OCR Combined Science B Revision Checklist

*Statements in **bold** are for higher tier only.*

Specification Statement	Learning Outcome	✓
	Biology	
	Unit B1	
B1.1.1	a) explain how the nucleus and genetic material of eukaryotic cells (plants and animals) and the genetic material, including plasmids, of prokaryotic cells are related to cell functions	
B1.1.1	b) describe how to use a light microscope to observe a variety of plant and animal cells	
B1.1.2	describe the genome as the entire genetic material of an organism	
B1.1.3	describe DNA as a polymer made up of nucleotides, forming two strands in a double helix	
B1.1.4	describe simply how the genome and its interaction with the environment influence the development of the phenotype of an organism, including the idea that most characteristics depend on instructions in the genome and are modified by interaction of the organism with its environment Learners are not expected to describe epigenetic effects	
B1.1.5	explain the terms chromosome, gene, allele, variant, genotype and phenotype	
B1.1.6	explain the importance of amino acids in the synthesis of proteins, including the genome as instructions for the polymerisation of amino acids to make proteins	
B1.2.1	explain the terms gamete, homozygous, heterozygous, dominant and recessive	
B1.2.2	explain single gene inheritance, including dominant and recessive alleles and use of genetic diagrams	
B1.2.3	predict the results of single gene crosses	
B1.2.4	use direct proportions and simple ratios in genetic crosses	
B1.2.5	use the concept of probability in predicting the outcome of genetic crosses	
B1.2.6	recall that most phenotypic features are the result of multiple genes rather than single gene inheritance Learners are not expected to describe epistasis and its effects	
B1.2.7	describe sex determination in humans	
B1.3.1	discuss the potential importance for medicine of our increasing understanding of the human genome, including the discovery of alleles associated with diseases and the genetic testing of individuals to inform family planning and healthcare	
B1.3.2	describe genetic engineering as a process which involves modifying the genome of an organism to introduce desirable characteristics	
B1.3.3	**describe the main steps in the process of genetic engineering including: isolating and replicating the required gene(s); putting the gene(s) into a vector (e.g. a plasmid); using the vector to insert the gene(s) into cells; selecting modified cells.**	
B1.3.4	explain some of the possible benefits and risks, including practical and ethical considerations, of using gene technology in modern agriculture and medicine	
	Unit B2	
B2.1.1	describe the relationship between health and disease	
B2.1.2	describe different types of disease (including communicable and non-communicable diseases)	
B2.1.3	explain how communicable diseases (caused by viruses, bacteria, protists and fungi) are spread in animals and plants	
B2.1.4	describe common human infections including influenza (viral), Salmonella (bacterial), Athlete's foot (fungal) and malaria (protist) and sexually transmitted infections in humans including HIV/AIDS (viral)	
B2.1.5	describe plant diseases including tobacco mosaic virus (viral), ash dieback (fungal) and crown gall disease (bacterial)	
B2.2.1	describe non-specific defence systems of the human body against pathogens, including	

	examples of physical, chemical and microbial defences	
B2.2.2	explain how platelets are adapted to their function in the blood	
B2.2.3	explain the role of the immune system of the human body in defence against disease	
B2.2.4	explain how white blood cells are adapted to their functions in the blood, including what they do and how it helps protect against disease	
B2.3.1	explain how the spread of communicable diseases may be reduced or prevented in animals and plants, to include a minimum of one common human infection, one plant disease and sexually transmitted infections in humans including HIV/AIDS	
B2.3.2	explain the use of vaccines in the prevention of disease, including the use of safe forms of pathogens and the need to vaccinate a large proportion of the population	
B2.4.1	a) describe how the interaction of genetic and lifestyle factors can increase or decrease the risk of developing non- communicable human diseases, including cardiovascular diseases, many forms of cancer, some lung and liver diseases and diseases influenced by nutrition, including type 2 diabetes	
B2.4.1	b) describe how to practically investigate the effect of exercise on pulse rate and recovery rate	
B2.4.2	use given data to explain the incidence of non-communicable diseases at local, national and global levels with reference to lifestyle factors, including exercise, diet, alcohol and smoking	
B2.4.3	in the context of data related to the causes, spread, effects and treatment of disease: a) translate information between graphical and numerical forms	
B2.4.3	b) construct and interpret frequency tables and diagrams, bar charts and histograms	
B2.4.3	c) understand the principles of sampling as applied to scientific data	
B2.4.3	d) use a scatter diagram to identify a correlation between two variables	
B2.4.4	describe interactions between different types of disease	
B2.5.1	explain the use of medicines, in the treatment of disease	
B2.5.2	calculate cross-sectional areas of bacterial cultures and of clear zones around antibiotic discs on agar jelly using πr^2	
B2.5.3	evaluate different strategies for lowering the risk of cardiovascular disease and treating it, including lifestyle changes, medicines and surgery	
B2.5.4	describe the process of discovery and development of potential new medicines including preclinical and clinical testing	
	<u>Unit B3</u>	
B3.1.1	a) describe the process of photosynthesis, including the inputs and outputs of the two main stages and the requirement of light in the first stage, and describe photosynthesis as an endothermic process	
B3.1.1	b) describe practical investigations into the requirements and products of photosynthesis	
B3.1.2	explain how chloroplasts in plant cells are related to photosynthesis	
B3.1.3	a) explain the mechanism of enzyme action including the active site, enzyme specificity and factors affecting the rate of enzyme-catalysed reactions, including substrate concentration, temperature and pH	
B3.1.3	b) describe practical investigations into the effect of substrate concentration, temperature and pH on the rate of enzyme controlled reactions	
B3.1.4	a) explain the effect of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis	
B3.1.4	b) describe practical investigations into the effect of environmental factors on the rate of photosynthesis	
B3.1.5	**use the inverse square law to explain why the rate of photosynthesis changes with distance from a light source**	
B3.1.6	**explain the interaction of temperature, light intensity and carbon dioxide, concentration in limiting the rate of photosynthesis, and use graphs depicting the effects**	
B3.1.7	in the context of the rate of photosynthesis: a) understand and use simple compound measures such as the rate of a reaction	
B3.1.7	b) translate information between graphical and numerical form	

