be detected by testing.	
Candidates will be assessed on their ability to:	
• describe the functions of the parts of the digestive system:	
– salivary glands	page 58
– oesophagus (gullet)	59
– stomach	59
– gall bladder	60
– pancreas	60
– small intestine	60-61
– large intestine (1.01)	61
• describe the functions of enzymes (carbohydrase, protease, lipase) and bile in digestion (1.02)	57, 60
• describe how the structure of villi helps the efficient absorption of the soluble products of digestion (1.03)	61
The blood	
Candidates will be assessed on their ability to:	
• recall that blood is a mixture of plasma, white blood cells, red blood cells and platelets	97-100
• describe the function of blood in transport	97, 101
– plasma carries hormones and small soluble molecules such as glucose, amino acids and carbon dioxide	97, 101
– red blood cells carry oxygen (1.05)	98

• describe the function of blood in defence against infection	p. 99, 179-180
– white blood cells ingest bacteria and produce antibodies	99, 179-180
– white blood cells, their function and relationship to their structure	99
– platelets bring about fibrin formation and the formation of a scab over a wound (1.06)	100
The nervous system	
Candidates will be assessed on their ability to:	
• describe how the structure of a neurone relates to its function (1.07)	120
• **describe the path of electrical impulses in a simple reflex arc (1.08)**	121, 123
• describe the role of the iris and pupil, retina and optic nerve in the iris reflex (1.09)	130
• **explain the role of the cornea, ciliary body, suspensory ligaments and lens in forming sharp images of near and distant objects on the retina (1.10)**	130-131 Phys4U : p. 208-11
• describe the main effects of	
– solvents on lungs and neurones	187
– alcohol on reaction times, liver and brain	188-189
– tobacco on respiratory and circulatory systems (1.11)	83-84
• understand how the use of drugs may	
– affect activities such as driving	185-189
– produce abnormal behaviour	185-189
– create the risk of viral infections (1.12)	184 186
• recall the effects on the body of	
– stimulants such as caffeine	186
– sedatives such as barbiturates	186
– pain killers such as paracetamol (1.13)	186
• describe the uses of paracetamol and the dangers of overdose (1.14)	186
• describe the uses of heroin in pain relief for terminally ill patients, and the dangers of addiction (1.15)	186
The kidney	
Candidates will be assessed on their ability to:	
• understand that homeostasis is the maintenance of a constant internal environment (1.16)	106-107
• recall that body water content and body temperature are both examples of homeostasis	110, 113
• recall that urea is made in the liver from excess amino acids (1.18)	111
• describe the structure and function of the urinary system, to include the renal artery, renal vein, kidney, ureter, bladder and urethra (1.19)	111
• **describe the structure and functions of the following parts of the nephron: glomerulus and Bowman's capsule, first and second coiled tube, capillary network and collecting tubule, to include ultra filtration and reabsorption (1.20)**	112
• **describe how the hormone ADH controls the water content of the blood (1.21)**	113

The skin	
Candidates will be assessed on their ability to:	
• describe the function of the skin in defence against infection, to include the outer layer of dead cells, the physical barrier to the environment and the role of the oil glands (1.22)	p. 109
• explain the function of the skin in the control of body temperature	109-110
– sweat glands release sweat that contains water and salts	111
– evaporation of water in sweat removes heat from the skin (1.23)	110
• recall that the skin contains capillary loops which affect blood flow in the skin (1.24)	110
• **explain the process of vasoconstriction and vasodilation in relation to the control of body temperature (1.25)**	110
• **understand how vasodilation increases heat loss by radiation and convection (1.26)**	110
• understand that shivering involves the movement of muscles which releases heat (1.27)	110
• understand the importance of temperature in relation to enzyme activity (1.28)	33
• describe the function of the skin in the nervous system (1.29)	126
• recall that touch receptors and temperature receptors carry nerve impulses to the brain along sensory nerves (1.30)	126

Module 2 : Inheritance and survival Biology for You	
Chromosomes and variation	
Candidates will be assessed on their ability to:	
• recall that each human body cell contains 23 pairs of chromosomes giving a diploid number of 46 (2.01)	p. 272
• **understand that mitosis is the division of a cell to produce two cells with identical sets of chromosomes, for growth or replacement (2.02)**	276
• **describe the outcome of mitosis – the replication of each chromosome and the separation of the replicas (recall or use of technical terms is not required) (2.03)**	276
• recall that each human gamete contains 23 chromosomes, the haploid number (2.04)	277
• **understand that meiosis is the division of a diploid cell to produce four haploid cells with sets of chromosomes that are not genetically identical to produce gametes (sperm and ovum) (recall or use of technical terms is not required) (2.05)**	277
• describe how the fusion of haploid male and female gametes (fertilisation) produces a diploid zygote (fertilised ovum or egg cell) (2.06)	277
• explain how sexual reproduction, involving fertilisation, leads to variation in the new generation (2.07)	155
• recall that individuals inherit some characteristics from their father through the sperm and some from their mother through the egg (2.08)	155, 278
• explain how the sex of an individual depends upon X and Y chromosomes and is determined at fertilisation (2.09)	278
• describe the functions of the sex hormone testosterone in promoting secondary sexual characteristics in men (2.10)	166
• describe the functions of the sex hormone oestrogen in promoting secondary sexual characteristics in women (2.11)	166
• recall that oestrogen causes the lining of the uterus to thicken during the early part of the menstrual cycle (2.12)	162
• recall that progesterone maintains the lining of the uterus during the middle part of the menstrual cycle and during pregnancy (2.13)	163
• recall that manufactured sex hormones can be used to treat infertility in women (2.14)	167-168
Genes and variation	
Candidates will be assessed on their ability to:	
• understand that genes are parts of chromosomes which are found within the nucleus (2.15)	272
• understand that the unit of inheritance is the gene which is a section of a long chain (DNA) molecule; describe a DNA molecule as two strands coiled to form a double helix, the strands linked by a series of paired bases (adenine with thymine and cytosine with guanine) (2.16)	273
• describe some of the implications of the outcome of the Human Genome Project (2.17)	291



