Cambridge IGCSE Science (Co-ordinated – Double)

	Biology	
	Syllabus point	**Presentation(s)**
B1: Characteristics of living organisms	List and describe the characteristics of living organisms.	
	Supplementary **Define the terms:** • ***nutrition*** **as taking in of nutrients which are organic substances and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them** • ***excretion*** **as removal from organisms of toxic materials, the waste products of metabolism (chemical reactions in cells including respiration) and substances in excess of requirements** • ***respiration*** **as the chemical reactions that break down nutrient molecules in living cells to release energy** • ***sensitivity*** **as the ability to detect or sense changes in the environment (stimuli) and to make responses** • ***reproduction*** **as the processes that make more of the same kind of organism** • ***growth*** **as a permanent increase in size and dry mass by an increase in cell number or cell size or both** • ***movement*** **as an action by an organism or part of an organism causing a change of position or place.**	• ***Plant and Animal Growth*** • ***The Digestive System*** • ***Meiosis and Reproduction*** • ***Mitosis*** • ***Respiration*** • ***The Nervous System***
B2.1: Cell structure	State that living organisms are made up of cells	• ***Cells***
	Identify and describe the structure of a plant cell (palisade cell) and an animal cell (liver cell), as seen under a light microscope.	• ***Cells***
	Describe the differences in structure between typical animal and plant cells.	• ***Cells***
	Supplementary **Relate the structures seen under the light microscope in the plant cell and in the animal cell to their functions.**	• ***Cells***
	Supplementary **Relate the structure of the following to their functions:** • **red blood cells – transport** • **root hair cells – absorption.**	• ***Cells***
	Calculate magnification and size of biological specimens using millimetres as units.	• ***Cells***
B2.2: Movement in and out of cells	Define *diffusion* as the net movement of molecules from a region of their higher concentration to a region of their lower concentration down a concentration gradient, as a result of their random movement.	• ***Diffusion***
	Describe the importance of diffusion of gases and solutes and of water as a solvent.	• ***Diffusion***

	Supplementary **Define *osmosis* as the diffusion of water molecules from a region of their higher concentration (dilute solution) to a region of their lower concentration (concentrated solution), through a partially permeable membrane.**	• ***Osmosis***
	Supplementary **Describe the importance of osmosis in the uptake of water by plants, and its effects on plant and animal tissues.**	• ***Osmosis*** • ***The Movement of Water in Plants***
	Supplementary **Describe and explain the importance of a water potential gradient in the uptake of water by plants.**	• ***The Movement of Water in Plants***
B3: Enzymes	Define *enzymes* as proteins that function as biological catalysts.	• ***Enzymes***
	Investigate and describe the effect of changes in temperature and pH on enzyme activity.	• ***Enzymes***
	Supplementary **Explain the effect of changes in temperature and pH on enzyme activity.**	• ***Enzymes***
B4.1: Nutrients	List the chemical elements that make up: • carbohydrates • fats • proteins.	• ***Digestive Enzymes***
	Supplementary **Define *nutrition* as taking in of nutrients which are organic substances and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them.**	
	Describe the structure of large molecules made from smaller basic units, i.e: • simple sugars to starch and glycogen • amino acids to proteins • fatty acids and glycerol to fats and oils.	• ***Digestive Enzymes***
	Describe tests for: • starch (iodine solution) • reducing sugars (Benedict's solution) • protein (biuret test) • fats (ethanol).	• ***Photosynthesis***
	List the principal sources of, and describe the importance of: • carbohydrates • fats • proteins • vitamins (C and D only) • mineral salts (calcium and iron only) • fibre (roughage)	

	• water.	
	Supplementary **Describe the use of microorganisms in the manufacture of yoghurt.**	
	Describe the deficiency symptoms for: • vitamins (C and D only) • mineral salts (calcium and iron only.	
B4.2: Plant Nutrition	Define *photosynthesis* as the fundamental process by which plants manufacture carbohydrates from raw materials using energy from light.	• ***Photosynthesis***
	Supplementary **Explain that chlorophyll traps light energy and converts it into chemical energy for the formation of carbohydrates and their subsequent storage.**	• ***Photosynthesis***
	State the word equation for production of simple sugars & oxygen.	• ***Photosynthesis*** • ***Uses of Glucose in Plants***
	Supplementary **State the balanced equation for photosynthesis in symbols** **$6CO_2 + 6H_2O$ (with light & chlorophyll) → $C_6H_{12}O_6 + 6O_2$**	• ***Photosynthesis***
	Investigate the necessity for chlorophyll, light and carbon dioxide for photosynthesis, using appropriate controls.	• ***Photosynthesis***
	Supplementary **Investigate and state the effect of varying light intensity on the rate of photosynthesis (e.g. in submerged aquatic plants).**	• ***Photosynthesis***
	Describe the intake of carbon dioxide and water by plants.	• ***Photosynthesis***
	Identify and label the cuticle, cellular and tissue structure of a dicotyledonous leaf, as seen in cross-section under the light microscope and describe the significance of the features of a leaf in terms of functions, to include: • distribution of chloroplasts – photosynthesis • stomata and mesophyll cells – gas exchange • vascular bundles (xylem and phloem) – transport and support.	• ***Leaves***
	Describe the importance of: • nitrate ions for protein synthesis • magnesium ions for chlorophyll synthesis.	• ***Photosynthesis*** • ***Minerals for Plant*** • ***Uses of Glucose in Plants***
	Supplementary **Explain the effects of nitrate ion and magnesium ion deficiency on plant growth.**	• ***Minerals for Plant***
	Supplementary **Describe the uses, and the dangers of overuse, of nitrogen-containing fertilisers.**	• ***Minerals for Plants***

B4.3: Animal Nutrition	State what is meant by the term balanced diet and describe a balanced diet related to age, sex and activity of an individual.	
	Supplementary **Describe the effects of malnutrition in relation to starvation, coronary heart disease, constipation and obesity.**	
	Define *ingestion* as taking substances (e.g. food, drink) into the body through the mouth.	• ***The Digestive System***
	Define *egestion* as passing out of food that has not been digested, as faeces, through the anus.	
	Identify the main regions of the alimentary canal and associated organs including mouth, salivary glands, oesophagus, stomach, small intestine: duodenum and ileum, pancreas, liver, gall bladder, large intestine: colon and rectum, anus.	• ***The Digestive System***
	Describe the functions of the regions of the alimentary canal listed above, in relation to ingestion, digestion, absorption, assimilation and egestion of food.	• ***The Digestive System***
	Define *digestion* as the break-down of large, insoluble food molecules into small, water-soluble molecules using mechanical and chemical processes.	• ***The Digestive System***
	Identify the types of human teeth and describe their structure and functions.	
	State the causes of dental decay and describe the proper care of teeth.	
	State the significance of chemical digestion in the alimentary canal in producing small, soluble molecules that can be absorbed.	• ***The Digestive System***
	Supplementary **Outline the role of bile in emulsifying fats, to increase the surface area for the action of enzymes.**	• ***Digestive Enzymes***
	State the functions of a typical amylase, a protease and a lipase, listing the substrate and end-products.	• ***Digestive Enzymes***
	Define *absorption* as movement of digested food molecules through the wall of the intestine into the blood.	• ***The Digestive System***
	Supplementary **Describe the significance of villi in increasing the internal surface area of the small intestine.**	• ***The Digestive System***
	Identify the small intestine as the region for the absorption of digested food.	• ***The Digestive System***
	Supplementary **Describe the structure of a villus, including the role of capillaries and lacteals.**	• ***The Digestive System***
	Describe the role of the liver in the metabolism of glucose (glucose → glycogen).	
	Describe the role of fat as an energy storage substance.	