B3.1.7	c) plot and draw appropriate graphs selecting appropriate scales for axes	
B3.1.7	d) extract and interpret information from graphs, charts and tables	
B3.2.1	describe some of the substances transported into and out of photosynthetic organisms in terms of the requirements of those organisms, including oxygen, carbon dioxide, water and mineral ions	
B3.2.2	a) explain how substances are transported into and out of cells through diffusion, osmosis and active transport.	
B3.2.2	b) describe practical investigations into the processes of diffusion and osmosis	
B3.2.3	explain how the partially permeable cell membranes of plant cells and prokaryotic cells are related to diffusion, osmosis and active transport	
B3.2.4	explain how water and mineral ions are taken up by plants, relating to the structure of the root hair cells to their function	
B3.2.5	a) explain how the structure of xylem and phloem are adapted to their functions in the plant	
B3.2.5	b) describe how to use a light microscope to observe the structure of the xylem and phloem	
B3.2.6	a) describe the processes of transpiration and translocation, including the structure and function of the stomata.	
B3.2.6	b) describe how to use a light microscope to observe the structure of stomata	
B3.2.6	c) describe how to use a simple potometer	
B3.2.7	a) explain the effect of a variety of environmental factors on the rate of water uptake by a plant, to include light intensity, air movement, and temperature	
B3.2.7	b) describe practical investigations into the effect of environmental factors on the rate of water uptake by a plant	
B3.2.8	in the context of water uptake by plants: a) use simple compound measures such as rate	
B3.2.8	b) carry out rate calculations	
B3.2.8	c) plot, draw and interpret appropriate graphs	
B3.2.8	d) calculate percentage gain and loss of mass	
B3.3.1	a) explain the importance of sugars, fatty acids and glycerol, and amino acids in the synthesis and breakdown of carbohydrates, lipids and proteins	
B3.3.1	b) describe the use of qualitative tests for biological molecules	
B3.3.2	describe photosynthetic organisms as the main producers of food and therefore biomass for life on Earth	
B3.3.3	describe some of the substances transported into organisms in terms of the requirements of those organisms, including dissolved food molecules	
B3.3.4	describe different levels of organisation in an ecosystem from individual organisms to the whole ecosystem	
B3.3.5	explain the importance of interdependence and competition in a community	
B3.3.6	recall that many different substances cycle through the abiotic and biotic components of an ecosystem	
B3.3.7	explain the importance of the carbon cycle and the water cycle to living organisms	
B3.3.8	explain the role of microorganisms in the cycling of substances through an ecosystem	
B3.3.9	calculate the percentage of mass, in the context of the use and cycling of substances in ecosystems	
B3.4.1	explain how some abiotic and biotic factors affect communities, including environmental conditions, toxic chemicals, availability of food and other resources, and the presence of predators and pathogens	
B3.4.2	describe how to carry out a field investigation into the distribution and abundance of organisms in an ecosystem and explain how to determine their numbers in a given area	
B3.4.3	in the context of data related to organisms within a population: a) calculate arithmetic means	
B3.4.3	b) use fractions and percentages	
B3.4.3	c) plot and draw appropriate graphs selecting appropriate scales for the axes	

B3.4.3	d) extract and interpret information from charts, graphs and tables	
	Unit B4	
B4.1.1	compare the processes of aerobic and anaerobic respiration, including conditions under which they occur, the inputs and outputs, and comparative yields of ATP	
B4.1.2	explain why cellular respiration occurs continuously in all living cells	
B4.1.3	explain how mitochondria in eukaryotic cells (plants and animals) are related to cellular respiration	
B4.1.4	describe cellular respiration as an exothermic process	
B4.1.5	a) describe practical investigations into the effect of different substances on the rate of respiration in yeast	
B4.1.5	b) carry out rate calculations for chemical reactions in the context of cellular respiration	
B4.2.1	explain how electron microscopy has increased our understanding of sub-cellular structures	
B4.2.2	in the context of cells and sub-cellar structures: a) demonstrate an understanding of number, size and scale and the quantitative relationship between units	
B4.2.2	b) use estimations and explain when they should be used	
B4.2.2	**c) calculate with numbers written in standard form**	
B4.3.1	a) describe the role of the cell cycle in growth, including interphase and mitosis	
B4.3.1	b) describe how to use a light microscope to observe stages of mitosis	
B4.3.2	describe cancer as the result of changes in cells that lead to uncontrolled growth and division	
B4.3.3	explain the role of meiotic cell division in halving the chromosome number to form gametes, including the stages of interphase and two meiotic divisions	
B4.3.4	describe the function of stem cells in embryonic and adult animals and meristems in plants	
B4.3.5	explain the importance of cell differentiation, in which cells become specialised by switching genes off and on to form tissues with particular functions	
B4.4.1	discuss potential benefits, risks and ethical issues associated with the use of stem cells in medicine	
	Unit B5	
B5.1.1	describe some of the substances transported into and out of the human body in terms of the requirements of cells, including oxygen, carbon dioxide, water, dissolved food molecules and urea	
B5.1.2	explain how the partially permeable cell membranes of animal cells are related to diffusion, osmosis and active transport	
B5.1.3	describe the human circulatory system, including its relationships with the gaseous exchange system, the digestive system and the excretory system	
B5.1.4	explain how the structure of the heart is adapted to its function, including cardiac muscle, chambers and valves	
B5.1.5	explain how the structure of arteries, veins and capillaries are adapted to their functions, including differences in the vessel walls and the presence of valves	
B5.1.6	explain how red blood cells and plasma are adapted to their functions in the blood	
B5.1.7	explain the need for exchanges surfaces and a transport system in multicellular organisms in terms of surface area:volume ratio	
B5.1.8	calculate surface area:volume ratios	
B5.2.1	explain how the components of the nervous system work together to enable it to function, including sensory receptors, sensory neurons, the CNS, motor neurons and effectors	
B5.2.2	explain how the structure of nerve cells and synapses relate to their functions	
B5.2.3	a) explain how the structure of a reflex arc, including the relay neuron, is related to its function	
B5.2.3	b) describe practical investigations into reflex actions	
B5.3.1	describe the principles of hormonal coordination and control by the human endocrine system	
B5.3.2	**explain the roles of thyroxine and adrenaline in the body, including thyroxine as an example of a negative feedback system**	
B5.4.1	explain the importance of maintaining a constant internal environment in response to internal	

