OCR 21st Century GCSE Additional Science 2011

GCSE Additional Science: Biology

Module B4: The Processes of Life **Boardworks Presentation**

B4.1 How do chemical reactions take place in living things?	
1. understand that the basic processes of life carried out by all living things depend on chemical reactions within cells that require energy released by respiration	**Cells** **Respiration**
2. understand the role of photosynthesis in making food molecules and energy available to living organisms through food chains	**Uses of Glucose in Plants**
3. describe photosynthesis as a series of chemical reactions that use energy from sunlight to build large food molecules in plant cells and some microorganisms (eg phytoplankton)	**Photosynthesis**
4. describe respiration as a series of chemical reactions that release energy by breaking down large food molecules in all living cells	**Respiration**
5. recall that enzymes are proteins that speed up chemical reactions	**Enzymes**
6. recall that cells make enzymes according to the instructions carried in genes	**Enzymes**
7. understand that molecules have to be the correct shape to fit into the active site of the enzyme (the lock and key model)	**Enzymes**
8. understand that enzymes need a specific constant temperature to work at their optimum, and that they permanently stop working (denature) if the temperature is too high	**Enzymes**
9. (HT) explain that enzyme activity at different temperatures is a balance between: a. increased rates of reaction as temperature increases b. changes to the active site at higher temperatures, including denaturing (Candidates are not expected to explain why rates of reaction increase with temperature)	**Enzymes**
10. recall that an enzyme works at its optimum at a specific pH	**Enzymes**
11. (HT) explain the effect of pH on enzyme activity in terms of changes to the shape of the active site.	**Enzymes**

B4.2 How do plants make food?	
1. recall the names of the reactants and products of photosynthesis, and use the word equation: carbon dioxide + water ----light energy----> glucose + oxygen	**Photosynthesis**
2. (HT) recall the formulae of the reactants and products of photosynthesis, and use the symbol equation: $6CO_2 + 6H_2O$ ----light energy----> $C_6H_{12}O_6 + 6O_2$	**Photosynthesis**
3. recall the main stages of photosynthesis: a. light energy absorbed by the green chemical chlorophyll b. energy used to bring about the reaction between carbon dioxide and water to produce glucose (a sugar) c. oxygen produced as a waste product	**Photosynthesis**
4. recall that glucose may be: a. converted into chemicals needed for growth of plant cells, for example cellulose, protein and chlorophyll b. converted into starch for storage c. used in respiration to release energy	**Uses of Glucose in Plants**
5. recall the structure of a typical plant cell, limited to chloroplasts, cell membrane, nucleus, cytoplasm, mitochondria, vacuole and cell wall	**Cells**

6. understand the functions of the structures in a typical plant cell that have a role in photosynthesis, including: a. chloroplasts contain chlorophyll and the enzymes for the reactions in photosynthesis b. cell membrane allows gases and water to pass in and out of the cell freely while presenting a barrier to other chemicals c. nucleus contains DNA which carries the genetic code for making enzymes and other proteins used in the chemical reactions of photosynthesis d. cytoplasm where the enzymes and other proteins are made	**Leaves**
7. recall that minerals taken up by plant roots are used to make some chemicals needed by cells, including nitrogen from nitrates to make proteins	**Uses of Glucose in Plants**
8. understand that diffusion is the passive overall movement of molecules from a region of their higher concentration to a region of their lower concentration	**Diffusion**
9. recall that the movement of oxygen and carbon dioxide in and out of leaves during photosynthesis occurs by diffusion	**Diffusion**
10. understand that osmosis (a specific case of diffusion) is the overall movement of water from a dilute to a more concentrated solution through a partially permeable membrane	**Osmosis**
11. recall that the movement of water into plant roots occurs by osmosis	**Osmosis**
12. (HT) understand that active transport is the overall movement of chemicals across a cell membrane requiring energy from respiration	**Active Transport**
13. (HT) recall that active transport is used in the absorption of nitrates by plant roots	**Active Transport**
14. understand that the rate of photosynthesis may be limited by: a. temperature b. carbon dioxide c. light intensity	**Photosynthesis**
15. interpret data on factors limiting the rate of photosynthesis	**Photosynthesis**
16. describe and explain techniques used in □ eldwork to investigate the effect of light on plants, including: a. using a light meter b. using a quadrat c. using an identification key	**Investigating Ecosystems**
17. understand how to take a transect.	**Investigating Ecosystems**

B4.3 How do living organisms obtain energy?	
1. understand that all living organisms require energy released by respiration for some chemical reactions in cells, including chemical reactions involved in: a. movement b. synthesis of large molecules c. (HT) active transport	**Respiration**
2. understand that synthesis of large molecules includes: a. synthesis of polymers required by plant cells such as starch and cellulose from glucose in plant cells b. synthesis of amino acids from glucose and nitrates, and then proteins from amino acids in plant, animal and microbial cells	**Respiration**
3. recall that aerobic respiration takes place in animal and plant cells and some microorganisms, and requires oxygen	**Respiration**
4. recall the names of the reactants and products of aerobic respiration and use the word equation: glucose + oxygen --> carbon dioxide + water (+ energy released)	**Respiration**
5. (HT) recall the formulae of the reactants and products of aerobic respiration and use the symbol equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$	**Respiration**