B5.1: Transportation in plants	State the functions of xylem and phloem.	• ***Cells*** • ***The Movement of Water in Plants***
	Identify the positions of xylem and phloem tissues as seen in transverse sections of unthickened, herbaceous, dicotyledonous roots, stems and leaves.	• ***The Movement of Water in Plants***
	Identify root hair cells, as seen under the light microscope, and state their functions.	• ***The Movement of Water in Plants***
	Supplementary **Relate the structure and functions of root hairs to their surface area and to water and ion uptake.**	• ***The Movement of Water in Plants***
	State the pathway taken by water through root, stem and leaf (root hair, root cortex cells, xylem, mesophyll cells).	• ***The Movement of Water in Plants***
	Investigate, using a suitable stain, the pathway of water through the above-ground parts of a plant.	• ***The Movement of Water in Plants***
	Define *transpiration* as evaporation of water at the surfaces of the mesophyll cells followed by loss of water vapour from plant leaves, through the stomata.	• ***The Movement of Water in Plants***
	Supplementary **Describe how water vapour loss is related to cell surfaces, air spaces and stomata**.	• ***The Movement of Water in Plants***
	Describe the effects of variation of temperature, humidity and light intensity on transpiration rate.	• ***The Movement of Water in Plants***
	Supplementary **Explain the mechanism of water uptake and movement in terms of transpiration producing a tension ('pull') from above, creating a water potential gradient in the xylem, drawing cohesive water molecules up the plant.**	
	Supplementary **Define *translocation* in terms of the movement of sucrose and amino acids in phloem; from regions of production to regions of storage OR to regions of utilisation in respiration or growth.**	
B5.2: Transport in humans	Describe the circulatory system as a system of tubes with a pump and valves to ensure one-way flow of blood.	• ***The Circulatory System***
	Supplementary **Describe double circulation in terms of a low pressure circulation to the lungs and a high pressure circulation to the body tissues and relate these differences to the different functions of the two circuits.**	• ***The Circulatory System***
	Describe the structure of the heart including the muscular wall and	• ***The Circulatory System***

	septum, atria, ventricles, valves and associated blood vessels.	
	Supplementary **Describe coronary heart disease in terms of the blockage of coronary arteries and state the possible causes (diet, stress and smoking) and preventive measures.**	
	Describe the function of the heart in terms of muscular contraction and the working of the valves.	• ***The Circulatory System***
	Investigate the effect of physical activity on pulse rate.	• ***Respiration***
	Supplementary **Investigate, state and explain the effect of physical activity on pulse rate.**	• ***Respiration***
	Name the main blood vessels to and from the heart, lungs, liver and kidney.	• ***The Circulatory System***
	Describe the structure and functions of arteries, veins and capillaries.	• ***The Circulatory System***
	Supplementary **Explain how structure and function are related in arteries, veins and capillaries.**	• ***The Circulatory System***
	Identify red and white blood cells as seen under the light microscope on prepared slides, and in diagrams and photomicrographs.	• ***The Circulatory System***
	List the components of blood as red blood cells, white blood cells, platelets and plasma.	• ***The Circulatory System***
	State the functions of blood: • red blood cells – haemoglobin and oxygen transport • white blood cells – phagocytosis and antibody formation • platelets – causing clotting (no details) • plasma – transport of blood cells, ions, soluble nutrients, hormones and carbon dioxide.	• ***The Circulatory System***
	Supplementary **Describe the immune system in terms of antibody production, tissue rejection and phagocytosis.**	
B6.1: Aerobic and anaerobic respiration	Define *respiration* as the chemical reactions that break down nutrient molecules in living cells to release energy.	• ***Respiration***
	State the uses of energy in the body of humans: muscle contraction, protein synthesis, cell division, growth, the passage of nerve impulses and the maintenance of a constant body temperature.	• ***Respiration***
	State the word equation for aerobic respiration.	• ***Respiration***
	Supplementary **Define *aerobic respiration* as the release of a relatively large amount of energy in cells by the breakdown of food substances in the presence of oxygen.**	• ***Respiration***

	Supplementary **State the equation for aerobic respiration using symbols ($C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$).**	• ***Respiration***
	Supplementary **Define *anaerobic respiration* as the release of a relatively small amount of energy by the breakdown of food substances in the absence of oxygen.**	• ***Anaerobic Respiration***
	Supplementary **State the word equation for anaerobic respiration in muscles during hard exercise (glucose → lactic acid) and the microorganism yeast (glucose → alcohol + carbon dioxide).**	• ***Anaerobic Respiration***
	Supplementary **Describe the effect of lactic acid in muscles during exercise (include oxygen debt in outline only).**	• ***Anaerobic Respiration***
	Supplementary **Describe the role of anaerobic respiration in yeast during brewing and bread-making.**	• ***Anaerobic Respiration***
	Supplementary **Compare aerobic respiration and anaerobic respiration in terms of relative amounts of energy released.**	
B6.2: Gas exchange	Identify on diagrams and name the larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries.	• ***Diffusion***
	Supplementary **List the features of gas exchange surfaces in animals.**	• ***Diffusion***
	Supplementary **Explain the role of mucus and cilia in protecting the gas exchange system from pathogens and particles.**	
	Supplementary **Describe the effects of tobacco smoke and its major toxic components (tar, nicotine, carbon monoxide, smoke particles) on the gas exchange system.**	
	State the differences in composition between inspired and expired air.	• ***Diffusion***
	Use lime water as a test for carbon dioxide to investigate the differences in composition between inspired and expired air.	• ***Respiration***
	Investigate and describe the effects of physical activity on rate and depth of breathing.	• ***Respiration***
	Supplementary **Explain the effects of physical activity on rate and depth of breathing.**	• ***Respiration***
B7.1: Nervous control in humans	Describe the human nervous system in terms of the central nervous system (brain and spinal cord as areas of coordination) and the peripheral nervous system which together serve to coordinate and regulate body functions.	• ***The Nervous System*** • ***Nerves and Reflexes***
	Supplementary **Describe the structure and function of the eye, including accommodation and pupil reflex.**	

	Identify motor (effector), relay (connector) and sensory neurones from diagrams.	• ***The Nervous System***
	Describe a simple reflex arc in terms of sensory, relay and motor neurones, and a reflex action as a means of automatically and rapidly integrating and coordinating stimuli with responses.	• ***The Nervous System*** • ***Nerves and Reflexes***
B7.2: Hormones	Define a *hormone* as a chemical substance, produced by a gland, carried by the blood, which alters the activity of one or more specific target organs and is then destroyed by the liver.	
	State the role of the hormone adrenaline in the chemical control of metabolic activity, including increasing the blood glucose concentration and pulse rate.	
	Give examples of situations in which adrenaline secretion increases.	
	Supplementary **Compare nervous and hormonal control systems.**	
B7.3: Tropic responses	Define and investigate *geotropism* (as a response in which a plant grows towards or away from gravity) and *phototropism* (as a response in which a plant grows towards or away from the direction from which light is coming).	• ***Plant and Animal Growth***
	Supplementary **Explain the chemical control of plant growth by auxins including geotropism and phototropism in terms of auxins regulating differential growth.**	• ***Plant and Animal Growth***
B7.4: Homeostasis	Define *homeostasis* as the maintenance of a constant internal environment.	
	Identify, on a diagram of the skin: hairs, sweat glands, temperature receptors, blood vessels and fatty tissue.	
	Describe the maintenance of a constant body temperature in humans in terms of insulation and the role of temperature receptors in the skin, sweating, shivering, vasodilation and vasoconstriction of arterioles supplying skin-surface capillaries and the coordinating role of the brain.	
	Supplementary **Explain the concept of control by negative feedback.**	
	Supplmentary **Describe the control of the glucose content of the blood by the liver, and by insulin and glucagon from the pancreas.**	
B8.1: Asexual and sexual reproduction	Define *asexual reproduction* as the process resulting in the production of genetically identical offspring from one parent.	• ***Asexual Reproduction***
	Supplementary **Discuss the advantages and disadvantages to a species of asexual reproduction.**	• ***Asexual Reproduction***