	and external change	
B5.4.2	in the context of maintaining a constant internal environment: extract and interpret data from graphs, charts and tables	
B5.4.2	b) translate information between numerical and graphical forms	
B5.5.1	describe the role of hormones in human reproduction, including the control of the menstrual cycle	
B5.5.2	**explain the interactions of FSH, LH, oestrogen and progesterone in the control of the menstrual cycle**	
B5.5.3	explain the use of hormones in contraception and evaluate hormonal and non-hormonal methods of contraception	
B5.5.4	**explain the use of hormones in modern reproductive technologies to treat infertility**	
B5.6.1	explain how insulin controls the blood sugar level in the body	
B5.6.2	**explain how glucagon and insulin work together to control the blood sugar level in the body**	
B5.6.3	compare type 1 and type 2 diabetes and explain how they can be treated	
# Chemistry		
<u>Unit C1</u>		
C1.1.1	recall and explain the main features of the particle model in terms of the states of matter and change of state, distinguishing between physical and chemical changes and recognise that the particles themselves do not have the same properties as the bulk substances	
C1.1.2	**explain the limitations of the particle model in relation to changes of state when particles are represented by inelastic spheres**	
C1.1.3	use ideas about energy transfers and the relative strength of forces between particles to explain the different temperatures at which changes of state occur	
C1.1.4	use data to predict states of substances under given conditions	
C1.1.5	interpret evidence for how it is thought the atmosphere was originally formed	
C1.1.6	describe how it is thought an oxygen-rich atmosphere developed over time	
C1.1.7	describe the major sources of carbon monoxide and particulates (incomplete combustion), sulfur dioxide (combustion of sulfur impurities in fuels), oxides of nitrogen (oxidation of nitrogen at high temperatures and further oxidation in the air)	
C1.1.8	explain the problems caused by increased amounts of these substances and describe approaches to decreasing the emissions of these substances into the atmosphere including the use of catalytic converters, low sulfur petrol and gas scrubbers to decrease emissions	
C1.1.9	use chemical symbols to write the formulae of elements and simple covalent compounds	
C1.1.10	use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations	
C1.1.11	use arithmetic computations and ratios when balancing equations	
C1.1.12	describe tests to identify oxygen, hydrogen and carbon dioxide	
C1.1.13	explain oxidation in terms of gain of oxygen	
C1.2.1	distinguish between endothermic and exothermic reactions on the basis of the temperature change of the surroundings	
C1.2.2	draw and label a reaction profile for an exothermic and an endothermic reaction, identifying activation energy	
C1.2.3	explain activation energy as the energy needed for a reaction to occur	
C1.2.4	interpret charts and graphs when dealing with reaction profiles	
C1.2.5	**calculate energy changes in a chemical reaction by considering bond breaking and bond making energies**	
C1.2.6	carry out arithmetic computations when calculating energy changes	
C1.3.1	describe the greenhouse effect in terms of the interaction of radiation with matter	
C1.3.2	evaluate the evidence for additional anthropogenic causes of climate change, including the correlation between change in atmospheric carbon dioxide concentration and the consumption of fossil fuels, and describe the uncertainties in the evidence base	