6. recall that anaerobic respiration takes place in animal, plant and some microbial cells in conditions of low oxygen or absence of oxygen, to include: a. plant roots in waterlogged soil b. bacteria in puncture wounds c. human cells during vigorous exercise	**Anaerobic Respiration**
7. recall the names of the reactants and products of anaerobic respiration in animal cells and some bacteria, and use the word equation: glucose --> lactic acid (+ energy released)	**Anaerobic Respiration**
8. recall the names of the reactants and products of anaerobic respiration in plant cells and some microorganisms including yeast, and use the word equation: glucose --> ethanol + carbon dioxide (+ energy released)	**Anaerobic Respiration**
9. understand that aerobic respiration releases more energy per glucose molecule than anaerobic respiration	**Anaerobic Respiration**
10. recall the structure of typical animal and microbial cells (bacteria and yeast) limited to: a. nucleus b. cytoplasm c. cell membrane d. mitochondria (for animal and yeast cells) e. cell wall (for yeast and bacterial cells) f. circular DNA molecule (for bacterial cells)	**Cells**
11. understand the functions of the structures in animal, plant, bacteria and yeast cells that have a role in respiration, including: a. mitochondria contain enzymes for the reactions in aerobic respiration (in animals, plants and yeast) b. cell membrane allows gases and water to pass in and out of the cell freely while presenting a barrier to other chemicals c. nucleus or circular DNA in bacteria contains DNA which carries the genetic code for presenting a barrier to other chemicals d. cytoplasm where enzymes are made and which contains the enzymes used in anaerobic respiration	**Respiration**
12. describe examples of the applications of the anaerobic respiration of microorganisms, including the production of biogas and fermentation in bread making and alcohol production.	**Anaerobic Respiration**

Module B5: Growth and development — Boardworks Presentation

B5.1 How do organisms develop?	
1. recall that cells in multicellular organisms can be specialised to do particular jobs	Multicellular Organisms
2. recall that groups of specialised cells are called tissues, and groups of tissues form organs	Multicellular Organisms
3. recall that a fertilised egg cell (zygote) divides by mitosis to form an embryo	Meiosis and Reproduction
4. recall that in a human embryo up to (and including) the eight cell stage, all the cells are identical (embryonic stem cells) and could produce any type of cell required by the organism	Stem Cells
5. understand that after the eight cell stage, most of the embryo cells become specialised and form different types of tissue	Stem Cells
6. understand that some cells (adult stem cells) remain unspecialised and can become specialised, at a later stage, to become many, but not all, types of cell required by the organism	Stem Cells
7. understand that in plants, only cells within special regions called meristems are mitotically active	Plant and Animal Growth
8. understand that the new cells produced from plant meristems are unspecialised and can develop into any kind of plant cell	Plant and Animal Growth
9. understand that unspecialised plant cells can become specialised to form different types of tissue (including xylem and phloem) within organs (including owers, leaves, stems and roots)	Stem Cells
10. understand that the presence of meristems (as sources of unspecialised cells) allows the production of clones of a plant from cuttings, and that this may be done to reproduce a plant with desirable features	Asexual Reproduction
11. understand that a cut stem from a plant can develop roots and then grow into a complete plant which is a clone of the parent, and that rooting can be promoted by the presence of plant hormones (auxins)	Asexual Reproduction
12. understand that the growth and development of plants is also affected by the environment, eg phototropism	Plant and Animal Growth
13. understand how phototropism increases the plant's chance of survival	Plant and Animal Growth
14. (HT) explain phototropism in terms of the effect of light on the distribution of auxin in a shoot tip.	Plant and Animal Growth

B5.2 How does an organism produce new cells?	
1. recall that cell division by mitosis produces two new cells that are genetically identical to each other and to the parent cell	Mitosis
2. describe the main processes of the cell cycle: a. cell growth during which: - numbers of organelles increase - the chromosomes are copied when the two strands of each DNA molecule separate and new strands form alongside them b. mitosis during which: - copies of the chromosomes separate - the nucleus divides	Mitosis
3. recall that meiosis is a type of cell division that produces gametes	Meiosis and Reproduction
4. understand why, in meiosis, it is important that the cells produced only contain half the chromosome number of the parent cell	Meiosis and Reproduction
5. understand that a zygote contains a set of chromosomes from each parent.	Meiosis and Reproduction

B5.3 How do genes control growth and development within the cell?	
1. recall that DNA has a double helix structure	DNA
2. recall that both strands of the DNA molecule are made up of four different bases which always pair up in the same way: A with T, and C with G	Genes and Protein Synthesis
3. understand that the order of bases in a gene is the genetic code for the production of a protein	Genes and Protein Synthesis
4. explain how the order of bases in a gene is the code for building up amino acids in the correct order to make a particular protein	DNA
5. recall that the genetic code is in the cell nucleus of animal and plant cells but proteins are produced in the cell cytoplasm	Genes and Protein Synthesis
6. understand that genes do not leave the nucleus but a copy of the gene (messenger RNA) is produced to carry the genetic code to the cytoplasm	Genes and Protein Synthesis
7. understand that although all body cells in an organism contain the same genes, many genes in a particular cell are not active (switched off) because the cell only produces the specific proteins it needs	Genes and Protein Synthesis
8. understand that in specialised cells only the genes needed for the cell can be switched on, but in embryonic stem cells any gene can be switched on during development to produce any type of specialised cell	Plant and Animal Growth
9. understand that adult stem cells and embryonic stem cells have the potential to produce cells needed to replace damaged tissues	Stem Cells
10. understand that ethical decisions need to be taken when using embryonic stem cells and that this work is subject to Government regulation	Stem Cells
11. (HT) understand that, in carefully controlled conditions of mammalian cloning, it is possible to reactivate (switch on) inactive genes in the nucleus of a body cell to form cells of all tissue types.	Stem Cells