• understand how some inherited characteristics can be modified by environmental conditions, eg the influence of the mother's diet or smoking on a baby's birth weight (2.18)	p. 255
• explain how alternative forms of a gene (alleles) cause variation in a characteristic, to include eye colour (2.19)	282
• recall that some alleles cause diseases which can be inherited (2.20)	286-287
• understand the terms dominant and recessive (2.21)	281
• describe the mechanism of monohybrid inheritance using genetic diagrams (2.22)	282-284
• **understand the terms homozygous, heterozygous, genotype and phenotype (2.23)**	280-281
• **predict ratios of genotypes and phenotypes in a given monohybrid cross (2.24)**	
• recall that a mutation is a change in the chemical structure of a gene (2.25)	282-284
• recall that mutations can be caused by ionising radiation, including ultraviolet light, X-rays and gamma rays, and by some substances in tobacco (2.26)	285
• describe how asexual reproduction leads to genetically identical individuals (clones) (2.27)	154, 234
Genetically modified organisms	
– Candidates will be assessed on their ability to:	
• **describe how the transfer of a required gene from a donor to a recipient, including the use of enzymes, can produce genetically modified organisms (2.28)**	289
• understand that crop plants can be genetically modified, and the reasons for doing so (2.29)	293
• **describe the potential benefits and ethical dilemmas posed by advances in genetic modification (2.30)**	293
Selection, survival and evolution	
Candidates will be assessed on their ability to:	
• understand how adaptations such as	
– hair colour, hair length, size of ears in mammals	336-338
– gills, streamlined shape, mucus-covered scales in fish	146-147
– extensive roots, reduced leaves with thick cuticles in cacti	336
allow survival in particular environmental conditions (2.31)	336-338
• describe how competition between individuals of the same species controls population size (2.32)	339-340
• describe how the populations of predator and prey are dependent on each other (2.33)	343
• describe how new species may evolve from variants which are better adapted to their environment (2.34)	296-301
• understand that fossils provide evidence for evolution (2.35)	302-303
• explain how natural selection can lead to evolution or extinction of species (2.36)	305
• explain the principles of natural selection (2.37)	298-299

• explain how selective breeding (artificial selection) can be used, for example,	p. 290
– in cattle to improve the quality and quantity of milk	290
– to increase the number of offspring in sheep	290
– to increase yield from dwarf wheat (2.38)	290
Pollution and human survival	
Candidates will be assessed on their ability to:	
• recall that increasing population size leads to increased pollution (2.39)	344-345
• interpret data on environmental change (2.40)	376-381
 • describe how human activity can affect the environment, especially changes in population size, and in economic and industrial conditions, given suitable information (2.41)	344-345
• recall that burning fossil fuels releases harmful wastes into the air, especially smoke and acidic gases (2.42)	347
 • recall that acidic gases combine with water vapour to form acid rain which damages plants and animals (2.43)	347
 • recall that some harmful substances occur in vehicle exhaust gases, including carbon dioxide, carbon monoxide, nitrogen oxides (2.44)	347, 371
• describe how air pollution by vehicles can be reduced (2.45)	347

Module 3: Chemical patterns Chemistry for You	
Candidates will be assessed throughout this module on their ability to:	
• recall the formulae of elements and simple compounds in the module	Throughout
• represent chemical reactions by word equations; write simple balanced equations and use the state symbols (s), (l), (g) and (aq)	pages 24-6
• **write balanced equations to describe and explain a wide range of reactions including ionic equations**	**Throughout**
The structure of atoms	Chapter 3
Candidates will be assessed on their ability to:	
• describe the structure of an atom as a nucleus containing protons and neutrons, surrounded by orbiting electrons arranged in shells (3.01)	p. 28, 30
Elements and the periodic table	Chapter 4, 5, 6
Candidates will be assessed on their ability to:	
• recall that there are about 100 elements in the periodic table arranged in order of ascending atomic number and recall that elements are the 'building blocks' of all materials (3.02)	p. 42-3
• recall the position of metals and non-metals in the periodic table (3.03)	p. 48
• locate the positions in the periodic table of	
– the alkali metals	p. 43
– the halogens	p. 43
– the noble gases (3.04)	p. 43
• understand how the electron shells are filled in the atoms of the first twenty elements in the periodic table, eg potassium 2.8.8.1 (3.05)	p. 70
• understand the connection between the number of outer electrons and the position of an element in a group of the periodic table (3.06)	p. 70
• understand that the reactions of an element depend upon the arrangement of electrons in its atoms (3.07)	p. 70-1
• recall that there is a gradual change in properties of the elements from the top to the bottom of each group (3.08)	p. 51, 62, 67, 71
• understand that elements in the same group of the periodic table have similar chemical properties, as exemplified by the halogens (3.09)	p. 62-3
The properties of halogens	Chapter 6
Candidates will be assessed on their ability to:	
• recall that fluorine, chlorine, bromine and iodine are halogens (3.10)	p. 43, 62
• recall the variation in colour, the trends in boiling point and the physical states at room temperature, of the halogens (3.11)	p. 62

• describe the reactions of chlorine with sodium and iron (3.12)	p. 63
• describe the variation in reactivity of the halogens with increasing atomic number, as shown by displacement reactions with solutions of other halides (3.13)	p. 63
• describe the use of chlorine in	
– water purification	p. 64, 301
– bleaching (3.14)	p. 62, 64-5
• recall the use of iodine solution as an antiseptic (3.15)	p. 64
Rates of reaction	Chapter 16, 17
Candidates will be assessed on their ability to:	
• recall that there is great variation in the rates at which different reactions take place (3.16)	p. 199
• understand that the rate of chemical reaction increases if	
– the temperature is increased	p. 206-7
– the concentration of reactant is increased	p. 204-5
– the surface area of a solid reactant is increased	p. 202-3
– a catalyst is used (3.17)	p. 208-9
• describe experiments to investigate the above effects (3.18)	p. 200-9
• understand that reactions can occur when particles collide (3.19)	p. 203
• understand that the rate of a reaction is increased by	
– increased frequency of the collisions	p. 203, 205, 207
– greater energy of the collisions (3.20)	p. 207
• describe how the rates of enzyme catalysed reactions vary with temperature and pH (3.21)	p. 213

Module 4 : Chemistry in action Chemistry for You	
Candidates will be assessed throughout this module on their ability to:	
• recall the formulae of elements and simple compounds in the module	Throughout
• represent chemical reactions by word equations; write simple balanced equations and use the state symbols (s), (l), (g) and (aq)	pages 24-6
• **write balanced equations to describe and explain a wide range of reactions including ionic equations**	**Throughout**
Crude oil	Chapter 13
Candidates will be assessed on their ability to:	
• explain that crude oil was formed by the long-term effects of temperature and pressure on marine deposits (4.01)	p. 160
• recall that hydrocarbons contain carbon and hydrogen only (4.02)	p. 159
• understand that crude oil is a mixture of substances, most of which are hydrocarbons (4.03)	p. 159
• understand that the mixture of substances can be separated by fractional distillation, to yield fuels and other useful products (4.04)	p. 162-4
• describe the fractional distillation of crude oil (4.05)	p. 162-4
• describe some uses of the various fractions	p. 164
– gases	p. 164
– petrol (gasoline)	p. 164
– kerosene (paraffin)	p. 164
– diesel oil	p. 164
– fuel oil	p. 164
– bitumen (4.06)	p. 164
• evaluate data on the properties of different fractions related to the size of their molecules (4.07)	p. 163-4
Burning fuels	Chapter 15
Candidates will be assessed on their ability to:	
• understand that the products of complete combustion of hydrocarbons are carbon dioxide and water and that energy is released (4.08)	p. 187
• understand that oxidation is the addition of oxygen to a substance, eg the oxidation of methane to water and carbon dioxide (4.09)	p. 187
• understand that incomplete combustion can produce carbon and carbon monoxide (4.10)	p. 187
• recall that carbon monoxide is a toxic gas (4.11)	p. 187
• recall that incomplete combustion can occur in faulty gas appliances and other heating appliances and this can be dangerous (4.12)	p. 198 (Q4)