C1.3.3	describe the potential effects of increased levels of carbon dioxide and methane on the Earth's climate, including where crops can be grown, extreme weather patterns, melting of polar ice and flooding of low land	
C1.3.4	describe how the effects of increased levels of carbon dioxide and methane may be mitigated, including consideration of scale, risk and environmental implications	
C1.3.5	extract and interpret information from charts, graphs and tables	
C1.3.6	use orders of magnitude to evaluate the significance of data	
C1.4.1	describe the principal methods for increasing the availability of potable water, in terms of the separation techniques used, including the ease of treating waste, ground and salt water including filtration and membrane filtration; aeration, use of bacteria; chlorination and distillation (for salt water)	
C1.4.2	describe a test to identify chlorine (using blue litmus paper)	
	Unit C2	
C2.1.1	describe how and why the atomic model has changed over time to include the main ideas of Dalton, Thomson, Rutherford and Bohr	
C2.1.2	describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with most of the mass in the nucleus	
C2.1.3	recall relative charges and approximate relative masses of protons, neutrons and electrons	
C2.1.4	estimate the size and scale of atoms relative to other particles	
C2.1.5	recall the typical size (order of magnitude) of atoms and small molecules	
C2.1.6	relate size and scale of atoms to objects in the physical world	
C2.1.7	calculate numbers of protons, neutrons and electrons in atoms, given atomic number and mass number of isotopes or by extracting data from the Periodic Table	
C2.2.1	explain how the position of an element in the Periodic Table is related to the arrangement of electrons in its atoms and hence to its atomic number	
C2.2.2	describe how Mendeleev organised the elements based on their properties and relative atomic masses	
C2.2.3	describe how discovery of new elements and the ordering elements by atomic number supports Mendeleev's decisions to leave gaps and reorder some elements	
C2.2.4	describe metals and non-metals and explain the differences between them on the basis of their characteristic physical and chemical properties, including melting point, boiling point, state and appearance, density, formulae of compounds, relative reactivity and electrical conductivity	
C2.2.5	recall the simple properties of Group 1 elements including their reaction with moist air, water and chlorine	
C2.2.6	recall the simple properties of Group 7 elements including their states and colours at room temperature and pressure, their colours as gases, their reactions with Group 1 elements and their displacement reactions with other metal halides	
C2.2.7	predict possible reactions and probable reactivity of elements from their positions in the Periodic Table	
C2.2.8	describe experiments to identify the reactivity pattern of Group 7 elements including displacement reactions	
C2.2.9	describe experiments to identify the reactivity pattern of Group 1 elements	
C2.3.1	recall the simple properties of Group 0 including their low melting and boiling points, their state at room temperature and pressure and their lack of chemical reactivity	
C2.3.2	explain how observed simple properties of Groups 1, 7 and 0 depend on the outer shell of electrons of the atoms and predict properties from given trends down the groups	
C2.3.3	explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number	
C2.3.4	explain how the atomic structure of metals and non-metals relates to their position in the Periodic Table	
C2.3.5	describe the nature and arrangement of chemical bonds in ionic compounds	

C2.3.6	explain ionic bonding in terms of electrostatic forces and transfer of electrons	
C2.3.7	calculate numbers of protons, neutrons and electrons in atoms and ions, given atomic number and mass number or by using the Periodic Table	
C2.3.8	construct dot and cross diagrams for simple ionic substances	
C2.3.9	explain how the bulk properties of ionic materials are related to the type of bonds they contain	
C2.3.10	use ideas about energy transfers and the relative strength of attraction between ions to explain the melting points of ionic compounds compared to substances with other types of bonding	
C2.3.11	describe the limitations of particular representations and models of ions and ionically bonded compounds, including dot and cross diagrams, and 3-D representations	
C2.3.12	translate information between diagrammatic and numerical forms and represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for ionic compounds	
C2.4.1	use chemical symbols to write the formulae of elements and simple covalent and ionic compounds	
C2.4.2	use the formulae of common ions to deduce the formula of Group 1 and Group 7 compounds	
C2.4.3	use the names and symbols of the first 20 elements, Groups 1, 7 and 0 and other common elements from a supplied Periodic Table to write formulae and balanced chemical equations where appropriate	
C2.4.4	describe the physical states of products and reactants using state symbols (s, l, g and aq)	
Unit C3		
C3.1.1	describe the nature and arrangement of chemical bonds in metals	
C3.1.2	explain how the bulk properties of metals are related to the type of bonds they contain	
C3.2.1	deduce an order of reactivity of metals based on experimental results including reactions with water, dilute acid and displacement reactions with other metals	
C3.2.2	explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion to include potassium, sodium, calcium, aluminium, magnesium, zinc, iron, lead, [hydrogen], copper, silver	
C3.2.3	use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations **and ionic equations**	
C3.2.4	explain, using the position of carbon in the reactivity series, the principles of industrial processes used to extract metals, including the extraction of zinc	
C3.2.5	explain why electrolysis is used to extract some metals from their ores	
C3.2.6	**evaluate alternative biological methods of metal extraction (bacterial and phytoextraction)**	
C3.3.1	describe electrolysis in terms of the ions present and reactions at the electrodes	
C3.3.2	predict the products of electrolysis of binary ionic compounds in the molten state	
C3.3.3	recall that metals (or hydrogen) are formed at the cathode and non-metals are formed at the anode in electrolysis using inert electrodes	
C3.3.4	**use the names and symbols of common elements and compounds and the principle of conservation of mass to write half equations**	
C3.3.5	**explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced**	
C3.3.6	explain how electrolysis is used to extract some metals from their ores including the extraction of aluminium	
C3.3.7	describe competing reactions in the electrolysis of aqueous solutions of ionic compounds in terms of the different species present, including the formation of oxygen, chlorine and the discharge of metals or hydrogen linked to their relative reactivity	
C3.3.8	describe the technique of electrolysis of an aqueous solution of a salt	
C3.4.1	recall that crude oil is a main source of hydrocarbons and is a feedstock for the petrochemical industry	
C3.4.2	explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is a finite resource	
C3.4.3	describe and explain the separation of crude oil by fractional distillation	