Module B6: Brain and mind — Boardworks Presentation

B6.1 How do animals respond to changes in their environment?	
1. recall that a stimulus is a change in the environment of an organism	Nerves and Reflexes
2. understand that simple reflexes produce rapid involuntary responses to stimuli	Nerves and Reflexes
3. understand that the simplest animals rely on reflex actions for the majority of their behaviour	Nerves and Reflexes
4. understand that these reflex actions help to ensure that the simplest animals respond to a stimulus in a way that is most likely to result in their survival, to include finding food and sheltering from predators	Nerves and Reflexes
5. recall examples of simple reflexes in humans, to include newborn reflexes (eg stepping, grasping, sucking), pupil reflex, knee jerk and dropping a hot object	Nerves and Reflexes
6. understand that nervous co-ordination, including simple reflexes, requires: a. receptors to detect stimuli b. processing centres to receive information and coordinate responses c. effectors to produce the response	Nerves and Reflexes
7. understand that receptors and effectors can form part of complex organs, for example: a. light receptor cells in the retina of the eye b. hormone secreting cells in a gland c. muscle cells in a muscle	Nerves and Reflexes
8. understand that nervous systems use electrical impulses for fast, short-lived responses including simple reflexes	Nerves and Reflexes
9. recall that hormones are chemicals that are produced in glands, travel in the blood and bring about slower, longer-lasting responses, eg insulin and oestrogen	Nerves and Reflexes
10. recall that the development of nervous and hormonal communication systems depended on the evolution of multicellular organisms.	Nerves and Reflexes

B6.2 How is information passed through the nervous system	
1. recall that nervous systems are made up of neurons (nerve cells) linking receptor cells (eg in eyes, ears and skin) to effector cells (in muscles/glands)	**The Nervous System**
2. recall that neurons transmit electrical impulses when stimulated	**The Nervous System**
3. recall that an axon is a long extension of the cytoplasm in a neuron and is surrounded by a cell membrane	**The Nervous System**
4. understand that some axons are surrounded by a fatty sheath, which insulates the neuron from neighbouring cells and increases the speed of transmission of a nerve impulse	**The Nervous System**
5. recall that in humans and other vertebrates the central nervous system (CNS) is made up of the spinal cord and brain	**The Nervous System**
6. recall that in the mammalian nervous system the CNS (brain and spinal cord) is connected to the body via the peripheral nervous system (PNS) (sensory and motor neurons)	**The Nervous System**
7. understand that the CNS coordinates an animal's responses via: a. sensory neurons carrying impulses from receptors to the CNS b. motor neurons carrying impulses from the CNS to effectors	**The Nervous System**
8. understand that within the CNS, impulses are passed from sensory neurons to motor neurons through relay neurons	**The Nervous System**
9. describe the nervous pathway of a spinal reflex arc to include receptor, sensory neuron, relay neuron, spinal cord, motor neuron and effector	**The Nervous System**
10. understand that this arrangement of neurons into a fixed pathway allows reflex responses to be automatic and so very rapid, since no processing of information is required	**The Nervous System**
11. recall that there are gaps between adjacent neurons called synapses and that impulses are transmitted across them	**The Nervous System**
12. understand that at a synapse an impulse triggers the release of chemicals (transmitter substances) from the first neuron into the synapse, which diffuse across and bind to receptor molecules on the membrane of the next neuron	**The Nervous System**
13. understand that only specific chemicals bind to the receptor molecules, initiating a nerve impulse in the next neuron	**The Nervous System**
14. recall that some toxins and drugs, including Ecstasy, beta blockers and Prozac, affect the transmission of impulses across synapses	**The Nervous System**
15. understand that Ecstasy (MDMA) blocks the sites in the brain's synapses where the transmitter substance, serotonin, is removed	**The Nervous System**
16. understand that the effects of Ecstasy on the nervous system are due to the subsequent increase in serotonin concentration	**The Nervous System**
17. recall that the cerebral cortex is the part of our brain most concerned with intelligence, memory, language and consciousness	**The Brain and Learning**
18. understand that scientists can map the regions of the brain to particular functions (including studies of patients with brain damage, studies in which different parts of the brain are stimulated electrically, and brain scans such as MRI, showing brain structure and activity).	**The Brain and Learning**

B6.3 Can reflex responses be learned?	
1. understand that a reflex response to a new stimulus can be learned by introducing the secondary (new) stimulus in association with the primary stimulus, and that this is called conditioning	**The Brain and Learning**
2. describe and explain two examples of conditioning, including Pavlov's dogs	
3. understand that in a conditioned reflex the final response (eg salivation) has no direct connection to the secondary stimulus (eg ringing of a bell)	**The Brain and Learning**
4. understand that conditioned reflexes are a form of simple learning that can increase an animal's chance of survival	**The Brain and Learning**
5. recall that in some circumstances the brain can modify a reflex response via a neuron to the motor neuron of the reflex arc, for example keeping hold of a hot object.	**The Brain and Learning**