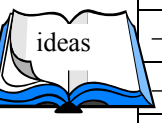
Plastics	Chapter 13
Candidates will be assessed on their ability to:	
• **understand that cracking of some oil fractions (obtained from the fractional distillation of crude oil) yields useful hydrocarbon molecules, some of which have carbon-carbon double bonds (4.13)**	p. **165**
• **recall the conditions used in industry to crack fractions obtained from crude oil**	p. **165**
• **describe the alkanes as saturated hydrocarbons and alkenes as unsaturated hydrocarbons which contain a double bond (4.15)**	p. **167**
• recall the formulae of methane, ethane, propane and butane and draw the structures of their molecules (4.16)	p. 159
• **recall the formulae of ethene and propene and draw the structures of their molecules (4.17)**	p. **167**
• **describe how bromine water is used to distinguish between alkenes and alkanes**	p. **167**
• **explain how addition polymers are formed from unsaturated monomers (4.19)**	p. **168**
• describe some uses of	
– poly(ethene)	p. 171
– poly(propene)	p. 171
– poly(styrene)	p. 171
– poly(chloroethene), (polyvinyl chloride, PVC) (4.20)	p. 171
• understand the problems of the disposal of some plastics (4.21)	p. 172-3
Enzymes	Chapter 17
Candidates will be assessed on their ability to:	
• describe the uses of enzymes in washing powders and in food and drink manufacture	p. 214, 217
• recall that the dairy industry uses enzymes made by microorganisms to produce yoghurt and cheese (4.23)	p. 216
Types of chemical reactions	
Candidates will be assessed on their ability to:	
• know that there are several different types of chemical reactions (4.24)	Throughout
• understand that neutralisation can be used to make salts, some of which may be used as fertilisers (4.25)	p. 144-7, 246-7
• understand the process of thermal decomposition, for example, as shown by the action of heat on limestone and copper carbonate (4.26)	p. 128-9
• describe the effect of water on calcium oxide and appreciate the solution produced is limewater (4.27)	p. 128-9
• understand why calcium oxide and calcium hydroxide are used to neutralise soil acidity (4.28)	p. 156
• recall that calcium carbonate is used in the production of glass, cement and iron (4.29)	p. 130-3, 91

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, 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

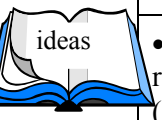
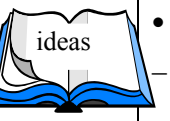
• identify the live, neutral and earth conductors in a correctly wired plug and recall the colour of the insulation used on each conductor (5.12)	p. 275
• recall that a fuse is placed in the live conductor and understand that the fuse protects the appliance, circuit and connecting wires from overheating (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)**	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. 302-4, 113
• 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

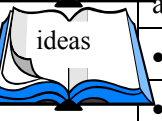


• describe the change of direction of light as it enters glass from air and as it leaves glass into air (eg, glass block, glass prism) (6.10)	p. 176, 192
• understand the refraction of light in terms of the change of speed when light crosses a boundary (6.11)	p. 176, 193
• recall that light and infra-red 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

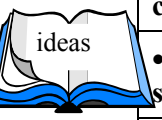
Atoms	Chapter 39
Candidates will be assessed on their ability to:	
• understand the terms atomic (proton) number and mass (nucleon) number and explain the existence of isotopes (6.27)	p. 353
• use symbols such as $^{14}_{6}C$ to describe particular nuclei (6.28)	p. 353
• understand that radioactivity 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 7: Food production and the environment Biology for You	
Action in leaves	
Candidates will be assessed on their ability to:	
• recall that plant and animal cells are similar because they contain nuclei, cytoplasm and membranes (7.01)	pages 8-9
• recall that plant cells also have cellulose cell walls, chloroplasts containing chlorophyll and vacuoles (7.02)	9
• recall the reactants for (carbon dioxide, water) and products of (glucose, oxygen) photosynthesis (7.03)	205
• outline the uses of glucose produced by photosynthesis (respiration, food storage, cellulose and growth) (7.04)	209
• understand that phloem is a living tissue that transports sugars, made during photosynthesis, from the leaves to the fruits and other storage organs (7.05)	224 230
• explain the interdependence of plants and animals in relation to oxygen and carbon dioxide (7.06)	210
• explain the effect of limiting factors on the rate of photosynthesis, to include light intensity, temperature, carbon dioxide concentration (7.07)	211-213
Action in roots	
Candidates will be assessed on their ability to:	
• understand why plants need mineral salts (including nitrates to make proteins for growth and magnesium to make chlorophyll) (7.08)	218
• **describe how mineral salts are taken up in the roots by active transport using energy from respiration (7.09)**	26
• recall that osmosis is the diffusion of water molecules from a region of higher water concentration to a region of lower water concentration through a selectively permeable membrane (7.10)	21
• describe how water is absorbed by the root hairs from the soil by the process of osmosis (7.11)	22-23, 226
Control of plant activity	
Candidates will be assessed on their ability to:	
• recall that xylem contains dead hollow cells that transport water from the roots to all other parts of the plant (7.12)	224-225
• describe how water is lost by diffusion through the stomata of the leaves during transpiration (7.13)	227-228