	Define *sexual reproduction* as the process involving the fusion of haploid nuclei to form a diploid zygote and the production of genetically dissimilar offspring.	• ***Asexual Reproduction***
	Supplementary **Discuss the advantages and disadvantages to a species of sexual reproduction.**	• ***Meiosis and Reproduction***
B8.2: Sexual reproduction in plants	Identify and draw, using a hand lens if necessary, the sepals, petals, stamens, anthers, carpels, ovaries and stigmas of one, locally available, named, insect pollinated, dicotyledonous flower, and examine the pollen grains under a light microscope or in photomicrographs.	
	Supplementary **Use a hand lens to identify and describe the anthers and stigmas of one, locally available, named, wind-pollinated flower.**	
	State the functions of the sepals, petals, anthers, stigmas and ovaries.	
	Candidates should expect to apply their understanding of the flowers they have studied to unfamiliar flowers.	
	Define *pollination* as the transfer of pollen grains from the male part of the plant (anther of stamen) to the female part of the plant (stigma).	
	Name the agents of pollination.	
	Supplementary **Compare the different structural adaptations of insect-pollinated and wind-pollinated flowers.**	
	Investigate and state the environmental conditions that affect germination of seeds: requirement for water and oxygen, suitable temperature.	
	Supplementary **Investigate and describe the structure of a non-endospermic seed in terms of the embryo (radicle, plumule and cotyledons) and testa, protected by the fruit.**	
	Supplementary **State that seed and fruit dispersal by wind and by animals provides a means of colonising new areas.**	
	Supplementary **Describe, using named examples, seed and fruit dispersal by wind and by animals.**	
B8.3: Sexual reproduction in humans	Identify on diagrams of the male reproductive system, the testes, scrotum, sperm ducts, prostate gland, urethra and penis, and state the functions of these parts.	
	Supplementary **Compare male and female gametes in terms of size, numbers and mobility.**	

	Identify on diagrams of the female reproductive system, the ovaries, oviducts, uterus, cervix and vagina, and state the functions of these parts.	
	Describe the menstrual cycle in terms of changes in the uterus and ovaries.	
	Describe fertilisation in terms of the joining of the nuclei of male gamete (sperm) and the female gamete (egg).	• ***Meiosis and Reproduction***
	Outline early development of the zygote simply in terms of the formation of a ball of cells that becomes implanted in the wall of the uterus.	• ***Meiosis and Reproduction***
	Supplementary **Indicate the functions of the amniotic sac and amniotic fluid.**	
	Supplementary **Describe the function of the placenta and umbilical cord in relation to exchange of dissolved nutrients, gases and excretory products (no structural details are required).**	• ***Diffusion***
	Supplementary **Describe the advantages and disadvantages of breast-feeding compared with bottlefeeding using formula milk.**	
	Describe the methods of transmission of human immunodeficiency virus (HIV), and the ways in which HIV/AIDS can be prevented from spreading.	
	Supplementary **Outline how HIV affects the immune system in a person with HIV/AIDS.**	
B9.1: Chromosomes and genes	Define *inheritance* as the transmission of genetic information from generation to generation.	• ***Inheritance***
	Define the terms: • *chromosome* as a thread of DNA, made up of a string of genes • *gene* as a length of DNA that is the unit of heredity and codes for a specific protein. A gene may be copied and passed on to the next generation • *allele* as any of two or more alternative forms of a gene.	• ***Inheritance*** • ***Genes and Protein Synthesis***
	Supplementary **Define the terms:** • ***haploid nucleus*** **as a nucleus containing a single set of unpaired chromosomes (e.g. sperm and egg),** • ***diploid nucleus*** **as a nucleus containing two sets of chromosomes (e.g. in body cells).**	• ***Meiosis and Reproduction*** • ***Asexual Reproduction***
	Describe the inheritance of sex in humans (XX and XY chromosomes).	• ***Inheritance***
B9.2: Cell division	**Supplementary** **Define *mitosis* as nuclear division giving rise to genetically identical cells in which the chromosome number is maintained by the exact duplication of chromosomes (details of stages are not required).**	• ***Mitosis***

	Supplementary **State the role of mitosis in growth, repair of damaged tissues, replacement of worn out cells and asexual reproduction.**	• ***Mitosis*** • ***Asexual Reproduction***
	Supplementary **Define *meiosis* as reduction division in which the chromosome number is halved from diploid to haploid (details of stages are not required).**	• ***Meiosis and Reproduction***
	Supplementary **State that gametes are the result of meiosis.**	• ***Meiosis and Reproduction***
	Supplementary **State that meiosis results in genetic variation so the cells produced are not all genetically identical.**	• ***Meiosis and Reproduction***
9.3: Monohybrid inheritance.	Define the terms: • *genotype* as the genetic makeup of an organism in terms of the alleles present (e.g. Tt or GG), • *phenotype* as the physical or other features of an organism due to both its genotype and its environment (e.g. tall plant or green seed), • *homozygous* as having two identical alleles of a particular gene (e.g. TT or gg). Two identical homozygous individuals that breed together will be pure-breeding, • *heterozygous* as having two different alleles of a particular gene (e.g. Tt or Gg), not pure-breeding, • *dominant* as an allele that is expressed if it is present (e.g. T or G), • *recessive* as an allele that is only expressed when there is no dominant allele of the gene present (e.g. t or g).	• ***Inheritance***
	Calculate and predict the results of monohybrid crosses involving 1 : 1 and 3 : 1 ratios.	• ***Inheritance***
9.4: Variation and selection	**Supplementary** **State that continuous variation is influenced by genes and environment, resulting in a range of phenotypes between two extremes, e.g. height in humans.**	
	Supplementary **State that discontinuous variation is caused by genes alone and results in a limited number of distinct phenotypes with no intermediates e.g. A, B, AB and O blood groups in humans.**	
	Supplementary **Define *mutation* as a change in a gene or chromosome.**	• ***Genes and Protein Synthesis***
	Supplementary **Outline the effects of ionising radiation on the rate of mutation.**	• ***Genes and Protein Synthesis***
	Describe the role of artificial selection in the production of varieties of animals and plants with increased economic importance.	• ***Altering Genes***
	Supplementary **Describe variation and state that competition leads to differential survival of, and reproduction by, those organisms best fitted to the environment.**	• ***Fossils and Species Development***
	Define *natural selection* as the greater chance of passing on of genes by the best adapted organisms.	• ***Fossils and Species Development***