B6.4 How do humans develop more complex behaviour?	
1. understand that the evolution of a larger brain gave early humans a better chance of survival	**The Brain and Learning**
2. recall that mammals have a complex brain of billions of neurons that allows learning by experience, including social behaviour	**The Brain and Learning**
3. understand that during development the interaction between mammals and their environment results in neuron pathways forming in the brain	**The Brain and Learning**
4. understand that learning is the result of experience where: a. certain pathways in the brain become more likely to transmit impulses than others b. new neuron pathways form and other neuron pathways are lost	**The Brain and Learning**
5. understand that this is why some skills may be learnt through repetition	**The Brain and Learning**
6. understand that the variety of potential pathways in the brain makes it possible for the animal to adapt to new situations	**The Brain and Learning**
7. understand the implications of evidence suggesting that children may only acquire some skills at a particular age, to include language development in feral children	**The Brain and Learning**
8. describe memory as the storage and retrieval of information	**The Brain and Learning**
9. recall that memory can be divided into short-term memory and long-term memory	**The Brain and Learning**
10. understand that humans are more likely to remember information if: a. they can see a pattern in it (or impose a pattern on it) b. there is repetition of the information, especially over an extended period of time c. there is a strong stimulus associated with it, including colour, light, smell, or sound	**The Brain and Learning**
11. understand how models can be used to describe memory (including the multi-store model) to include short-term memory, long-term memory, repetition, storage, retrieval and forgetting	**The Brain and Learning**
12. understand that models are limited in explaining how memory works.	**The Brain and Learning**

OCR 21st Century GCSE Additional Science 2011

GCSE Additional Science: Chemistry

Module C4: Chemical patterns	Boardworks Presentation
C4.1 What are the patterns in the properties of elements?	
1. understand that atoms of each element have different proton numbers	The Periodic Table
2. understand that arranging the elements in order of their proton numbers gives repeating patterns in the properties of elements	The Periodic Table
3. understand that early attempts to find connections between the chemical properties of the elements and their relative atomic mass were dismissed by the scientific community	The Periodic Table
4. recall the significant stages in the history of the development of the Periodic Table to include the ideas of Döbereiner, Newlands and Mendeleev	The Periodic Table
5. understand how Mendeleev used his Periodic Table to predict the existence of unknown elements	The Periodic Table
6. use the Periodic Table to obtain the names, symbols, relative atomic masses and proton number of elements	The Periodic Table
7. understand that a group of elements is a vertical column in the Periodic Table and that the elements in a group have similar properties	The Periodic Table
8. recall that a period is a row of elements in the Periodic Table	The Periodic Table
9. use the Periodic Table to classify an element as a metal or non-metal	The Periodic Table
10. use patterns in the Periodic Table to interpret data and predict properties of elements (i) Candidates will be give a copy of the Periodic Table (as in Appendix G) with the examination paper	The Periodic Table
11. recall and recognise the chemical symbols for the Group 1 metals (also known as the alkali metals) lithium, sodium and potassium	Group 1- Alkali Metals
12. recall that the alkali metals are shiny when freshly cut but tarnish rapidly in moist air due to reaction with oxygen	Group 1- Alkali Metals
13. use qualitative and quantitative data to identify patterns and make predictions about the properties of Group 1 metals (for example, melting point, boiling point, density, formulae of compounds and relative reactivity	Group 1- Alkali Metals
14. describe the reactions of lithium, sodium and potassium with cold water	Group 1- Alkali Metals
15. recall that alkali metals react with water to form hydrogen and an alkaline solution of a hydroxide with the formula MOH	Group 1- Alkali Metals
16. recall that alkali metals react vigorously with chlorine to form colourless, crystalline salts with the formula MCl	Group 1- Alkali Metals
17. understand and give examples to show that the alkali metals become more reactive as the group is descended	Group 1- Alkali Metals
18. recall the main hazard symbols and be able to give the safety precautions for handling hazardous chemicals (limited to explosive, harmful, toxic, corrosive, oxidizing and highliy flammable	Group 1- Alkali Metals
19. state and explain the precautions necessary when working with Group 1 metals and alkalis	Group 1- Alkali Metals
20. recall and recognise the chemical symbols for the atoms of the Group 7 elements (also known as the halogens) chlorine, bromine and iodine	Group 7- Halogens
21. recall the states of these halogens at room temperature and pressure	Group 7- Halogens
22. recall the colours of these halogens in their normal physical state at room temperature and as gases	Group 7- Halogens
23. recall that the halogens consist of diatomic molecules	Group 7- Halogens

24. use qualitative and quantitative data to identify patterns and make predictions about the properties of the Group 7 elements (for example melting point, boiling point, formulae of compounds and relative reactivity)	**Group 7- Halogens**
25. understand that the halogens become less reactive as the group is descended and give examples to show this	**Group 7- Halogens**
26. understand how a trend in reactivity for halogens can be shown by their displacement reactions and by their reactions with alkali metals and with iron	**Group 7- Halogens**
27. state and explain the safety precautions necessary when working with the halogens	**Group 7- Halogens**
28. recall the formulae of: b. the chlorides, (HT) bromides and iodides (halides) of Group 1 metals (limited to lithium, sodium and potassium)	**Group 7- Halogens**
29. write word equations for reactions of alkali metals and halogens in this module and for other reactions when given appropriate information	**Group 7- Halogens**
30. interpret symbol equations, including the number of atoms of each element, the number of molecules of each element or covalent compound and the number of 'formulas' of ionic compounds, in reactants and products (i) In this context, 'formula' is used in the case of ionic compounds as an equivalent to molecules in covalent compounds; the concept of the mole is not covered in the specification	
31. (HT) balance unbalanced symbol equations	
32. (HT) write balanced equations, including the state symbols (s), (g), (l) and (aq), for reactions of alkali metals and halogens in this module and for other reactions when given appropriate information	**Group 7- Halogens**
33. recall the state symbols (s), (l), (g) and (aq) and understand their use in equations.	**Making Salts**