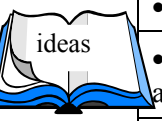
• understand the functions of water in plant cells including photosynthesis and maintenance of turgidity (7.14)	p. 208 228
• describe how the rate of water loss through the stomata varies with temperature, light, air movement, humidity (7.15)	228
• interpret data on how plant hormones affect the growth of roots and shoots (7.16)	243-244
• describe the commercial use of plant hormones for tissue culture, cuttings, fruit development and killing weeds (7.17)	245
Energy and ecosystems	
Candidates will be assessed on their ability to:	
• describe food chains quantitatively using pyramids of biomass (7.18)	359
• describe how energy is transferred in ecosystems through food chains from producers to each level of consumer (7.19)	362-363
• explain how energy is lost from food chains by respiration and excretion (7.20)	360-363
• understand that there is a greater loss of energy when the transfer involves a mammal in which energy from respiration is used to generate heat (7.21)	363
Action of microorganisms in ecosystems	
Candidates will be assessed on their ability to:	
• describe how the process of decay is affected by:	
– moisture	369-370
– temperature	369-370
– oxygen	369-370
– the presence of microorganisms (7.22)	369-370
• describe the carbon cycle including the role of microorganisms, photosynthesis, respiration and combustion (7.23)	371
• describe the reasons for deforestation (including the use of trees as fuel, urban development and farming) (7.24)	346
• understand that sustainable forestry requires replacement planting (7.25)	346
• explain how deforestation has affected the carbon dioxide concentration in the atmosphere (including combustion, reduced photosynthesis and decomposition) (7.26)	346
• explain how better conservation can lead to greater biodiversity (7.27)	350-351
• **describe the nitrogen cycle and explain the roles of**	
– **nitrogen-fixing bacteria**	373
– **decomposers**	373
– **nitrifying bacteria**	373
– **denitrifying bacteria**	373
– **nitrate fertilisers (7.28)**	373



Maximising food production	
Candidates will be assessed on their ability to:	
• explain the benefits to farmers of using pesticides, including insecticides, herbicides and fungicides (7.29)	p. 348, 364-365
• recall the dangers of the over-use of pesticides (7.30)	348, 364-365
• explain the use of biological control in food production (including the introduction of predators and sterile males) (7.31)	365
• **explain how greenhouse management maximises food production by optimising conditions for photosynthesis and by controlling pests (7.32)**	221
• **interpret evidence about the costs and benefits of intensive farming to include the supply of heat, the use of pesticides, inorganic fertilisers and transport (7.33)**	219, 366
Natural ecosystems	
Candidates will be assessed on their ability to:	
• recall that biodiversity is the number of different types of living things in an ecosystem (7.34)	350
• evaluate qualitative comparisons of biodiversity between two habitats (7.35)	350-351
• explain the distribution and relative abundance of common plants growing in an area (7.36)	334



Module 8 : Health and exercise Biology for You	
The lungs	
Candidates will be assessed on their ability to:	
• describe how the structure of the thorax enables ventilation of the lungs and efficient gas exchange (to include trachea, cartilage rings, bronchi, bronchioles, alveoli, diaphragm, ribs and intercostal muscles) (8.01)	p. 75 77
• describe the process of inhaling (breathing in) (8.02)	76
• explain how the membrane lining the internal surface of the nose and lungs traps dirt particles and bacteria and the role of the cilia in eliminating these (8.03)	74
• explain how cigarette smoke can lead to emphysema (8.04)	83
• describe how the tar in cigarette smoke contains carcinogens, which can cause lung cells to mutate to form lung cancer (8.05)	83-84
• describe some methods people can use to help them to give up smoking (8.06)	--------
The circulation	
Candidates will be assessed on their ability to:	
• describe the main features of the circulatory system to include the circulation to the lungs and circulation to the rest of the body (8.07)	89-90
• explain how the structure of a red blood cell relates to its function (8.08)	98
• explain how the structure of the heart relates to its function, including the role of the valves (8.09)	92-93
• recall that the coronary vessels supply the heart muscle with glucose and oxygen (8.10)	94
• recall that a pulse is caused by blood pumping along an artery from the heart (8.11)	91
• describe how the structure of arteries and veins relate to their function (8.12)	91
• explain how substances are transferred by diffusion between tissues and capillaries (8.13)	89, 101
• explain the effects of life style and diet on the circulatory system (8.14)	96
• describe the general effects of heart disease and arteriosclerosis (8.15)	95
• understand how insulin produced by the pancreas regulates the glucose concentration in the blood (8.16)	108
• **explain the advantages to diabetics of the use of human insulin produced by genetically modified bacteria (8.17)**	114, 289
Respiration, energy and exercise	
Candidates will be assessed on their ability to:	
• recall that aerobic respiration provides energy for work (8.18)	69

• explain how glucose and oxygen diffuse from capillaries into respiring cells, and how carbon dioxide diffuses from respiring cells into capillaries (8.19)	p. 89, 98, 101
• explain why heart rate and breathing rate increase with exercise and interpret data on these measurements (8.20)	79 94
• explain why respiration is increased in exercising muscles and why diffusion of oxygen and carbon dioxide at the lung surface and muscle cells is increased (8.21)	78-79
• explain why during vigorous exercise, muscle cells may not receive sufficient oxygen for their energy requirements (8.22)	82
• understand that during anaerobic respiration, glucose is changed to lactic acid and energy is released (8.23)	82
• recall that lactic acid causes muscle cramp (8.24)	82
• explain why extra oxygen is needed to remove the lactic acid (oxygen debt) (8.25)	82
Misuse of drugs	
Candidates will be assessed on their ability to:	
• recall the effects of steroid abuse in young people and athletes (8.26)	134
Inherited diseases	
Candidates will be assessed on their ability to:	
• **describe the mechanism of inheritance of some genetic disorders, to include cystic fibrosis and sickle cell anaemia (8.27)**	286-288
• recall the symptoms of cystic fibrosis (8.28)	286
• recall the symptoms of sickle cell anaemia (8.29)	288
 • explain the potential of gene therapy for the relief of symptoms of inherited diseases such as cystic fibrosis (8.30)	291
• understand why gene therapy would not prevent the disease from being passed on to the next generation (8.31)	291
 • **explain how genetic counselling and pedigree analysis can identify carriers; discuss the moral and spiritual dilemmas relating to testing of fetuses for genetic disease (8.32)**	288