	Supplementary **Explain the importance of natural selection as a possible mechanism for evolution.**	• ***Fossils and Species Development***
	Supplementary **Describe the development of strains of antibiotic resistant bacteria as an example of natural selection.**	
B10: Energy flow in ecosystems	The Sun is the principal source of energy input to biological systems.	
	Define the terms: • *food chain* as a chart showing the flow of energy (food) from one organism to the next beginning with a producer (e.g. mahogany tree → caterpillar → song bird → hawk) • *food web* as a network of interconnected food chains showing the energy flow through part of an ecosystem • *producer* as an organism that makes its own organic nutrients, usually using energy from sunlight, • *consumer* as an organism that gets its energy by feeding on other organisms • *herbivore* as an animal that gets its energy by eating plants • *carnivore* as an animal that gets its energy by eating animals.	
	Supplementary **Describe energy losses between trophic levels.**	
	Supplementary **Define the terms:** • ***decomposer* as an organism that gets its energy from dead or waste organic matter** • ***ecosystem* as a unit containing all of the organisms and their environment, interacting together, in a given area e.g. decomposing log or a lake** • ***trophic level* as the position of an organism in a food chain or food web.**	
	Supplementary **Explain why food chains usually have fewer than five levels.**	
	Describe the carbon cycle.	
	Supplementary **Discuss the effects of the combustion of fossil fuels and the cutting down of forests on the oxygen and carbon dioxide concentrations in the atmosphere.**	
B11: Human influences on the ecosystem	List the undesirable effects of deforestation (to include extinction, loss of soil, flooding, carbon dioxide build up).	
	Supplementary **Describe the undesirable effects of overuse of fertilisers (to include eutrophication of lakes and rivers).**	
	Describe the undesirable effects of pollution to include: • water pollution by sewage and chemical waste, • air pollution by greenhouse gases (carbon dioxide and methane) contributing to global warming.	

	Supplementary **Discuss the causes and effects on the environment of acid rain, and the measures that might be taken to reduce its incidence.**	
	Supplementary **Explain how increases in greenhouse gases (carbon dioxide and methane) are thought to cause global warming.**	
	Describe the need for conservation of: • species and their habitats, • natural resources (limited to water and non-renewable materials, including fossil fuels).	

Cambridge IGCSE Science (Co-ordinated – Double)

	Chemistry	
	Syllabus point	**Presentations**
C1: The Particulate nature of matter	See P4.1 and P4.2 for details of essential common content.	
	Demonstrate understanding of the terms *atom* and *molecule*.	• ***Representing Chemicals***
C2: Experimental techniques – methods of separation and purification	Describe paper chromatography.	• ***Chromatography***
	Interpret simple chromatograms.	• ***Chromatography***
	Describe methods of separation and purification: filtration, crystallisation, distillation, fractional distillation.	
	Understand the importance of purity in substances in everyday life, e.g. foodstuffs and drugs.	
	Supplementary **Identify substances and assess their purity from melting point and boiling point information.**	
	Supplementary **Suggest suitable purification techniques, given information about the substances involved.**	
C3.1: Physical and chemical changes	Identify physical and chemical changes, and understand the differences between them.	
C3.2: Elements, compounds and mixtures	Describe the differences between elements, compounds and mixtures.	○ ***Representing Chemicals***
	Supplementary **Demonstrate understanding of the concepts of element, compound and mixture.**	• ***Representing Chemicals***

C3.3: Atomic structure and the Periodic Table	Describe the structure of an atom in terms of electrons and a nucleus containing protons and neutrons.	• ***Atomic Structure***
	Supplementary **Describe the build-up of electrons in 'shells' and understand the significance of the noble gas electronic structures and of valency electrons (the ideas of the distribution of electrons in s and p orbitals and in d block elements are *not* required).**	• ***Atomic Structure*** • ***Electron Arrangement***
	State the relative charges and approximate relative masses of protons, neutrons and electrons.	• ***Atomic Structure***
	Define *proton number* and *nucleon number.*	• ***Atomic Structure***
	Use proton number and the simple structure of atoms to explain the basis of the Periodic Table (see C9), with special reference to the elements of proton number 1 to 20.	• ***The Periodic Table***
	Define *isotopes.*	• ***Isotopes***
C3.4: Ions and ionic bonds	Describe the formation of ions by electron loss or gain.	• ***Ions and Ionic Bonding***
	Describe the formation of ionic bonds between metals and non-metals as exemplified by elements from Groups I and VII.	• ***Ions and Ionic Bonding***
	Supplementary **Explain the formation of ionic bonds between metallic and non-metallic elements.**	• ***Ions and Ionic Bonding***
	Describe the lattice structure of ionic compounds as a regular arrangement of alternating positive and negative ions, exemplified by the sodium chloride structure.	• ***Ionic Compounds***
C3.5: Molecules and covalent bonds	State that non-metallic elements form non-ionic compounds using a different type of bonding called covalent bonding.	• ***Covalent Bonding***
	Supplementary **Draw dot-and-cross diagrams to represent the sharing of electron pairs to form single covalent bonds in simple molecules, exemplified by (but not restricted to) H_2, Cl_2, H_2O, CH_4 and HCl.**	• ***Covalent Bonding***
	Describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds.	• ***Covalent Bonding*** • ***Ionic Compounds***
	Draw dot-and-cross diagrams to represent the multiple bonding in N_2, C_2H_4 and CO_2.	• ***Covalent Bonding***
C3.6: Giant structures	**Supplementary** **Describe the giant covalent structures of graphite and diamond.**	• ***Giant Covalent Structures***
	Supplementary **Relate their structures to the use of graphite as a lubricant and of diamond in cutting.**	• ***Giant Covalent Structures***

	Supplementary **Describe the structure of silicon (IV) oxide (silicon dioxide).**	
C4: Stoichiometry	Use the symbols of the elements to write the formulae of simple compounds.	• ***Representing Chemicals*** • ***Formulae and Equations***
	Deduce the formula of a simple compound from the relative numbers of atoms present.	• ***Representing Chemicals*** • ***Formulae and Equations***
	Deduce the formula of a simple compound from a model or a diagrammatic representation.	• ***Formulae and Equations***
	Construct and use word equations.	• ***Formulae and Equations***
	Supplementary **Determine the formula of an ionic compound from the charges on the ions present.**	• ***Ions and Ionic Bonding***
	Supplementary **Construct and use symbolic equations with state symbols, including ionic equations.**	• ***Formulae and Equations***
	Supplementary **Deduce the balanced equation for a chemical reaction, given relevant information.**	• ***Formulae and Equations***
	Supplementary **Define *relative atomic mass*, A_r**	• ***Formulae and Equations***
	Supplementary **Define *relative molecular mass*, M_r, as the sum of the relative atomic masses (*relative formula mass* or M_r will be used for ionic compounds).**	• ***Formulae and Equations***
C4.1: The mole concept	**Supplementary** **Define the *mole* in terms of a specific number of particles called Avogadro's constant. (Questions requiring recall of Avogadro's constant will not be set.).**	• ***Formulae and Equations***
	Supplementary **Use the molar gas volume, taken as 24 dm^3 at room temperature and pressure.**	
	Supplementary **Calculate stoichiometric reacting masses and reacting volumes of solutions; solution concentrations will be expressed in mol/dm^3. (Calculations involving the idea of limiting reactants may be set.)**	• ***Quantitative Chemistry***
C5: Electricity and chemistry	State that electrolysis is the chemical effect of electricity on ionic compounds, causing them to break up into simpler substances, usually elements.	• ***Electrolysis***
	Use the terms *electrode*, *electrolyte*, *anode* and *cathode.*	• ***Electrolysis***
	Supplementary **Describe electrolysis in terms of the ions present and the reactions at the electrodes.**	• ***Electrolysis***
	Describe the electrode products, using inert	• ***Electrolysis***