C4.2 How do chemists explain the patterns in the properties of elements?	
1. describe the structure of an atom in terms of protons and neutrons in a very small central nucleus with electrons arranged in shells around the nucleus	**Atomic Structure**
2. recall the relative masses and charges of protons, neutrons and electrons	**Atomic Structure**
3. understand that in any atom the number of electrons equals the number of protons	**Atomic Structure**
4. understand that all the atoms of the same element have the same number of protons	**Atomic Structure**
5. understand that the elements in the Periodic Table are arranged in order of proton number	**The Periodic Table**
6. recall that some elements emit distinctive flame colours when heated (for example lithium, sodium and potassium) (i) Recall of specific flame colours emitted by these elements is not required	**Spectroscopy and Flame Tests**
7. understand that the light emitted from a particular element gives a characteristic line spectrum	**Spectroscopy and Flame Tests**
8. understand that the study of spectra has helped chemists to discover new elements	**Spectroscopy and Flame Tests**
9. understand that the discovery of some elements depended on the development of new practical techniques (for example spectroscopy)	**Spectroscopy and Flame Tests**
10. (HT) use the Periodic Table to work out the number of protons, electrons and neutrons in an atom	**Atomic Structure**
11. use simple conventions, such as 2.8.1 and dots in circles, to represent the electron arrangements in the atoms of the first 20 elements in the Periodic Table, when the number of electrons or protons in the atom is given (or can be derived from the Periodic Table)	**Electron Arrangement**
12. understand that a shell (or energy level) fills with electrons across a period	**Electron Arrangement**

13. understand that elements in the same group have the same number of electrons in their outer shell and how this relates to group number	Electron Arrangement
14. (HT) understand that the chemical properties of an element are determined by its electron arrangement, illustrated by the electron configurations of the atoms of elements in Groups 1 and 7.	Electron Arrangement

C4.3 How do chemists explain the properties of compounds of Group 1 and Group 7 elements	
1. understand that molten compounds of metals with non-metals conduct electricity and that this is evidence that they are made up of charged particles called ions	Ionic Compounds
2. understand that an ion is an atom (or group of atoms) that has gained or lost electrons and so has an overall charge	Ions and Ionic Bonding
3. account for the charge on the ions of Group 1 and Group 7 elements by comparing the number and arrangement of the electrons in the atoms and ions of these elements	Ions and Ionic Bonding
4. (HT) work out the formulae of ionic compounds given the charges on the ions	Ions and Ionic Bonding
5. (HT) work out the charge on one ion given the formula of a salt and the charge on the other ion	Ions and Ionic Bonding
6. recall that compounds of Group 1 metals with Group 7 elements are ionic	Ions and Ionic Bonding
7. understand that solid ionic compounds form crystals because the ions are arranged in a regular lattice	Ionic Compounds
8. describe what happens to the ions when an ionic crystal melts or dissolves in water	Ionic Compounds
9. explain that ionic compounds conduct electricity when molten or when dissolved in water because the ions are charged and they are able to move around independently in the liquid.	Ionic Compounds

Module C5: Chemicals of the natural environment	Boardworks Presentation

C5.1 What types of chemicals make up the atmosphere?	
1. recall that dry air consists of gases, some of which are elements (for example, oxygen, nitrogen and argon) and some of which are compounds (for example, carbon dioxide)	Air
2. recall that the relative proportions of the main gases in the atmosphere are about 78% nitrogen, 21% oxygen, 1% argon and 0.04% carbon dioxide	Air
3. recall the symbols for the atoms and molecules of these gases in the air	Air
4. recall that most non-metal elements and most compounds between non-metal elements are molecular	Covelant Bonds
5. understand that molecular elements and compounds with small molecules have low melting and boiling points	Covelant Bonds
6. interpret quantitative data (for example, melting and boiling points) and qualitative data about the properties of molecular elements and compounds	Covelant Bonds
7. understand that molecular elements and compounds, such as those in the air, have low melting and boiling points, and are gases at room temperature, because they consist of small molecules with weak forces of attraction between the molecules	Covelant Bonds
8. understand that pure molecular compounds do not conduct electricity because their molecules are not charged	Covelant Bonds
9. understand that bonding within molecules is covalent (HT) and arises from the electrostatic attraction between the nuclei of the atoms and the electrons shared between them	Covelant Bonds

10. understand that covalent bonds are strong, in contrast to the weak forces of attraction between small covalent molecules	
11. translate between representations of molecules including molecular formulae, 2-D diagrams in which covalent bonds are represented by lines, and 3-D diagrams for: a. elements that are gases at 20℃ b. simple molecular compounds.	**Covelant Bonds**