Module 9 : Chemicals and the Earth **Chemistry for You**	
Candidates will be assessed throughout this module on their ability to:	
• recall the formulae of elements and simple compounds in the module	Throughout
• represent chemical reactions by word equations; write simple balanced equations and use the state symbols (s), (l), (g) and (aq)	p. 24-6
• **write balanced equations to describe and explain a wide range of reactions including ionic equations and those occurring in electrolytic cells**	**Throughout (Electrolysis Chapter 9)**
Metals	
Candidates will be assessed on their ability to:	
• recall some everyday uses of iron/steel, aluminium and copper (9.01)	p. 94, 107, 56, 59
Extracting metals from their ores	Chapter 8,9
Candidates will be assessed on their ability to:	
• recall that most metals are extracted from their ores which are found in their natural state in the Earth (9.02)	p. 88
• understand that reduction is the loss of oxygen from a compound, eg the formation of copper from copper oxide (9.03)	p. 90
• **define oxidation in terms of loss of electrons and reduction in terms of gain of electrons (9.04)**	p. **115**
• understand that the extraction of metals involves reduction of their ores (9.05)	p. 90
• relate the order of reactivities of metals to the stabilities of their ores and to their method of extraction	p. 89, 98
– by heating the ore with carbon monoxide (eg iron)	p. 91
– by using electrical energy (eg aluminium) (9.06)	p. 107, 120
• describe the process by which iron is extracted from iron oxide in a blast furnace, including outline diagrams, raw materials, reactions and the formation and uses of slag (9.07)	p. 91
• recall that a chemical reaction caused by electricity is called electrolysis (9.08)	p. 100
• understand that electrolysis is the movement of charged ions to the anode and cathode, followed by discharge (9.09)	p. 101-5
• describe the extraction of aluminium from purified bauxite including simple cell diagrams, nature of electrolyte and electrodes and reactions (9.10)	p. 107
• describe the purification of copper by electrolysis, including a simple diagram of the cell (9.11)	p. 113

The transition metals	Chapter 5
Candidates will be assessed on their ability to:	
• locate the position of the transition metals in the periodic table (9.12)	p. 43, 56
• describe the physical properties of the common transition metals (high melting points, good conductors of heat and electricity and high density as exemplified by iron and copper) (9.13)	p. 56
• recognise that transition metals form coloured compounds (9.14)	p. 57
• describe some uses of transition metals and their compounds as catalysts (9.15)	p. 57
The alkali metals	Chapter 5
Candidates will be assessed on their ability to:	
• recall that lithium, sodium and potassium are alkali metals (9.16)	p. 50
• recall that the alkali metals have comparatively low melting points and are soft (9.17)	p. 50
• describe the reactions of lithium, sodium and potassium with water to form hydroxides which are alkaline (pH>7), and hydrogen gas (9.18)	p. 51, 47
• describe the pattern in reactivity of the alkali metals lithium, sodium, and potassium towards water, and use this pattern to predict the reactivity of other alkali metals (9.19)	p. 51
Rocks and their uses	Chapter 10, 26
Candidates will be assessed on their ability to:	
• recall that hydrogen, chlorine and sodium hydroxide are produced by the electrolysis of concentrated aqueous sodium chloride (rock salt) (9.20)	p. 122-3
• recall the uses of sodium chloride, hydrogen and sodium hydroxide (9.21)	p. 118-19, 124-5
• understand that the crystalline nature of igneous rocks and the fact that they do not contain fossils are evidence for their formation from hot, molten magma (9.22)	p. 332
• understand that crystal size in igneous rocks depends on the rate of cooling (9.23)	p. 332
• understand that the presence of fossils in a rock is evidence that it has been formed from sediments (9.24)	p. 330
• understand that in sedimentary rocks the deepest layers are usually the oldest, that sedimentary rocks may contain fossils, and that the type of fossil can help to date the rocks (9.25)	p. 330, Teacher Support Pack
• explain how metamorphic rocks are formed by the action of heat and pressure on existing rocks (9.26)	p. 331
• understand that metamorphic rocks having the same composition as other rocks is evidence for their formation from these rocks – for example marble and limestone are both calcium carbonate (9.27)	p. 331

The atmosphere	Chapter 25
Candidates will be assessed on their ability to:	
• recall the current composition of the atmosphere (9.28)	p. 314
• understand that the early atmosphere was probably formed from the gases produced by volcanic activity (9.29)	p. 320-1
 • recall that originally the atmosphere probably contained a large amount of carbon dioxide together with water vapour, hydrogen, nitrogen and carbon monoxide (9.30)	p. 320-1
• explain the origins of the oceans by condensation of water vapour and describe how the percentage of carbon dioxide in the atmosphere was consequently reduced (9.31)	p. 320-1
• explain that the first primitive plants released oxygen as a result of photosynthesis and that the percentage of oxygen gradually increased (9.32)	p. 320-1
 • explain that at present the atmosphere is in a state of approximate balance because	
– the process of photosynthesis produces oxygen in the presence of sunlight	p. 318, 180
– respiration and the burning of fuels use oxygen and produce carbon dioxide	p. 318, 189
– carbon dioxide is absorbed by the seas and oceans (9.33)	p. 318, 297
Useful products from air	Chapter 20
Candidates will be assessed on their ability to:	
• recall the conditions under which nitrogen, from air, and hydrogen can be combined to form ammonia and that the Haber process is an important industrial process (9.34)	p. 241, 243
• understand that this reaction is reversible and may reach a dynamic equilibrium (9.35)	p. 240-1
• **explain the choice of conditions used in the Haber process in terms of rates of reaction and of the effects on equilibrium and yields of**	p. 241
– **catalyst**	p. 241
– **pressure**	p. 241
– **temperature (9.36)**	p. 241
• recall that nitrogenous fertilisers promote growth in plants (9.37)	p. 242, 248
• understand that a nitrogenous fertiliser is manufactured by neutralising ammonia with nitric or sulfuric acid (9.38)	p. 246-7
• describe the environmental consequences of the over-use of fertilisers (9.39)	p. 250
The noble gases	Chapter 6
Candidates will be assessed on their ability to:	
• describe the noble gases as chemically inert compared with the other elements (9.40)	p. 66
• relate this lack of reactivity to the electronic arrangement in their atoms (9.41)	p. 66
• describe some uses of the noble gases in, for example, fluorescent lights, airships, balloons and light bulbs (9.42)	p. 68-9