C3.4.4	describe the fractions of crude oil as largely a mixture of compounds of formula C_nH_{2n+2} which are members of the alkane homologous series	
C3.4.5	use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur	
C3.4.6	deduce the empirical formula of a compound from the relative numbers of atoms present or from a model or diagram and vice versa	
C3.4.7	use arithmetic computation and ratio when determining empirical formulae	
C3.4.8	describe the arrangement of chemical bonds in simple molecules	
C3.4.9	explain covalent bonding in terms of the sharing of electrons	
C3.4.10	construct dot and cross diagrams for simple covalent substances	
C3.4.11	represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for simple molecules	
C3.4.12	describe the limitations of dot and cross diagrams, ball and stick models and two and three dimensional representations when used to represent simple molecules	
C3.4.13	translate information between diagrammatic and numerical forms	
C3.4.14	explain how the bulk properties of simple molecules are related to the covalent bonds they contain and their bond strengths in relation to intermolecular forces	
C3.4.15	describe the production of materials that are more useful by cracking	
	<u>Unit C4</u>	
C4.1.1	compare quantitatively the physical properties of glass and clay ceramics, polymers, composites and metals, including melting point, softening temperature (for polymers), electrical conductivity, strength (in tension or compression), stiffness, flexibility, brittleness, hardness, density, ease of reshaping	
C4.1.2	explain how the properties of materials are related to their uses and select appropriate materials given details of the usage required	
C4.2.1	explain how the bulk properties of materials (including strength, melting point, electrical and thermal conductivity, brittleness, flexibility, hardness and ease of reshaping) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged, recognising that the atoms themselves do not have these properties	
C4.2.2	recall that carbon can form four covalent bonds	
C4.2.3	explain that the vast array of natural and synthetic organic compounds occurs due to the ability of carbon to form families of similar compounds, chains and rings	
C4.2.4	describe the nature and arrangement of chemical bonds in polymers with reference to their properties including strength, flexibility or stiffness, hardness and melting point of the solid	
C4.2.5	describe the nature and arrangement of chemical bonds in giant covalent structures	
C4.2.6	explain the properties of diamond and graphite in terms of their structures and bonding, include melting point, hardness and (for graphite) conductivity and lubricating action	
C4.2.7	represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures e.g. allotropes of carbon	
C4.2.8	describe and compare the nature and arrangement of chemical bonds in ionic compounds, simple molecules, giant covalent structures, polymers and metals	
C4.3.1	compare ‘nano’ dimensions to typical dimensions of atoms and molecules	
C4.3.2	describe the surface area to volume relationship for different-sized particles and describe how this affects properties	
C4.3.3	describe how the properties of nanoparticulate materials are related to their uses including properties which arise from their size, surface area and arrangement of atoms in tubes or rings	
C4.3.4	explain the properties fullerenes and graphene in terms of their structures	
C4.3.5	explain the possible risks associated with some nanoparticulate materials including: a) possible effects on health due to their size and surface area b) reasons that there is more data about uses of nanoparticles than about possible health effects c) the relative risks and benefits of using nanoparticles for different purposes	

C4.3.6	estimate size and scale of atoms and nanoparticles including the ideas that: a) nanotechnology is the use and control of structures that are very small (1 to 100 nanometres in size) b) data expressed in nanometres is used to compare the sizes of nanoparticles, atoms and molecules	
C4.3.7	interpret, order and calculate with numbers written in standard form when dealing with nanoparticles	
C4.3.8	use ratios when considering relative sizes and surface area to volume comparisons	
C4.3.9	calculate surface areas and volumes of cubes	
C4.4.1	explain reduction and oxidation in terms of loss or gain of oxygen, identifying which species are oxidised and which are reduced	
C4.4.2	**explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced**	
C4.4.3	describe the basic principles in carrying out a life-cycle assessment of a material or product including: the use of water, energy and the environmental impact of each stage in a life cycle, including its manufacture, transport and disposal incineration, landfill and electricity generation schemes biodegradable and non-biodegradable materials	
C4.4.4	interpret data from a life-cycle assessment of a material or product	
C4.4.5	describe the process where PET drinks bottles are reused and recycled for different uses and explain why this is viable	
C4.4.6	evaluate factors that affect decisions on recycling with reference to products made from crude oil and metal ores	
	<u>Unit C5</u>	
C5.1.1	explain that many useful materials are formulations of mixtures	
C5.1.2	explain what is meant by the purity of a substance, distinguishing between the scientific and everyday use of the term 'pure'	
C5.1.3	use melting point data to distinguish pure from impure substances	
C5.1.4	recall that chromatography involves a stationary and a mobile phase and that separation depends on the distribution between the phases	
C5.1.5	interpret chromatograms, including calculating Rf values	
C5.1.6	suggest chromatographic methods for distinguishing pure from impure substances including the use of: a) paper chromatography b) aqueous and non-aqueous solvents c) locating agents	
C5.1.7	describe, explain and exemplify the processes of filtration, crystallisation, simple distillation, and fractional distillation	
C5.1.8	suggest suitable purification techniques given information about the substances involved	
C5.2.1	recall and use the law of conservation of mass	
C5.2.2	explain any observed changes in mass in non-enclosed systems during a chemical reaction and explain them using the particle model	
C5.2.3	calculate relative formula masses of species separately and in a balance chemical equation	
C5.2.4	**recall and use the definitions of the Avogadro constant (in standard form) and of the mole**	
C5.2.5	**explain how the mass of a given substance is related to the amount of that substance in moles and vice versa and use the relationship: number of moles = mass of substance (g) ÷ relative formula mass (g)**	
C5.2.6	**deduce the stoichiometry of an equation from the masses of reactants and products and explain the effect of a limiting quantity of a reactant**	
C5.2.7	**use a balanced equation to calculate masses of reactants or products**	
C5.2.8	use arithmetic computation, ratio, percentage and multistep calculations throughout quantitative chemistry	
C5.2.9	**carry out calculations with numbers written in standard form when using the Avogadro constant**	
C5.2.10	change the subject of a mathematical equation	
C5.3.1	**explain how the mass of a solute and the volume of the solution is related to the concentration of the solution and calculate concentration using the formula: concentration (g/dm^3) = mass of solute (g) ÷ volume (dm^3)**	