	electrodes, in the electrolysis of: • molten lead(II) bromide • aqueous copper chloride • dilute sulfuric acid.	
	Supplementary **State and use the general principle that metals or hydrogen are formed at the negative electrode (cathode), and that nonmetals (other than hydrogen) are formed at the positive electrode (anode).**	• ***Electrolysis***
	Supplementary **Relate the products of electrolysis to the electrolyte and electrodes used, exemplified by the specific examples in the Core together with aqueous copper(II) sulfate using carbon electrodes and using copper electrodes (as used in the refining of copper).**	
	Describe the electroplating of metals, using laboratory apparatus.	• ***Electrolysis***
	Supplementary **Predict the products of the electrolysis of a specified binary compound in the molten state, or in aqueous solution.**	• ***Electrolysis***
	Supplementary **Describe, in outline, the chemistry of the manufacture of:** • **aluminium from pure aluminium oxide in molten cryolite** • **chlorine, hydrogen and sodium hydroxide from concentrated aqueous sodium chloride.**	• ***Electrolysis***
C6.1: Energetics of a reaction	Relate the terms *exothermic* and *endothermic* to the temperature changes observed during chemical reactions.	• ***Energy and Reactions***
	Supplementary **Demonstrate understanding that exothermic and endothermic changes relate to the transformation of chemical energy to heat (thermal energy), and vice versa.**	• ***Energy and Reactions***
C7.1: Speed of reaction	Describe the effect of concentration, particle size, catalysis and temperature on the speeds of reactions.	• ***Changing Reaction Rates***
	Describe a practical method for investigating the speed of a reaction involving gas evolution.	• ***Measuring Reaction Rates***
	Devise a suitable method for investigating the effect of a given variable on the speed of a reaction.	• ***Measuring Reaction Rates***
	Interpret data obtained from experiments concerned with speed of reaction.	• ***Measuring Reaction Rates***
	Describe the application of the above factors to the danger of explosive combustion with fine powders (e.g. flour mills) and gases (e.g. mines).	• ***Measuring Reaction Rates***
	Supplementary **Describe and explain the effects of temperature and concentration in terms of collisions between reacting particles (concept of activation energy will not be examined).**	• ***Changing Reaction Rates***
	Define catalyst as an agent which increases rate but which remains unchanged.	• ***Catalysts***

C7.2 Redox	Define *oxidation* and *reduction* in terms of oxygen loss/gain, and identify such reactions from given information.	• ***Electrolysis***
	Supplementary **Define *redox* in terms of electron transfer, and identify such reactions from given information.**	• ***Electrolysis***
C8.1: Characteristic properties of acids and bases	Describe neutrality and relative acidity and alkalinity in terms of pH (whole numbers only) measured using full-range indicator and litmus.	• ***Acids and Alkalis***
	Describe the characteristic reactions between acids and metals, bases (including alkalis) and carbonates.	• ***Acids and Alkalis***
	Describe and explain the importance of controlling acidity in the environment (air, water and soil).	
C8.2: Types of oxides	Classify oxides as either acidic or basic, related to metallic and non-metallic character of the other element.	
	Supplementary **Further classify some other oxides as neutral, given relevant information.**	
C8.3: Preparation of salts	Describe the preparation, separation and purification of salts using techniques selected from section C2.1 and the reactions specified in section C8.1.	• ***Making Salts***
	Supplementary **Suggest a method of making a given salt from suitable starting materials, given appropriate information.**	• ***Making Salts***
C8.4: Identification of ions and gases	1 Use the following tests to identify: **aqueous cations:** • *ammonium*, *copper (II)*, *iron (II)*, *iron (III)* and *zinc* by means of aqueous sodium hydroxide and aqueous ammonia as appropriate. (Formulae of complex ions are **not** required.) **anions:** • *carbonate* by means of dilute acid and then limewater, • *chloride* by means of aqueous silver nitrate under acidic conditions • *nitrate* by reduction with aluminium, • *sulfate* by means of aqueous barium ions under acidic conditions, **gases:** • *ammonia* by means of damp red litmus paper, • *carbon dioxide* by means of limewater, • *chlorine* by means of damp litmus paper, • *hydrogen* by means of a lighted splint, • *oxygen* by means of a glowing splint.	• ***Precipitation Reactions***

C9: The periodic table	Describe the way the Periodic Table classifies elements in order of proton number.	• *The Periodic Table*
	Supplementary **Use the Periodic Table to predict properties of elements by means of groups and periods.**	• *The Periodic Table*
C9.1 Periodic table	Describe the change from metallic to non-metallic character across a period.	• *The Periodic Table*
	Supplementary **Describe the relationship between Group number, number of outer-shell (valency) electrons and metallic/non-metallic character.**	• *The Periodic Table*
C9.2: Group properties	Describe lithium, sodium and potassium in Group I as a collection of relatively soft metals showing a trend in melting point and reaction with water.	• *Group I Alkali Metals*
	Supplementary **Predict the properties of other elements in Group I, given data where appropriate.**	• *Group I Alkali Metals*
	Describe the trends in properties of chlorine, bromine and iodine in Group VII including colour, physical state and reactions with other halide ions.	• *Group 7 Halogens*
	Supplementary **Predict the properties of other elements in Group VII, given data where appropriate.**	• *Group 7 Halogens*
C9.3: Transition metals	Describe the transition elements as a collection of metals having high densities, high melting points and forming coloured compounds, and which, as elements and compounds, often act as catalysts.	• *Catalysts*
C9.4: Noble gases	Describe the noble gases as being unreactive.	• *Group O Noble Gases*
	Describe the uses of the noble gases in providing an inert atmosphere, i.e. argon in lamps, helium for filling balloons.	• *Group O Noble Gases*
C10.1: Properties of metals	Distinguish between metals and non-metals by their general physical and chemical properties.	• *Metallic Bonding* • *Giant Covalent Structures* • *Ionic Compounds*
	Supplementary **Identify and interpret diagrams that represent the structure of an alloy.**	• *New Materials*
	Explain why metals are often used in the form of alloys.	• *New Materials*

C10.2: Reactivity series	Place in order of reactivity: potassium, sodium, calcium, magnesium, zinc, iron, hydrogen and copper, by reference to the reactions, if any, of the elements with: • water or steam, • dilute hydrochloric acid (except for alkali metals).	• ***The Periodic Table*** • ***Extracting Metals*** • ***Making Salts***
	Supplementary **Compare the reactivity series to the tendency of a metal to form its positive ion, illustrated by its reaction, if any, with:** **• the aqueous ions of other listed metals,** **• the oxides of the other listed metals.**	
	Supplementary **Deduce an order of reactivity from a given set of experimental results.**	•
C10.3: Extraction of metals	Describe the use of carbon in the extraction of some metals from their ores.	• ***Extracting Metals***
	Supplementary **Describe the essential reactions in the extraction of iron in the blast furnace.**	•
	Supplementary **Relate the method of extraction of a metal from its ore to its position in the reactivity series.**	• ***Extracting Metals***
C10.4: Uses of metals	Explain the use of aluminium in aircraft manufacture in terms of the properties of the metal and alloys made from it.	
	Supplementary **Explain the use of zinc for galvanising steel, and for sacrificial protection.**	
	Explain the use of aluminium in food containers because of its resistance to corrosion.	
C11: Air and water	Describe a chemical test for water.	
	Describe and explain, in outline, the purification of the water supply by filtration and chlorination.	
	State some of the uses of water in industry and in the home.	
	Supplementary **Describe the separation of oxygen and nitrogen from liquid air by fractional distillation.**	
	Describe the composition of clean air as being a mixture of 78% nitrogen, 21% oxygen and small quantities of noble gases, water vapour and carbon dioxide.	• ***Air***
	State the common air pollutants as carbon monoxide, sulfur dioxide and oxides of nitrogen, and describe their sources.	
	Supplementary **Explain the presence of oxides of nitrogen in car exhausts and their catalytic removal.**	
	Supplementary **Explain why the proportion of carbon dioxide in the atmosphere is increasing, and why this is important.**	