Module 10 : Understanding chemical reactions Chemistry for You	
Candidates will be assessed throughout this module on their ability to:	
• recall the formulae of elements and simple compounds in the module	Throughout
• represent chemical reactions by word equations; write simple balanced equations and use the state symbols (s), (l), (g) and (aq)	p. 24-6
• **write balanced equations to describe and explain a wide range of reactions including ionic equations**	Throughout
Atoms and isotopes	Chapter 3
Candidates will be assessed on their ability to:	
• recall that all atoms of the same element have the same number of protons (10.01)	p. 43
• recall the relative charges and relative masses of protons, neutrons and electrons (10.02)	p. 29
• understand the terms atomic number and mass number (10.03)	p. 31
• understand that isotopes are atoms of the same elements with the same number of protons and electrons, but different numbers of neutrons (10.04)	p. 33
• **calculate the relative atomic mass of an element from relative masses and abundances of its isotopes (10.05)**	p. 34
Chemical bonds	Chapters 21, 22
Candidates will be assessed on their ability to:	
• recall that some elements combine by means of chemical reactions to form compounds, for example, water, carbon dioxide, sodium chloride and iron sulfide (10.06)	p. 16, 17
• recall that an ion is an atom or group of atoms with a positive or negative charge (10.07)	p. 71, 262-3
• recall that ionic bonds are formed between atoms of a metal and a non-metal, for example, sodium and chlorine forming sodium chloride (10.08)	p. 262-3-3
• recall that chemical bonding involves the transfer or sharing of electrons (10.09)	p. 262-3, 270
• explain the formation of simple ionic compounds (for example, sodium chloride) in terms of transfer of electrons (10.10)	p. 262-3
• describe the structure of ionic compounds as a lattice structure, consisting of a regular arrangement of ions, held together by strong forces between them, forming crystals (10.11)	p. 266-7
• describe and explain the physical properties of giant ionic structures, including sodium chloride and magnesium oxide (10.12)	p. 266-7
• recall that covalent bonds are formed between atoms of some non metals to produce molecules (including hydrogen, nitrogen, oxygen, chlorine and hydrogen chloride) (10.13)	p. 270-1
• explain the formation of simple covalent molecules (eg hydrogen, hydrogen chloride, water, methane, **carbon dioxide**) in terms of shared electrons between non-metal atoms, using dot and cross diagrams (10.14)	p. 271, Teacher Support Pack

• describe the physical properties of simple molecular compounds (10.15)	p. 276
• **understand that covalent bond formation can result in simple molecules (eg hydrogen, iodine) and giant structures (eg diamond and graphite) (10.16)**	p. 272-3, 276
• **describe and explain the differences between the physical properties of simple molecular substances and those with giant molecular structures (10.17)**	p. 276
Energy transfers	Chapter 15
Candidates will be assessed on their ability to:	
• recall that changes of temperature often accompany reactions (10.18)	p. 190-2
• recall that an exothermic reaction is one in which thermal energy is given out (10.19)	p. 190-2
• recall that an endothermic reaction in one in which thermal energy is taken in (10.20)	p. 190-2
• **understand that the breaking of bonds is endothermic and that the making of bonds is exothermic (10.21)**	p. 194
Using chemical equations	Chapters 3, 28
Candidates will be assessed on their ability to:	
• calculate the relative formula masses of simple compounds, given relative atomic masses (10.22)	p. 35
• **use chemical equations quantitatively to determine the masses of substances used and produced (10.23)**	p. 362-3
• **determine the empirical formulae of simple compounds from reacting masses (10.24)**	p. 358-61

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) $a = \frac{(v-u)}{t}$	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**	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* × *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* × *g* × *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* = ½ × *m* × *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
ideas • 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
ideas • 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
ideas • 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** $\boldsymbol{E = I \times V \times t}$ – **(*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
ideas • 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

Specification content – for Separate Sciences

The modules listed below, when taken in conjunction with the appropriate ones from the twelve previous modules, 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

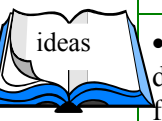
Candidates may therefore wish to follow a modular pathway leading to an award in the single separate sciences as set out below:

	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

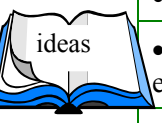
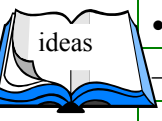
Module 13: Microorganisms and disease in humans

Biology for You

Structure and reproduction of microorganisms	
Candidates will be assessed on their ability to:	
• understand that pathogenic microorganisms are parasitic and they include all viruses and some bacteria, protozoa and fungi (13.01)	pages 171-173
• recognise the potential of microorganisms for extremely rapid reproduction (13.02)	p. 173
• recall the structure of a virus, including DNA or RNA core and protein coat, and that viruses lack some basic processes common to most living organisms (13.03)	p. 173
• understand that replication of viruses takes place by	
– injection of viral DNA into host cell	173
– the control of protein manufacture by viral DNA	173
– the production of new viruses	173
– the destruction of host cell and escape of new viruses which can then attack new host cells (13.04)	173
• recall the structure of a bacterial cell including single chromosome (nucleoid), cytoplasm (in some cases including plasmids), surface membrane and wall (13.05)	171 268
• understand that bacteria reproduce by cell division (mitosis) and that some bacteria form spores when unfavourable conditions arise (13.06)	172
• recall that these spores are resistant to low temperature, high temperature, change in pH, desiccation and the effect of chemicals, and that they can grow into new bacterial cells if favourable conditions return (13.07)	171-172, 268
• recall the structure of fungi including mycelium of branched hyphae with nuclei, cytoplasm, surface membrane and wall; understand that reproduction is by spore production (13.08)	172 269
• recall the structure of yeast and understand that it reproduces by budding (13.09)	154
• recall the word equation for anaerobic respiration in yeast	81
– glucose → ethanol + carbon dioxide and energy released (13.10)	81
• understand the effect of temperature, food supply and the build up of toxic waste products on the rate of reproduction of bacteria and fungi (including yeast); evaluate data relating to potential and actual population growth in microorganisms (13.11)	81, 172



The spread and control of disease	
Candidates will be assessed on their ability to:	
• recall that infectious diseases are caused by pathogens (13.12)	p. 171-172
• understand the importance of safe drinking water (13.13)	175
• understand that pathogens are spread in various ways	
– in water (cholera bacterium) or food (*Salmonella* bacterium)	175
– in air (influenza virus)	175
– by contact (athlete's foot fungus)	172
– by body fluids (hepatitis B virus)	176
– by animal vectors (housefly: dysentery bacterium, *Anopheles* mosquito: malarial protozoan) (13.14)	176
• recognise the impact of global travel on the spread of disease and distinguish between the terms epidemic and endemic (13.15)	-------
• explain the importance to the individual and to the community of personal hygiene measures in preventing disease (13.16)	176
• describe the causative agents, symptoms, methods of transmission and means of control of malaria and influenza (13.17)	183
• understand that sterilisation can be achieved by the use of heat, chemicals (including chlorine) and irradiation (13.18)	190-191
• distinguish between antiseptics and disinfectants and explain their different characteristics and applications (13.19)	177
• explain the 'flash' process for milk pasteurisation; interpret data from experiments to investigate the effectiveness of pasteurisation (13.20)	190
• explain the treatment of sewage by the 'activated sludge' method, including the part played by the respiration of aerobic bacteria and of anaerobic bacteria, producing methane; label a diagram showing this sewage treatment process (13.21)	316-317
• understand that food poisoning is caused by various pathogens including *Escherichia coli* and *Salmonella* (13.22)	175
• explain how intensive methods of animal rearing may result in the spread of *Salmonella* bacteria (13.23)	366
• describe how *Salmonella* bacteria in meat and eggs reproduce quickly in warm storage conditions and produce toxins which have harmful effects in the human gut (13.24)	175
• explain methods of avoiding food poisoning by *Salmonella* including improved animal rearing, suitable food storage and cooking techniques (13.25)	190-191
• understand the danger of consuming irradiated food in which microorganisms have been killed but which may still contain their toxins (13.26)	191
• explain the roles of phagocytes and lymphocytes in the body's defence against microorganisms (13.27)	99 179