C5.2 What reactions happen in the hydrosphere?	
1. recall that the Earth's hydrosphere (oceans, seas, lakes and rivers) consists mainly of water with some dissolved compounds, called salts	**Making Salts**
2. understand that the ions in crystals of a solid ionic compound are arranged in a regular way forming a lattice	**Ionic Compounds**
3. understand that ions in a crystal are held together by forces of attraction between oppositely charged ions and that this is called ionic bonding	**Ionic Compounds**
4. understand how the physical properties of solid ionic compounds (melting point, boiling point, electrical conductivity) relate to their bonding and giant, three-dimensional structures	**Ionic Compounds**
5. describe what happens to the ions when an ionic crystal dissolves in water	**Ionic Compounds**
6. explain that ionic compounds conduct electricity when dissolved in water because the ions are charged and they are able to move around independently in the solution	**Ionic Compounds**
7. (HT) work out the formulae for salts in seawater given the charges on ions (for example sodium chloride, magnesium chloride, magnesium sulfate, sodium sulfate, potassium chloride and potassium bromide)	**Making Salts**
8. understand that the ions in an ionic compound can be detected and identified because they have distinct properties and they form compounds with distinct properties	
9. understand that an insoluble compound may precipitate on mixing two solutions of ionic compounds	**Precipation Reactions**
10. (HT) be able to write ionic equations for precipitation reactions when given appropriate information	**Precipation Reactions**
11. (HT) interpret given information on solubility to predict chemicals that precipitate on mixing solutions of ionic compounds	**Precipation Reactions**
12. understand that some metal ions can be identified in solution by adding alkali because they form insoluble hydroxides with characteristic colours	
13. interpret the results of adding aqueous sodium hydroxide to solutions of salts, given a data sheet of tests for positively charged ions and appropriate results (i) Candidates will be given a qualitative analysis data sheet showing tests for positively charged ions (as in Appendix H) with the examination paper	**Precipation Reactions**
14. understand that some negative ions in salts can be identified in solution by adding a reagent that reacts with the ions to form an insoluble solid	**Precipation Reactions**
15. interpret the results of tests for carbonate, chloride, bromide, iodide and sulfate ions given a data sheet of tests for negatively charged ions and appropriate results (using dilute acid, lime water, silver nitrate and barium chloride or barium nitrate as the reagents). (i) Candidates will be given a qualitative analysis data sheet showing tests for negatively charged ions (as in Appendix H) with the examination paper	**Precipation Reactions**

C5.3 What types of chemicals make up the Earth's lithosphere?	
1. recall that the Earth's lithosphere (the rigid outer layer of the Earth made up of the crust and the part of the mantle just below it) is made up of a mixture of minerals	
2. recall that diamond and graphite are minerals, both of which are composed of carbon atoms	Giant Covalent Structures
3. explain the properties of diamond in terms of a giant structure of atoms held together by strong covalent bonding (for example, melting point, boiling point, hardness, solubility and electrical conductivity)	Giant Covalent Structures
4. understand how the giant structure of graphite differs from that of diamond, and how this affects its properties	Giant Covalent Structures
5. recall that silicon, oxygen and aluminium are very abundant elements in the Earth's crust	Giant Covalent Structures
6. interpret data about the abundances of elements in rocks	
7. recall that much of the silicon and oxygen is present in the Earth's crust as the compound silicon dioxide	Giant Covalent Structures
8. understand that silicon dioxide is another giant covalent compound and so has properties similar to diamond.	Giant Covalent Structures

C5.4 How can we extract useful metals from minerals?	
1. recall that ores are rocks that contain varying amounts of minerals from which metals can be extracted	Extracting Metals
2. understand that for some minerals, large amounts of ore need to be mined to recover small percentages of valuable minerals (for example, in copper mining)	Extracting Metals
3. recall that zinc, iron and copper are metals that can be extracted by heating their oxides with carbon, and write simple word equations for these reactions (i) Technical details not required	Extracting Metals
4. understand that when a metal oxide loses oxygen it is reduced, while the carbon gains oxygen and is oxidised	Extracting Metals
5. understand that some metals are so reactive that their oxides cannot be reduced by carbon	Extracting Metals
6. write word equations when given appropriate information	Formulae and Equations
7. interpret symbol equations, including the number of atoms of each element, the number of molecules of each element or covalent compound and the number of 'formulas' of ionic compounds, in reactants and products (i) In this context, 'formula' is used in the case of ionic compounds as an equivalent to molecules in covalent compounds; the concept of the mole is not covered in the specification	Formulae and Equations
8. (HT) balance unbalanced symbol equations	Formulae and Equations
9. (HT) write balanced equations, including the state symbols (s), (l), (g) and (aq), when given appropriate information	Formulae and Equations
10. recall the state symbols (s), (l), (g) and (aq) and understand their use in equations	Formulae and Equations
11. use the Periodic Table to obtain the relative atomic masses of elements	Formulae and Equations
12. use relative atomic masses to calculate relative formula masses	Formulae and Equations
13. calculate the mass of an element in the gram formula mass of a compound	Formulae and Equations Quantitative Chemistry
14. (HT) calculate the mass of the metal that can be extracted from a mineral given its formula or an equation	Quantitative Chemistry
15. describe electrolysis as the decomposition of an electrolyte with an electric current	Electrolysis
16. understand that electrolytes include molten ionic compounds	Electrolysis
17. describe what happens to the ions when an ionic crystal melts	Electrolysis
18. understand that, during electrolysis, metals form at the negative electrode and non-metals form at the positive electrode	Electrolysis
19. describe the extraction of aluminium from aluminium oxide by electrolysis	Electrolysis

20. (HT) understand that during electrolysis of molten aluminium oxide, positively charged aluminium ions gain electrons from the negative electrode to become neutral atoms	Electrolysis
oxide ions lose electrons to the positive electrode to become neutral atoms which then combine to form oxygen molecules	Electrolysis
oxide ions lose electrons to the positive electrode to become neutral atoms which then combine to form oxygen molecules	Electrolysis
22. (HT) use ionic theory to explain the changes taking place during the electrolysis of a molten salt to account for the conductivity of the molten salt and the changes at the electrodes	Electrolysis
23. understand that the uses of metals are related to their properties (limited to strength, malleability, melting point and electrical conductivity)	Metallic Bonding
24. explain the physical properties of high strength and high melting point of metals in terms of a giant structure held together by strong bonds (metallic bonding)	Metallic Bonding
25. (HT) understand that in a metal crystal there are positively charged ions, held closely together by a sea of electrons that are free to move, and use this to explain the physical properties of metals, including malleability and conductivity	Metallic Bonding
26. evaluate, given appropriate information, the impacts on the environment that can arise from the extraction, use and disposal of metals.	Yield