	State the adverse effect of common air pollutants on buildings and on health.	
	Describe the formation of carbon dioxide: • as a product of complete combustion of carbon-containing substances, • as a product of respiration, • as a product of the reaction between an acid and a carbonate.	
	Supplementary **Describe the essential conditions for the manufacture of ammonia by the Haber process including the sources of the hydrogen and nitrogen, i.e. hydrocarbons or steam and air.**	
	Describe the rusting of iron in terms of a reaction involving air and water, and simple methods of rust prevention, including paint and other coatings to exclude oxygen.	
	Describe the need for nitrogen-, phosphorus- and potassium-containing fertilisers.	• ***Minerals for Plants - Biology***
	Describe the displacement of ammonia from its salts by warming with an alkali.	
C12: Sulfur	**Supplementary** **Describe the manufacture of sulfuric acid by the Contact process, including essential conditions.**	
	Supplementary **Describe the properties of dilute sulfuric acid as a typical acid.**	
C13: Carbonates	Describe the manufacture of lime (calcium oxide) from calcium carbonate (limestone) in terms of the chemical reactions involved, and its uses in treating acidic soil and neutralising industrial waste products.	
C14.1: Fuels	Recall coal, natural gas and petroleum as fossil fuels that produce carbon dioxide on combustion.	
	Supplementary **Understand the essential principle of fractional distillation in terms of differing boiling points (ranges) of fractions related to molecular size and intermolecular attractive forces.**	
	Name methane as the main constituent of natural gas.	
	Describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation.	
	State the use of: • refinery gas for bottled gas for heating and cooking, • gasoline fraction for fuel (petrol) in cars, • diesel oil/gas oil for fuel in diesel engines.	

C14.2: Introduction to organic compounds	Identify and draw the structures of methane, ethane, ethene and ethanol.	
	Supplementary **Describe the concept of homologous series of alkanes and alkenes as families of compounds with similar properties.**	
	State the type of compound present, given a chemical name ending in *-ane*, *-ene* and *-ol*, or a molecular structure.	
	Supplementary **Name, identify and draw the structures of the unbranched alkanes and alkenes (not *cis-trans*), containing up to four carbon atoms per molecule.**	
C14.3: Hydrocarbons	Describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning.	
	State that the products of complete combustion of hydrocarbons, exemplified by methane, are carbon dioxide and water.	
	Name cracking as a reaction which produces alkenes.	
	Supplementary **Describe the manufacture of alkenes by cracking.**	
	Recognise saturated and unsaturated hydrocarbons • from molecular structures, • by their reaction with aqueous bromine.	
	Describe the addition reactions of alkenes, exemplified by ethene, with bromine, hydrogen and steam.	
14.4: Alcohols	State that ethanol may be formed by reaction between ethene and steam.	
	Supplementary **Describe the formation of ethanol by the catalytic addition of steam to ethene.**	
	Describe the complete combustion reaction of ethanol.	
	State the uses of ethanol as a solvent and as a fuel.	
C14.5: Macromolecules	**Supplementary** **Describe macromolecules in terms of large molecules built up from small units (monomers), different macromolecules having different units.**	• ***New Materials***
Synthetic	Describe the formation of poly(ethene) as an example of addition polymerisation of monomer units.	• ***New Materials***

	Supplementary **Draw the structure of poly(ethene).**	
	Supplementary **Describe the formation of a simple condensation polymer exemplified by nylon.**	
C14.7: Natural macromolecules	**Supplementary** **Describe proteins as possessing the same (amide) linkages as nylon but formed from the linking of amino acids.**	
	Supplementary **State that proteins can be hydrolysed to amino acids under acid or alkaline conditions. (Structures and names are not required.)**	

Cambridge IGCSE Science (Co-ordinated – Double)

	Physics	
	Syllabus point	**Presentation(s)**
P1: Motion	Define speed and calculate speed from total distance ÷ total time	• ***Speed***
	Supplementary **Distinguish between speed and velocity.**	• ***Speed***
	Plot and interpret a speed/time graph and a distance/time graph.	• ***Speed***
	Recognise from the shape of a speed/time graph when a body is • at rest, • moving with constant speed, • moving with changing speed.	• ***Speed*** • ***Acceleration***
	Supplementary **Recognise linear motion for which the acceleration is constant and calculate the acceleration.**	• ***Acceleration***
	Supplementary **Recognise motion for which the acceleration is not constant.**	• ***Acceleration***
	Supplementary **Calculate the area under a speed/time graph to work out the distance travelled for motion with constant acceleration.**	• ***Speed***
	Demonstrate a qualitative understanding that acceleration is related to changing speed.	• ***Speed*** • ***Acceleration***
P2.1: Mass and weight	Be able to distinguish between the mass and weight of an object.	• ***Falling Objects***
	Supplementary **Demonstrate understanding that mass is a property that 'resists' change in motion.**	• ***Falling Objects***
	Know that the Earth is the source of a gravitational field.	• ***Falling Objects***
	Supplementary **Describe, and use the concept of, weight as the effect of a gravitational field on a mass.**	• ***Falling Objects***
P2.2: Density	Describe an experiment to determine the density of a liquid and of a regularly shaped solid and make the necessary calculation using the equation density = mass/volume or d = m/v.	
	Supplementary **Describe the determination of the density of an irregularly shaped solid by the method of displacement, and make the necessary calculation.**	
P2.3: Effects of forces	Know that a force is measured in newtons (N).	• ***Forces***
	Describe how forces may change the size, shape and motion of a body.	• ***Forces***
	Plot extension/load graphs and describe the associated experimental procedure.	• ***Forces***

	Supplementary **Interpret extension/load graphs.**	• ***Forces***
	State and use Hooke's Law and recall and use the expression force = constant × extension (F = k x).	• ***Elasticity***
	Recognise the significance of the term 'limit of proportionality' for an extension/load graph.	• ***Elasticity***
	Recall and use the relation between force, mass and acceleration (including the direction).	• ***Acceleration***
	Find the resultant of two or more forces acting along the same line.	• ***Forces***
	Explain how a system is in equilibrium when there is no resultant force.	• ***Forces***
P2.4: Pressure	Relate (without calculation) pressure to force and area.	
	Supplementary **Recall and use the equation P = F/A.**	
P3.1: Energy	Know that energy and work are measured in joules (J), and power in watts (W).	• ***Potential and Kinetic Energy***
	Demonstrate understanding that an object may have energy due to its motion (kinetic) or its position (potential), and that energy may be transferred and stored.	• ***Potential and Kinetic Energy***
	Supplementary **Recall and use the expressions K.E. = ½ mv2 and P.E. = mgh**	• ***Potential and Kinetic Energy***
	Give and identify examples of energy in different forms, including kinetic, gravitational, chemical, strain, nuclear, thermal (heat), electrical, light and sound.	• ***Potential and Kinetic Energy***
	Give and identify examples of the conversion of energy from one form to another, and of its transfer from one place to another.	• ***Potential and Kinetic Energy***
	Supplementary **Apply the principle of energy conservation to simple examples.**	• ***Potential and Kinetic Energy***
P3.2: Energy resources	Distinguish between renewable and non-renewable sources of energy.	
	Supplementary **Demonstrate understanding that energy is released by nuclear fusion in the Sun.**	• ***Nuclear Fusion***
	Know that the Sun is the source of energy for all our energy resources except geothermal and nuclear.	