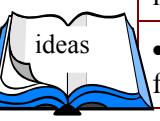
• **describe the role of memory B lymphocytes in secondary responses to antigen; interpret data showing variation in blood antibody levels in response to first and subsequent infections (13.28)**	p. 180
• **describe the production of monoclonal antibodies (technical details of the processes are not required) (13.29)**	192
• **understand the principles behind the use of monoclonal antibodies (13.30)**	192
 • recall that antibiotics are produced by some microorganisms and describe their effects; evaluate data relating to the effectiveness of different antibiotics (13.31)	182
• recall that penicillins are a major group of antibiotics, produced by a number of genetically different strains of the fungus *Penicillium* (13.32)	182
• understand that penicillins prevent cell wall manufacture in a wide range of bacteria and are bactericidal (13.33)	182
• describe and explain the technique for producing penicillin in an industrial fermenter; interpret and label a diagram of such a fermenter (13.34)	182
 • **understand the limitations of the use of antibiotics**	182
– **the reasons for their ineffectiveness against viruses**	182
– **the problems arising from their over-use in terms of the rapid evolution of resistant strains of bacteria by mutation and natural selection (13.35)**	300

Module 14 : Biotechnology Biology for You	
Fermentation	
Candidates will be assessed on their ability to:	
• understand that microorganisms use an external food source to obtain energy, changing some substances in the medium and recall that this process is fermentation (14.01)	p. 81
• recall that a fermenter is a vessel used to cultivate these microorganisms and explain the need to supply suitable conditions in fermenters, including aseptic precautions, nutrients, optimum temperature and pH, oxygenation and agitation (14.02)	315
• explain the advantages of using microorganisms for food production	309
– rapid population growth; ease of manipulation	309
– production independent of climate	309
– use of waste products from other industrial processes (14.03)	309
• explain the role of bacteria in the production of yoghurt from milk by the conversion of lactose to lactic acid (14.04)	312
• recall the origin of mycoprotein (the fungus *Fusarium*) and understand the advantages of using mycoprotein (14.05)	319
• understand the stages in the commercial production of soy sauce including fermentation of a mixture of cooked soya beans and roasted wheat using *Aspergillus*, further fermentation using yeasts and then *Lactobacillus*, filtration, pasteurisation, sterile bottling (14.06)	314
• evaluate the potential of biotechnology in relation to world food shortage (14.07)	314
Gene technology	
Candidates will be assessed on their ability to:	
• understand that DNA controls the joining together of amino acids to make a specific protein in a cell; the order of bases in a section of DNA decides the order of amino acids in the protein (14.08)	275
• understand that sections of DNA coding for specific proteins can be transferred into microorganisms which are then cultivated in fermenters to produce useful substances such as human insulin (14.09)	275, 315
• **describe the stages of protein synthesis**	275
– **the coding by triplets of bases to produce mRNA**	275
– **the linking of mRNA to tRNA at ribosomes**	275
– **the linking of amino acids to form polypeptides (14.10)**	275
• **evaluate the potential for using genetically modified plants to improve the production of food including introducing resistance to pests or to herbicides, increasing nutritional quality, extending shelf life and understand the potential for environmental damage (14.11)**	293
• **evaluate the potential for using transgenic animals including the production of 'designer milk' such as milk containing human antibodies, low cholesterol milk (14.12)**	324

Manipulating reproduction	
Candidates will be assessed on their ability to:	
• describe the process of tissue culture (micropropagation) where very small pieces of plants (explants) are grown *in vitro* using nutrient media; describe the advantages of the process in producing virus-free stock and commercial quantities of plants quickly (14.13)	p. 234
• describe the stages in the production of cloned mammals, such as Dolly the sheep: the introduction of a diploid nucleus from a mature cell into an enucleated egg cell, stimulation of the diploid nucleus to divide by mitosis; evaluate the risk associated with later embryonic development; describe the social and ethical concerns of cloning mammals (including the possibility of cloning of human body parts for transplant surgery) (14.14)	291, 324
• understand the collection, dilution and storage of cattle semen from genetically suitable bulls and its use in artificial insemination (14.15)	291
• **explain how offspring with desired characteristics can be produced by stimulation of ovulation in genetically suitable cows using hormone treatment, *in vitro* fertilisation of these ova and implantation of the resulting embryos into surrogate mothers (14.16)**	291

Module 15: Preparing and analysing Chemistry for You	
Candidates will be assessed throughout this module on their ability to:	
• recall the formulae of elements and simple compounds in the module	throughout
• represent chemical reactions by word equations; write simple balanced equations and use the state symbols (s), (l), (g) and (aq)	pages 24-6
• **write balanced equations to describe and explain a wide range of reactions including ionic equations and those occurring in electrolytic cells**	Throughout (Electrolysis in Chapter 9)
Solubility of salts	
Candidates will be assessed on their ability to:	
• recall the general rules which describe the solubility of common types of salt in water	151
– all common sodium, potassium and ammonium salts are soluble	151
– all nitrates are soluble	151
– all common ethanoates are soluble	
– common chlorides are soluble except those of silver and lead	151
– common sulfates are soluble except those of lead, barium and calcium	151
– common carbonates and hydroxides are insoluble except those of sodium, potassium and ammonium (15.01)	
• use solubility information and knowledge of the methods of preparation of salts to predict and explain a suitable method for the preparation of pure solid samples of salts (15.02)	151
• understand that insoluble salts can be formed as precipitates by the reaction of suitable reagents in solution (15.03)	151
• describe and understand the preparation of pure, dry samples of insoluble salts (15.04)	151
Titration	
Candidates will be assessed on their ability to:	
• understand the need to use titration to determine the exact amount of a soluble reactant which reacts with an acid when preparing some soluble salts (15.05)	246, 364-5
• recall the procedure for carrying out simple acid-base titrations using burette, pipette and suitable indicators (15.06)	246, 364-5
Collection and identification of gases	
Candidates will be assessed on their ability to:	
• understand how to collect gases by upward and downward delivery, over water and using a gas syringe (15.07)	244, 200
• recall how to collect and how to test for hydrogen, oxygen, ammonia, carbon dioxide, hydrogen chloride and sulfur dioxide (15.08)	55, 316, 245, 318, 233, 148