Module C6: Chemical synthesis — Boardworks Presentations

C6.1 Chemicals and why we need them

1. understand the importance of chemical synthesis to provide food additives, fertilisers, dyestuffs, paints, pigments and pharmaceuticals	
2. interpret information about the sectors, scale and importance of chemical synthesis in industry and in laboratories	
3. recall the formulae of the following chemicals: chlorine gas, hydrogen gas, nitrogen gas, oxygen gas, hydrochloric acid, nitric acid, sulfuric acid, sodium hydroxide, sodium chloride, sodium carbonate, sodium nitrate, sodium sulfate, potassium chloride, magnesium oxide, magnesium hydroxide, magnesium carbonate, magnesium chloride, magnesium sulfate, calcium carbonate, calcium chloride and calcium sulfate	
4. (HT) work out the formulae of ionic compounds given the charges on the ions	Representing Chemicals
5. (HT) work out the charge on one ion given the formula of a salt and the charge on the other ion	Ions and Ionic Bonding
6. recall the main hazard symbols and be able to give the safety precautions for handling hazardous chemicals (limited to explosive, harmful, toxic, corrosive, oxidizing, and highly flammable	Ions and Ionic Bonding
7. recall examples of pure acidic compounds that are solids (citric and tartaric acids), liquids (sulfuric, nitric and ethanoic acids) or gases (hydrogen chloride)	Acids and Alkalis
8. recall that common alkalis include the hydroxides of sodium, potassium and calcium	Acids and Alkalis
9. recall the pH scale	Acids and Alkalis
10. recall the use of litmus paper, universal indicator and pH meters to detect acidity and alkalinity, and the use of universal indicator and pH meters to measure pH	Acids and Alkalis
11. recall the characteristic reactions of acids that produce salts, to include the reactions with metals and their oxides, hydroxides and carbonates	Making Salts

12. write word equations when given appropriate information	**Making Salts**
13. interpret symbol equations, including the number of atoms of each element, the number of molecules of each element or covalent compound and the number of 'formulas' of ionic compounds, in reactants and products (i) In this context, 'formula' is used in the case of ionic compounds as an equivalent to molecules in covalent compounds; the concept of the mole is not covered in the specification	**Making Salts**
14. (HT) balance unbalanced symbol equations	**Making Salts**
15. (HT) write balanced equations, including the state symbols (s), (l), (g) and (aq), to describe the characteristic reactions of acids and other reactions when given appropriate information	**Making Salts**
16. recall the state symbols (s), (l), (g) and (aq) and understand their use in equations	
17. recall that the reaction of an acid with an alkali to form a salt is a neutralisation reaction	**Acids and Alkalis**
18. explain that acidic compounds produce aqueous hydrogen ions, H+(aq), when they dissolve in water	**Acids and Alkalis**
19. explain that alkaline compounds produce aqueous hydroxide ions, OH–(aq), when they dissolve in water	**Acids and Alkalis**
20. write down the name of the salt produced given the names of the acid and alkali	**Acids and Alkalis**
21. (HT) write down the formula of the salt produced given the formulae of the acid and alkali	**Acids and Alkalis**
22. explain that during a neutralisation reaction, the hydrogen ions from the acid react with hydroxide ions from the alkali to make water: H+(aq) + OH (aq) H2O(l)	**Acids and Alkalis**
23. understand the terms endothermic and exothermic	**Energy and Reactions**
24. use and interpret simple energy level diagrams for endothermic and exothermic reactions	**Energy and Reactions**
25. understand the importance of the energy change during a reaction to the management and control of a chemical reaction.	**Energy and Reactions**

C6.2 Planning, carrying out and controlling a chemical synthesis

1. identify the stages in a given chemical synthesis of an inorganic compound (limited to acid-alkali reactions), including: a. choosing the reaction or series of reactions to make the required product b. carrying out a risk assessment c. (HT) working out the quantities of reactants to use d. carrying out the reaction in suitable apparatus in the right conditions (such as temperature, concentration) e. separating the product from the reaction mixture (limited to filltration) f. purifying the product (limited to evaporation, crystallisation and drying in an oven or desiccator) g. measuring the yield and checking the purity of the product (by titration)	
2. understand the purpose of these techniques: dissolving, crystallisation, filltration, evaporation, drying in an oven or desiccator	
3. understand the importance of purifying chemicals and checking their purity	
4. understand that a balanced equation for a chemical reaction shows the relative numbers of atoms and molecules of reactants and products taking part in the reaction	**Formulae and Equations**
5. understand that the relative atomic mass of an element shows the mass of its atom relative to the mass of other atoms	**Formulae and Equations**
6. use the Periodic Table to obtain the relative atomic masses of elements	**Formulae and Equations**