	Describe how electricity or other useful forms of energy may be obtained from: • chemical energy stored in fuel, • water, including the energy stored in waves, in tides, and in water behind hydroelectric dams, • geothermal resources, • nuclear fission, • heat and light from the Sun (solar cells and panels).	• ***Nuclear Fuels and Fission*** • ***Electrcity Supply***
	Give advantages and disadvantages of each method in terms of reliability, scale and environmental impact.	
	Supplementary **Recall and use the equation: efficiency = (energy input ÷ useful energy output) × 100%**	
	Demonstrate a qualitative understanding of efficiency.	
P3.3: Work	Relate (without calculation) work done to the magnitude of a force and the distance moved.	• ***Work and Power***
	Supplementary **Describe energy changes in terms of work done.**	• ***Work and Power***
	Recall and use W = F × d.	• ***Work and Power***
P3.4: Power	Relate (without calculation) power to work done and time taken, using appropriate examples.	• ***Work and Power***
	Supplementary **Recall and use the equation P = E/t in simple systems.**	• ***Work and Power***
P4.1: States of matter	State the distinguishing properties of solids, liquids and gases.	
P4.2: Molecular model	Describe qualitatively the molecular structure of solids, liquids and gases.	
	Supplementary **Relate the properties of solids, liquids and gases to the forces and distances between molecules and to the motion of the molecules.**	
	Interpret the temperature of a gas in terms of the motion of its molecules.	
	Describe qualitatively the pressure of a gas in terms of the motion of its molecules.	
	Describe qualitatively the effect of a change of temperature on the pressure of a gas at constant volume.	

P4.3: Evaporation	Describe evaporation in terms of the escape of more energetic molecules from the surface of a liquid.	
	Supplementary **Demonstrate understanding of how temperature, surface area and air flow over a surface influence evaporation.**	
	Relate evaporation to the consequent cooling.	
P4.4: Pressure changes	**Supplementary** **Relate the change in volume of a gas to change in pressure applied to the gas at constant temperature and use the equation pV = constant at constant temperature.**	
P5.1: Thermal expansion of liquids and gases	Describe qualitatively the thermal expansion of solids, liquids and gases.	
	Supplementary **Explain in terms of motion and arrangement of molecules the relative order of magnitude of the expansion of solids, liquids and gases.**	
	Identify and explain some of the everyday applications and consequences of thermal expansion.	
	Describe qualitatively the effect of a change of temperature on the volume of a gas at constant pressure.	
P5.2: Thermal capacity	**Supplementary** **Demonstrate understanding of the term thermal capacity.**	
	Supplementary **Describe an experiment to measure the specific heat capacity of a substance.**	
	Supplementary **Recall and use the equation:** **energy = mass × specific heat capacity × change in temperature.**	
P5.3: Melting and boiling	Describe melting and boiling in terms of energy input without a change in temperature.	
	Supplementary **Distinguish between boiling and evaporation.**	
	Describe condensation and solidification.	
	Supplementary **Use the terms latent heat of vaporisation and latent heat of fusion and give a molecular interpretation of latent heat.**	
	State the meaning of melting point and boiling point.	

P6.1: Conduction	Describe experiments to demonstrate the properties of good and bad conductors of heat.	
	Supplementary **Explain heat transfer in solids in terms of molecular motion.**	
P6.2: Convection	Recognise convection as the main method of heat transfer in fluids.	
	Supplementary **Relate convection in fluids to density changes.**	
	Describe experiments to illustrate convection in liquids and gases.	
P6.3: Radiation	Recognise radiation as the method of heat transfer that does not require a medium to travel through.	
	Supplementary **Describe experiments to show the properties of good and bad emitters and good and bad absorbers of infra-red radiation.**	
	Identify infra-red radiation as the part of the electromagnetic spectrum often involved in heat transfer by radiation.	
P6.4: Consequences of energy transfer	Identify and explain some of the everyday applications and consequences of conduction, convection and radiation.	
P7.1: General wave properties	Demonstrate understanding that wave motion transfers energy without transferring matter in the direction of wave travel.	• ***Ultrasound***
	Describe what is meant by wave motion as illustrated by vibration in ropes and springs and by experiments using water waves.	• ***Ultrasound***
	State the meaning of and use the terms speed, frequency, wavelength and amplitude.	• ***Ultrasound***
	Supplementary **Recall and use the equation $v = f\lambda$.**	
	Distinguish between transverse and longitudinal waves and give suitable examples.	• ***Ultrasound***
	Identify how a wave can be reflected off a plane barrier and can change direction as its speed changes.	
	Interpret reflection and refraction using wave theory.	

P8.1: Reflection of light	Describe the formation and characteristics of an optical image seen in a plane mirror.	
	Supplementary **Perform simple constructions, measurements and calculations based on reflections in plane mirrors.**	
	Use the law angle of incidence = angle of reflection.	
P8.2: Refraction of light	Describe an experimental demonstration of the refraction of light.	
	Describe, using ray diagrams, the passage of light through parallel-sided transparent material, indicating the angle of incidence *i* and angle of refraction *r*.	
	Supplementary **Describe the action of optical fibres and their use in medicine and communications technology.**	
	State the meaning of critical angle.	
	Identify and describe internal and total internal reflection using ray diagrams.	
P8.3: Thin converging lens	Describe the action of a thin converging lens on a beam of light using ray diagrams.	
	Use the terms *principal focus* and *focal length.*	
	Supplementary **Draw and interpret simple ray diagrams that illustrate the formation of real and virtual images by a single converging lens.**	
	Draw ray diagrams to illustrate the formation of a real image by a single lens.	
P8.4: Dispersion of light	Describe the dispersion of light by a glass prism.	
P9: Electromagnetic spectrum	Describe the main features of the electromagnetic spectrum.	
	Supplementary **State the approximate value of the speed of all electromagnetic waves *in vacuo.***	
	Describe the role of electromagnetic waves in: • radio and television communications (radio waves), • satellite television and telephones (microwaves), • electrical appliances, remote controllers for televisions and intruder alarms (infrared), • medicine and security (X-rays).	• ***Ionizing Radiation***
	Demonstrate understanding of safety issues regarding the use of	• ***Ionising Radiation***

	microwaves and X-rays.	
P10: Sound	Describe the production of sound by vibrating sources.	• ***Ultrasound***
	Supplementary **Describe transmission of sound in air in terms of compressions and rarefactions.**	• ***Ultrasound***
	State the approximate human range of audible frequencies.	• ***Ultrasound***
	Demonstrate understanding that a medium is needed to transmit sound waves.	• ***Ultrasound***
	Describe and interpret an experiment to determine the speed of sound in air.	
	Supplementary **State the order of magnitude of the speed of sound in air, liquids and solids.**	
	Relate the loudness and pitch of sound waves to amplitude and frequency.	• ***Ultrasound***
	Describe how the reflection of sound may produce an echo.	
P11: Magnetism	Describe the properties of magnets.	
	Supplementary **Give an account of induced magnetism.**	
	Identify the pattern of field lines round a bar magnet.	
	Distinguish between the magnetic properties of iron and steel.	
	Distinguish between the design and use of permanent magnets and electromagnets.	
P12.1: Electricity	Demonstrate understanding of *current*, *potential difference*, *e.m.f.* and *resistance*, and use with their appropriate units.	• ***Current, Voltage and Resistance***
	Supplementary **State that charge is measured in coulombs (C).**	• ***Current, Voltage and Resistance*** • ***Electrical Power***
	Use and describe the use of an ammeter and a voltmeter.	• ***Current, Voltage and Resistance***
P12.2: Electric charge	Describe and interpret simple experiments to show the production and detection of electrostatic charges.	• ***Current, Voltage and Resistance***
	State that there are positive and negative charges.	• ***Current, Voltage and Resistance***
	Supplementary **Describe an electric field as a region in which an electric charge experiences a force.**	• ***Current, Voltage and Resistance***