• appreciate the potential hazards when hydrogen, ammonia, hydrogen chloride and sulfur dioxide are collected or used (15.09)	p. 68, 244-5, 188, 172
Test for ions	
• understand that precipitation reactions form the basis of some tests for ions (15.10)	152, 309
• recall the tests for the following ions in solids or solutions as appropriate	
– H^+ using acid/base indicators and typical acid reactions;	143, 148
Na^+, K^+, Ca^{2+} , Cu^{2+} using flame tests	153
Al^{3+}, Ca^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, NH_4^+ using sodium hydroxide solution	309
CO_3^{2-} using dilute acid and identifying the carbon dioxide evolved	309
SO_3^{2-} using dilute hydrochloric acid and identifying the sulfur dioxide evolved	
SO_4^{2-} using dilute hydrochloric acid and barium chloride solution	152
Cl^-, Br^-, I^- using dilute nitric acid and silver nitrate solution	152
OH^- using acid/base indicators and reaction when heated with an ammonium salt (15.11)	309
• **explain, and write equations for, the ionic reactions involved in these tests (15.12)**	152, 309
Hard water	
Candidates will be assessed on their ability to:	
• define hard water as water which does not readily lather with soap but gives scum (15.13)	302
• appreciate that hard water wastes soap but does not affect soapless detergents and recall that dissolved calcium and magnesium salts cause hardness (15.14)	302, 312, 307
• understand that hardness results from contact with limestone, chalk and gypsum (15.15)	303
• recall and explain that boiling removes temporary hardness but not permanent hardness and that both types of hardness can be removed by ion exchange or the addition of sodium carbonate (15.16)	304-5
• understand industrial and domestic problems caused by deposition of scale (15.17)	302, 304
• understand that the presence of hardness in water causes the inner surface of pipework to become coated, which prevents corrosion and the entry of poisonous salts of copper or lead into the water supply (15.18)	302
• describe the treatment of water to make it suitable for domestic use, including the need for sedimentation, filtration and chlorination (15.19)	300-01



Quantitative chemistry	
Candidates will be assessed on their ability to:	
• **recall Avogadro's Law and use it to calculate volumes of gases in reactions, given the relevant equation (15.20)**	Teacher Support Pack worksheet
• **convert moles into masses and vice versa (15.21)**	p. 352-3
• **calculate the volume of a given mass of gas (given the molar volume at the appropriate temperature and pressure) and vice versa (15.22)**	354-5
• **calculate and inter-relate masses or volumes of substances involved in a reaction, given the relevant equation (15.23)**	362-3
• **convert mass-concentration into mol dm^{-3} and vice versa (15.24)**	356-7
• **perform simple calculations from the results of titration (15.25)**	364-5

Module 16 : Industrial and organic chemistry Chemistry for You	
Candidates will be assessed throughout this module on their ability to:	
• recall the formulae of elements and simple compounds in the module	
• represent chemical reactions by word equations; write simple balanced equations and use the state symbols (s), (l), (g) and (aq)	throughout
• **write balanced equations to describe and explain a wide range of reactions including ionic equations and those occurring in electrolytic cells**	pages 24-6
Making metals useful	
Candidates will be assessed on their ability to:	
• understand why aluminium is less reactive than expected and appreciate how anodising is achieved and the change that takes place during the process (16.01)	107-08
• appreciate the need for alloying aluminium to increase its strength (16.02)	282-3
• understand the important uses of aluminium and its alloys (16.03)	107, 284
• **explain the chemical reactions occurring in different parts of the blast furnace and the energy changes associated with them (16.04)**	91, 115
• understand that impure iron from the blast furnace and pure iron have very limited uses (16.05)	92
• describe the production of mild steel by lowering the carbon content in the impure iron using high pressure oxygen (16.06)	92
• describe the uses of mild steel (16.07)	94
• describe the uses of alloy steels such as stainless steel, titanium steel and manganese steel (16.08)	94-5
Sulfuric acid	
Candidates will be assessed on their ability to:	
• recall **and explain** the manufacture of sulfuric acid from sulfur and sulfide ores (16.09)	155, 89
• **explain the operating conditions used in the Contact process (16.10)**	Chp 19
• recall some uses of sulfuric acid to illustrate its economic importance (16.11)	154
Organic chemistry	
Candidates will be assessed on their ability to:	
• recall how ethanol is produced during the fermentation of carbohydrates and how to obtain a concentrated solution of ethanol by fractional distillation of the fermentation mixture (16.12)	214, 19, 180-1

• **recall that ethanol is also produced by hydration of ethene (16.13)**	page 180
• **evaluate the factors which are relevant to the choice of method to be used in the manufacture of ethanol, eg the relative availability of sugar cane and crude oil (16.14)**	p. 180
• understand that different amounts of ethanol are present in various drinks (16.15)	181
• understand the social issues and possible harmful effects of ethanol in alcoholic drinks (16.16)	181
• recall that industrial methylated spirit contains ethanol with added methanol to make it unfit to drink (16.17)	181
• understand the use of ethanol as a solvent and as a fuel (16.18)	181
• recall that ethanol can be oxidised to form ethanoic acid and that this reaction occurs in wine in an open bottle (16.19)	182
• understand that ethanoic acid is a typical acid, reacting with indicators and with metals, bases and carbonates to form ethanoate salts (16.20)	183
• recall that ethanoic acid is present in vinegar, which is used as a flavouring and as a preservative (16.21)	183
• recall that ethanol reacts with ethanoic acid to produce an ester, ethyl ethanoate (16.22)	183
• recall that esters are sweet smelling substances, which are present in flavourings (eg pear drops) and perfumes (16.23)	184
• **define homologous series and understand that alkanes, alkenes, alcohols and carboxylic acids are examples of such series (16.24)**	178
• **recall the names, formulae and structures of the first four members of each of these (16.25)**	159, 167, 178, 183 plus Teacher Support Pack worksheet
• **understand that members in an homologous series show a gradual variation in physical properties as exemplified by their boiling points (16.26)**	179
• **explain that the alcohols have similar chemical properties as exemplified by their combustion and esterification reactions (16.27)**	182-3
• **recall the formulae of esters formed from the acids and alcohols in this section and draw their structures (16.28)**	228, Teacher Support Pack worksheet

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) – $v = f \times \lambda$ $\quad f = \frac{v}{\lambda}$ $\quad \lambda = \frac{v}{f}$ (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*)** $\text{force} = \frac{\text{mass} \times (\text{orbital speed})^2}{\text{radius}} \qquad F = \frac{m \times v^2}{r}$ **(*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 (18.04)	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 (18.11)	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 (18.13)	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

end of subject content