C5.3.2	**explain how the concentration of a solution in mol/dm^3 is related to the mass of the solute and the volume of the solution and calculate the molar concentration using the formula: concentration (mol/dm^3) = numbers of moles of solute ÷ volume (dm^3)**	
C5.3.3	describe neutralisation as acid reacting with alkali to form a salt plus water including the common laboratory acids hydrochloric acid, nitric acid and sulfuric acid and the common alkalis, the hydroxides of sodium, potassium and calcium	
C5.3.4	recall that acids form hydrogen ions when they dissolve in water and solutions of alkalis contain hydroxide ions	
C5.3.5	recognise that aqueous neutralisation reactions can be generalised to hydrogen ions reacting with hydroxide ions to form water	
C5.3.6	describe and explain the procedure for a titration to give precise, accurate, valid and repeatable results	
C5.3.7	evaluate the quality of data from titrations	
# Physics		
<u>Unit P1</u>		
P1.1.1	describe the main groupings of the electromagnetic spectrum – radio, microwave, infrared, visible (red to violet), ultraviolet, X- rays and gamma rays, that these range from long to short wavelengths, from low to high frequencies, and from low to high energies	
P1.1.2	recall that our eyes can only detect a very limited range of frequencies in the electromagnetic spectrum	
P1.1.3	recall that all electromagnetic radiation is transmitted through space with the same very high (but finite) speed	
P1.1.4	explain, with examples, that electromagnetic radiation transfers energy from source to absorber	
P1.1.5	recall that different substances may absorb, transmit, or reflect electromagnetic radiation in ways that depend on wavelength	
P1.1.6	recall that in each atom its electrons are arranged at different distances from the nucleus, that such arrangements may change with absorption or emission of electromagnetic radiation, and that atoms can become ions by loss of outer electrons	
P1.1.7	recall that changes in molecules, atoms and nuclei can generate and absorb radiations over a wide frequency range, including: a) gamma rays are emitted from the nuclei of atoms b) X-rays, ultraviolet and visible light are generated when electrons in atoms lose energy c) high energy ultraviolet, gamma rays and X-rays have enough energy to cause ionisation when absorbed by some atoms d) ultraviolet is absorbed by oxygen to produce ozone, which also absorbs ultraviolet, protecting life on Earth e) infrared is emitted and absorbed by molecules	
P1.1.8	describe how ultra-violet radiation, X-rays and gamma rays can have hazardous effects, notably on human bodily tissues	
P1.1.9	give examples of some practical uses of electromagnetic radiation in the radio, microwave, infrared, visible, ultraviolet, X-ray and gamma ray regions of the spectrum	
P1.1.10	**recall that radio waves can be produced by, or can themselves induce, oscillations in electrical circuits**	
P1.2.1	explain that all bodies emit radiation, and that the intensity and wavelength distribution of any emission depends on their temperatures	
P1.2.2	**explain how the temperature of a body is related to the balance between incoming radiation, absorbed radiation and radiation emitted; illustrate this balance, using everyday examples including examples of factors which determine the temperature of the Earth**	
P1.3.1	describe wave motion in terms of amplitude, wavelength, frequency and period	
P1.3.2	describe evidence that for both ripples on water surfaces and sound waves in air, it is the wave and not the water or air itself that travels	
P1.3.3	describe the difference between transverse and longitudinal waves	
P1.3.4	describe how waves on a rope are an example of transverse waves whilst sound waves in air	

	are longitudinal waves	
P1.3.5	define wavelength and frequency	
P1.3.6	Select and apply the relationship between speed, frequency and wavelength to waves, including waves on water, sound waves and across the electromagnetic spectrum: wave speed (m/s) = frequency (HZ) × wavelength (m)	
P1.3.7	a) describe how the speed of ripples on water surfaces and the speed of sound waves in air may be measured b) describe how to use a ripple tank to measure the speed/frequency and wavelength of a wave	
P1.3.8	a) describe the effects of reflection and refraction of waves at material interfaces b) describe how to measure the refraction of light through a prism c) describe how to investigate the reflection of light off a plane mirror	
P1.3.9	**recall that waves travel in different substances at different speeds and that these speeds may vary with wavelength**	
P1.3.10	**explain how refraction is related to differences in the speed of the waves in different substances**	
P1.3.11	recall that light is an electromagnetic wave	
P1.3.12	recall that electromagnetic waves are transverse	
	<u>Unit P2</u>	
P2.1.1	describe how energy in chemical stores in batteries, or in fuels at the power station, is transferred by an electric current, doing work on domestic devices, such as motors or heaters	
P2.1.2	explain, with reference to examples, the relationship between the power ratings for domestic electrical appliances, the time for which they are in use and the changes in stored energy when they are in use	
P2.1.3	Select and apply the following equation in the context of energy transfers by electrical appliances: energy transferred (J, kWh) = power (W, kW) × time (s, h)	
P2.1.4	describe, with examples, where there are energy transfers in a system, that there is no net change to the total energy of a closed system	
P2.1.5	describe, with examples, system changes, where energy is dissipated, so that it is stored in less useful ways	
P2.1.6	explain ways of reducing unwanted energy transfer e.g. through lubrication, thermal insulation	
P2.1.7	describe the effects, on the rate of cooling of a building, of thickness and thermal conductivity of its walls qualitative only	
P2.1.8	Select and apply the equation: efficiency = useful energy transferred ÷ total energy transferred to calculate energy efficiency for any energy transfer **and describe ways to increase efficiency**	
P2.1.9	interpret and construct Sankey diagrams to show understanding that energy is conserved	
P2.2.1	describe the main energy resources available for use on Earth (including fossil fuels, nuclear fuel, biofuel, wind, hydroelectricity, the tides and the Sun)	
P2.2.2	explain the differences between renewable and non-renewable energy resources	
P2.2.3	compare the ways in which the main energy resources are used to generate electricity	
P2.2.4	recall that the domestic supply in the UK is a.c., at 50 Hz and about 230 volts and explain the difference between direct and alternating voltage	
P2.2.5	recall that, in the National Grid, transformers are used to transfer electrical power at high voltages from power stations, to the network and then used again to transfer power at lower voltages in each locality for domestic use	
P2.2.6	recall the differences in function between the live, neutral and earth mains wires, and the potential differences between these wires; hence explain that a live wire may be dangerous even when a switch in a mains circuit is open, and explain the dangers of providing any connection between the live wire and any earthed object	
P2.2.7	explain patterns and trends in the use of energy resources in domestic contexts, workplace contexts, and national contexts	
	<u>Unit P3</u>	
P3.1.1	recall that current is a rate of flow of charge, that for a charge to flow, a source of potential	