	State that unlike charges attract and that like charges repel.	• ***Current, Voltage and Resistance***
	Distinguish between electrical conductors and insulators and give typical examples.	• ***Current, Voltage and Resistance*** • ***Electrical Circuits***
P12.3: Current. Electromotive force and potential difference	State that current is related to the flow of charge.	• ***Current, Voltage and Resistance***
	Supplementary **Demonstrate understanding that a current is a rate of flow of charge and recall and use the equation I = Q/t.**	• ***Current, Voltage and Resistance***
	Use the term potential difference (p.d.) to describe what drives the current between two points in a circuit.	• ***Current, Voltage and Resistance***
	Supplementary **Distinguish between the direction of flow of electrons and conventional current.**	• ***Electrical Circuits***
	Supplementary **Demonstrate understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit.**	
P12.4: Resistance	State that resistance = p.d. / current and understand qualitatively how changes in p.d. or resistance affect current.	• ***Current, Voltage and Resistance***
	Recall and use the equation $R = V/I$.	• ***Current, Voltage and Resistance***
	Describe an experiment to determine resistance using a voltmeter and an ammeter.	• ***Current, Voltage and Resistance***
	Supplementary **Recall and use quantitatively the proportionality between resistance and length, and the inverse proportionality between resistance and cross-sectional area of a wire.**	• ***Current, Voltage and Resistance***
	Relate (without calculation) the resistance of a wire to its length and to its diameter.	• ***Current, Voltage and Resistance***
P12.5: Electrical energy	**Supplementary** **Recall and use the equations P = I V and E = I V t.**	• ***Electrical Power***
P12.6: Dangers of electricity	Identify electrical hazards including • damaged insulation, • overheating of cables, • damp conditions.	• ***Electrical Wiring and Safety***
	Supplementary **Demonstrate understanding of the use of circuit-breakers.**	• ***Electrical Wiring and Safety***
	Demonstrate understanding of the use of fuses.	• ***Electrical Wiring and Safety***
Circuit	Draw and interpret circuit diagrams containing sources, switches, resistors, lamps, ammeters, voltmeters, and fuses.	• ***Electrical Circuits***

	Supplementary **Draw and interpret circuit diagrams containing magnetising coils, transformers, bells and relays.**	• *Electrical Circuits*
P13.2: Series and parallel circuits	Demonstrate understanding that the current at every point in a series circuit is the same.	• *Series and Parallel Circuits.ppt*
	Supplementary **Recall and use the fact that the sum of the p.d.s across the components in a series circuit is equal to the total p.d. across the supply.**	• *Series and Parallel Circuits.ppt*
	Calculate the combined resistance of two or more resistors in series.	• *Series and Parallel Circuits.ppt*
	State that, for a parallel circuit, the current from the source is larger than the current in each branch.	• *Series and Parallel Circuits.ppt*
	Supplementary **Recall and use the fact that current from the source is the sum of the currents in the separate branches of a parallel circuit.**	• *Series and Parallel Circuits.ppt*
	State that the combined resistance of two resistors in parallel is less than that of either resistor by itself.	• *Series and Parallel Circuits.ppt*
	Supplementary **Calculate the effective resistance of two resistors in parallel.**	• *Series and Parallel Circuits.ppt*
	State the advantages of connecting lamps in parallel in a lighting circuit.	• *Series and Parallel Circuits.ppt*
P13.3: Action and use of circuit components	**Supplementary** **Describe the action of thermistors and light-dependent resistors and show understanding of their use as input transducers.**	• *Circuit Components*
	Supplementary **Describe the action of a relay and show understanding of its use in switching circuits.**	• *Circuit Components*
	Supplementary **Recognise and demonstrate understanding of circuits operating as light sensitive switches and temperature-operated alarms using a relay.**	• *Circuit Components*
P14.1: Electromagnetic induction	**Supplementary** **Describe an experiment that shows that a changing magnetic field can induce an e.m.f. in a circuit.**	• *Generators*
	Supplementary **State the factors affecting the magnitude of an induced e.m.f.**	• *Generators*
P14.2: A.C. generator	**Supplementary** **Describe a rotating-coil generator and the use of slip rings.**	• *Generators*
	Supplementary **Sketch a graph of voltage output against time for a simple a.c. generator.**	• *Generators*

P14.3: Transformer	**Supplementary** **Describe the construction of a basic iron-cored transformer as used for voltage transformations.**	• ***Generators***
	Supplementary **Recall and use the equation (Vp / Vs) = (Np / Ns).**	• ***Generators***
	Supplementary **Describe the use of the transformer in high-voltage transmission of electricity.**	• ***Generators***
	Supplementary **Recall and use the equation Vp I p = Vs I s (for 100% efficiency).**	• ***Generators***
	Supplementary **Explain why energy losses in cables are lower when the voltage is high.**	
P14.4: The magnetic effect of a current	Describe the pattern of the magnetic field due to currents in straight wires and in solenoids.	
	Supplementary **Describe the effect on the magnetic field of changing the magnitude and direction of the current.**	• ***Generators***
	Describe applications of the magnetic effect of current, including the action of a relay.	
P14.5: Force on current-carrying conductor	Describe and interpret an experiment to show that a force acts on a current-carrying conductor in a magnetic field, including the effect of reversing: • the current, • the direction of the field.	• ***Generators***
	Supplementary **State and use the relative directions of force, field and current.**	
P14.6: D.C. motor	**Supplementary** **Describe the turning effect on a current carrying coil in a magnetic field.**	• ***Motors***
	Supplementary **Relate this turning effect to the action of an electric motor.**	• ***Motors***
	Supplementary **Describe the effect of increasing (a) the number of turns in the coil (b) the current.**	• ***Motors***
P15.1: Detection of radioactivity	Demonstrate understanding of background radiation.	• ***Radioactive Substances***
	Describe the detection of α-particles, β-particles and γ-rays (β+ are not included; β-particles will be taken to refer to β–).	• ***Radioactive Substances***

P15.2: Characteristics of the three kinds of emission	State that radioactive emissions occur randomly over space and time.	• ***Radioactive Substances***
	Recall for radioactive emissions, and use to identify them: • their nature, • their relative ionising effects, • their relative penetrating abilities.	• ***Radioactive Decay*** • ***Ionizing Radiation***
	Supplementary **Describe the deflection of α-particles, β-particles and γ-rays in electric fields and magnetic fields.**	• ***Ionizing Radiation***
	Supplementary **Interpret their relative ionising effects.**	• ***Ionizing Radiation***
P15.3 Radioactive decay	State the meaning of radioactive decay.	• ***Radioactive Decay***
	Supplementary **Use equations (involving words or symbols) to represent changes in the composition of the nucleus when particles are emitted.**	• ***Radioactive Decay***
P15.4: Half-life	**Supplementary** **Use the term half-life in simple calculations, including the use of information in tables or decay curves.**	• ***Half-life***
P15.5: Safety precautions – isotopes	Describe the hazards of ionising radiation to living things.	• ***Ionizing Radiation***
	Describe how radioactive materials are handled, used and stored in a safe way to minimise the effects of these hazards.	• ***Ionizing Radiation***
P15.6: The nuclear atom	Use the term isotope.	• ***Atoms and Isotopes***
	Give and explain examples of practical applications of isotopes.	