	difference and a closed circuit are needed and that a current has the same value at any point in a single closed loop	
P3.1.2	Select and use the relationship between quantity of charge, current and time: charge (C) = current (A) × time (s)	
P3.1.3	recall that current (I) depends on both resistance (R) and potential difference (V) and the units in which these quantities are measured	
P3.1.4	a) select and apply the relationship between I, R, and V, to calculate the currents, potential differences and resistances in d.c. series circuits: potential difference (V) = current (A) × resistance (Ω). b) describe an experiment to investigate the resistance of a wire and be able to draw the circuit diagram of the circuit used	
P3.1.5	recall that for some components the value of R remains constant (fixed resistors) but that in others it can change as the current changes (e.g. heating elements, lamp filaments)	
P3.1.6	a) use graphs to explore whether circuit elements are linear or non-linear and relate the curves produced to their function and properties b) describe experiments to investigate the I-V characteristics of circuit elements. To include lamps, diodes, LDRs and thermistors. Be able to draw circuit diagrams for the circuits used	
P3.1.7	represent circuits with the conventions of positive and negative terminals, and the symbols that represent common circuit elements, filament lamps, diodes, LDRs and thermistors, switches and fixed and variable resistors	
P3.2.1	relate the potential difference between two points in the circuit to the work done on, or by, a given amount of charge as it moves between these points potential difference (V) = work done (energy transferred) (J) ÷ charge (C)	
P3.2.2	a) describe the difference between series and parallel circuits: to include ideas about how the current through each component and the potential difference across each component is affected by a change in resistance of a component. b) describe how to practically investigate the brightness of bulbs in series and parallel circuits. Be able to draw circuit diagrams for the circuits used	
P3.2.3	explain, why, if two resistors are in series the net resistance is increased, whereas with two in parallel the net resistance is decreased	
P3.2.4	solve problems for circuits which include resistors in series, using the concept of equivalent resistance	
P3.2.5	explain the design and use of d.c. series circuits for measurement and testing purposes including exploring the effect of: a) changing current in filament lamps, diodes, thermistors and LDRs b) changing light intensity on an LDR c) changing temperature of a thermistor (NTC only)	
P3.3.1	describe the energy transfers that take place when a system is changed by work done when a current flows through a component	
P3.3.2	explain, with reference to examples, how the power transfer in any circuit device is related to the energy transferred from the power supply to the device and its surroundings over a given time: power (W) = energy (J) ÷ time (s)	
P3.3.3	Select and use the relationship between the potential difference across the component and the total charge to calculate the energy transferred in an electric circuit when a current flows through a component: energy transferred (work done) (J) = charge (C) × potential difference (V)	
P3.3.4	Select and apply the relationships between power transferred in any circuit device, the potential difference across it, the current through it, and its resistance: a) power (W) = potential difference (V) × current (A) b) power (W)= (current (A))^2 × resistance (Ω)	
P3.3.5	use the idea of conservation of energy to show that when a transformer steps up the voltage, the output current must decrease and vice versa. select and use the equation: potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil	
P3.3.6	explain how transmitting power at higher voltages is more efficient way to transfer energy	
P3.4.1	describe the attraction and repulsion between unlike and like poles for permanent magnets	

P3.4.2	describe the characteristics of the magnetic field of a magnet, showing how strength and direction change from one point to another	
P3.4.3	explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic	
P3.4.4	describe the difference between permanent and induced magnets	
P3.4.5	describe how to show that a current can create a magnetic effect	
P3.4.6	describe the pattern and directions of the magnetic field around a conducting wire	
P3.4.7	recall that the strength of the field depends on the current and the distance from the conductor	
P3.4.8	explain how the magnetic effect of a solenoid can be increased	
P3.5.1	**describe the interaction forces between a magnet and a current-carrying conductor to include ideas about magnetic fields**	
P3.5.2	**show that Fleming's left-hand rule represents the relative orientations of the force, the conductor and the magnetic field**	
P3.5.3	**select and apply the equation that links the force (F) on a conductor to the strength of the field (B), the size of the current (I) and the length of conductor (l) to calculate the forces involved: force (N) = magnetic flux density (T) × current (A) × length of conductor (m)**	
P3.5.4	**explain how the force on a conductor in a magnetic field is used to cause rotation in the rectangular coil of a simple electric motor**	
	Unit P4	
P4.1.1	recall and apply Newton's third law	
P4.1.2	recall examples of ways in which objects interact: by gravity, electrostatics, magnetism and by contact (including normal contact force and friction)	
P4.1.3	describe how examples of gravitational, electrostatic, magnetic and contact forces involve interactions between pairs of objects which produce a force on each object	
P4.1.4	represent interaction forces as vectors	
P4.1.5	define weight	
P4.1.6	describe how weight is measured	
P4.1.7	Select and apply the relationship between the weight of an object, its mass and the gravitational field strength: weight (N) = mass (kg) × gravitational field strength (N/kg)	
P4.2.1	Select and apply the relationship: average speed (m/s) = distance (m) ÷ time (s)	
P4.2.2	recall typical speeds encountered in everyday experience for wind, and sound, and for walking, running, cycling and other transportation systems	
P4.2.3	a) make measurements of distances and times and calculate speeds. b) describe how to use appropriate apparatus and techniques to investigate the speed of a trolley down a ramp	
P4.2.4	make calculations using ratios and proportional reasoning to convert units, to include between m/s and km/h	
P4.2.5	explain the vector–scalar distinction as it applies to displacement and distance, velocity and speed	
P4.2.6	a) Select and apply the relationship: acceleration (m/s^2) = change in speed (m/s) ÷ time taken (s) b) explain how to use appropriate apparatus and techniques to investigate acceleration	
P4.2.7	select and apply the relationship: (final speed (m/s))^2 – (initial speed(m/s))^2 = 2 × acceleration (m/s^2) × distance (m)	
P4.2.8	draw and use graphs of distances and speeds against time to determine the speeds and accelerations involved	
P4.2.9	interpret distance–time and velocity–time graphs, including relating the lines and slopes in such graphs to the motion represented	
P4.2.10	**interpret enclosed areas in velocity – time graphs**	
P4.2.11	recall the value of acceleration in free fall and calculate the magnitudes of everyday accelerations using suitable estimates of speeds and times	
P4.3.1	describe examples of the forces acting on an isolated solid object or system	
P4.3.2	describe, using free body diagrams, examples where several forces lead to a resultant force on an object and the special case of balanced forces (equilibrium) when the resultant force is zero	

	qualitative only	
P4.3.3	**use scale drawings of vector diagrams to illustrate the addition of two or more forces, in situations when there is a net force, or equilibrium**	
P4.3.4	**Select and apply the equation for momentum and describe examples of the conservation of momentum in collisions: momentum (kg m/s) = mass (kg) × velocity (m/s)**	
P4.3.5	**select and apply Newton's second law in calculations relating force, change in momentum and time: change in momentum (kg m/s) = resultant force (N) × time for which it acts (s)**	
P4.3.6	apply Newton's first law to explain the motion of objects moving with uniform velocity and also the motion of objects where the speed and/or direction changes	
P4.3.7	**explain with examples that motion in a circular orbit involves constant speed but changing velocity**	
P4.3.8	**explain that inertial mass is a measure of how difficult it is to change the velocity of an object and that it is defined as the ratio of force over acceleration**	
P4.3.9	Select and apply Newton's second law relating force, mass and acceleration: force (N) = mass (kg) × acceleration (m/s^2)	
P4.3.10	use and apply equations relating force, mass, velocity, acceleration, and **momentum** to explain relationships between the quantities	
P4.3.11	explain methods of measuring human reaction times and recall typical results	
P4.3.12	explain the factors which affect the distance required for road transport vehicles to come to rest in emergencies and the implications for safety	
P4.3.13	explain the dangers caused by large decelerations	
P4.4.1	describe the energy transfers involved when a system is changed by work done by forces including: to raise an object above ground level to move an object along the line of action of the force	
P4.4.2	Select and apply the relationship to calculate the work done (energy transferred) by a force: work done (Nm or J) = force (N) × distance (m) (along the line of action of the force)	
P4.4.3	recall the equation and calculate the amount of energy associated with a moving object: kinetic energy (J) = 0.5 × mass (kg) × (speed (m/s))^2	
P4.4.4	Select the equation and calculate the amount of energy associated with an object raised above ground level: gravitational potential energy (J) = mass (kg) × gravitational field strength (N/kg) × height (m)	
P4.4.5	make calculations of the energy transfers associated with changes in a system, recalling relevant equations for mechanical processes	
P4.4.6	calculate relevant values of stored energy and energy transfers; convert between newton-metres and joules	
P4.4.7	describe all the changes involved in the way energy is stored when a system changes, for common situations: including an object projected upwards or up a slope, a moving object hitting an obstacle, an object being accelerated by a constant force, a vehicle slowing down	
P4.4.8	explain, with reference to examples, the definition of power as the rate at which energy is transferred (work done) in a system	
P4.4.9	Select and apply the relationship: power (W) = energy transferred (J) ÷ time (s)	
<u>Unit P5</u>		
P5.1.1	describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with almost all of the mass in the nucleus	
P5.1.2	describe how and why the atomic model has changed over time to include the main ideas of Dalton, Thomson, Rutherford and Bohr	
P5.1.3	recall the typical size (order of magnitude) of atoms and small molecules	
P5.1.4	recall that atomic nuclei are composed of both protons and neutrons, and that the nucleus of each element has a characteristic positive charge	
P5.1.5	recall that nuclei of the same element can differ in nuclear mass by having different numbers of neutrons, these are called isotopes	

P5.1.6	use the conventional representation to show the differences between isotopes, including their identity, charge and mass	
P5.1.7	recall that some nuclei are unstable and may emit alpha particles, beta particles, or neutrons, and electromagnetic radiation as gamma rays	
P5.1.8	relate emissions of alpha particles, beta particles, or neutrons, and gamma rays to possible changes in the mass or the charge of the nucleus, or both	
P5.1.9	use names and symbols of common nuclei and particles to write balanced equations that represent the emission of alpha, beta, gamma, and neutron radiations during radioactive decay	
P5.1.10	explain the concept of half-life and how this is related to the random nature of radioactive decay	
P5.1.11	**calculate the net decline, expressed as a ratio, in a radioactive emission after a given (integral) number of half-lives**	
P5.1.12	interpret activity-time graphs to find the half- life of radioactive materials	
P5.2.1	recall the differences in the penetration properties of alpha particles, beta particles and gamma rays	
P5.2.2	recall the differences between contamination and irradiation effects and compare the hazards associated with each of these	
P5.2.3	describe the different uses of nuclear radiations for exploration of internal organs, and for control or destruction of unwanted tissue	
P5.2.4	explain how ionising radiation can have hazardous effects, notably on human bodily tissues	
P5.2.5	explain why the hazards associated with radioactive material differ according to the radiation emitted and the half-life involved	