7. calculate the relative formula mass of a compound using the formula and the relative atomic masses of the atoms it contains	**Formulae and Equations**
8. substitute relative formula masses and data into a given mathematical formula to calculate reacting masses and/or products from a chemical reaction	**Quantitative Chemistry**
9. (HT) calculate the masses of reactants and products from balanced equations	**Quantitative Chemistry**
10. calculate percentage yields given the actual and the theoretical yield	**Yield**
11. describe how to carry out an acid-alkali titration accurately, when starting with a solution or a solid to be dissolved to make up a solution (i) Making up of standard solutions is not required	
12. substitute results in a given mathematical formula to interpret titration results quantitatively	
13. understand why it is important to control the rate of a chemical reaction (to include safety and economic factors)	**Measuring Reaction Rates**
14. explain what is meant by the term 'rate of chemical reaction'	**Measuring Reaction Rates**
15. describe methods for following the rate of a reaction (for example, by collecting a gas, weighing the reaction mixture or observing the formation or loss of a colour or precipitate)	**Measuring Reaction Rates**
16. interpret results from experiments that investigate rates of reactions	**Measuring Reaction Rates**
17. understand how reaction rates vary with the size of solid particles, the concentration of solutions of chemicals and the temperature of the reaction mixture (i) A qualitative treatment only is expected	**Changing Reaction Rates**
18. understand that catalysts speed up chemical reactions while not being used up in the reaction	**Catalysts**
19. interpret information about the control of rates of reaction in chemical synthesis	**Measuring Reaction Rates**
20. use simple ideas about collisions to explain how chemical reactions take place	**Changing Reaction Rates**
21. use simple collision theory and ideas about collision frequency to explain how rates of reaction depend on the size of solid particles and on the concentration of solutions of dissolved chemicals. (i) The effect of temperature on collision frequency is not considered since activation energy has a greater influence	**Changing Reaction Rates**

OCR 21st Century GCSE Additional Science 2011

GCSE Additional Science: Physics

Module P4: Explaining motion — Boardwork Presentations

P4.1 How can we describe motion?	
1. apply the following equation to situations where an average speed is involved: speed (m/s) = distance travelled (m) / time taken (s)	Speed
2. distinguish between average speed and instantaneous speed (in effect, an average over a short time interval) for examples of motion where speed is changing	Speed
3. (HT) understand that the displacement of an object at a given moment is its net distance from its starting point together with an indication of direction	Speed
4. draw and interpret a distance-time (or displacement-time) graph for an object that is: a. stationary b. moving at constant speed c. (HT) moving with increasing or decreasing speed	Speed
5. interpret a steeper gradient of a distance-time graph as a higher speed	Speed
6. (HT) calculate a speed from the gradient of a straight section of a distance-time graph	Speed
7. draw and interpret a speed-time graph for an object that is: a. stationary b. moving in a straight line with constant speed c. moving in a straight line with steadily increasing or decreasing speed (but no change of direction) c. specify, for each force, the object which exerts it, and the object on which it acts	Acceleration
8. understand that in many everyday situations, acceleration is used to mean the change in speed of an object in a given time interval	Acceleration
9. recall that the instantaneous velocity of an object is its instantaneous speed together with an indication of the direction	Speed
10. (HT) understand that the velocity of an object moving in a straight line is positive if it is moving in one direction and negative if it is moving in the opposite direction	Speed
11. (HT) draw and interpret a velocity-time graph for an object that is: a. stationary b. moving in a straight line with constant speed c. moving in a straight line with steadily increasing or decreasing speed (including situations involving a change of direction)	Acceleration
12. (HT) calculate the acceleration from the gradient of a velocity–time graph (or from a speedtime graph in situations where direction of motion is constant)	Acceleration
13. calculate acceleration using the equation: acceleration (m/s2) = change in velocity (m/s) / time taken (s)	Acceleration

P4.2 What are forces?	
1. recall that a force arises from an interaction between two objects	Forces
2. understand that when two objects interact, both always experience a force and that these two forces form an interaction pair	Forces
3. in simple everyday situations: a. identify forces arising from an interaction between two objects b. identify the 'partner' of a given force (ie the other force of the interaction pair) c. specify, for each force, the object which exerts it, and the object on which it acts d. use arrows to show the sizes and directions of forces acting	Forces
4. understand that the two forces in an interaction pair are equal in size and opposite in direction, and that they act on different objects	Forces
5. describe the interaction between two surfaces which slide (or tend to slide) relative to each other: each surface experiences a force in the direction that prevents (or tends to prevent) relative movement; this interaction is called friction	Forces
6. describe the interaction between an object and a horizontal surface it is resting on: the object pushes down on the surface, the surface pushes up on the object with an equal force, and this is called the reaction of the surface	Forces
7. recall that friction and the reaction of a surface arise in response to the action of an applied force, and their size matches the applied force up to a limit	Forces
8. use the ideas of friction and reaction to explain situations such as the driving force on vehicles (HT) and walking	Forces
9. use the idea of a pair of equal and opposite forces to explain in outline how rockets and jet engines produce a driving force.	Forces

P4.3 What is the connection between forces and motion?	
1. interpret situations in which several forces act on an object	Forces
2. understand that the resultant force on an object is the sum of all the individual forces acting on it, taking their directions into account	Forces
3. understand that if a resultant force acts on an object, it causes a change of momentum in the direction of the force	Forces
4. use the definition: momentum = mass × velocity (kg m/s) (kg) (m/s)	Momentum and Collisions
5. understand that the size of the change of momentum of an object is proportional to the size of the resultant force acting on the object and to the time for which it acts: change of momentum = resultant force × time for which it acts (kg m/s) (N) (s)	Momentum and Collisions
6. understand how the horizontal motion of objects (like cars and bicycles) can be analysed in terms of a driving force (produced by the engine or the cyclist), and a counter force (due to friction and air resistance)	Forces
7. understand that for an object moving in a straight line, if the driving force is: a. greater than the counter force, the vehicle will speed up b. equal to the counter force, the vehicle will move at constant speed in a straight line c. smaller than the counter force, the vehicle will slow down	Forces

8. understand that, in situations involving a change in momentum (such as a collision), the longer the duration of the impact, the smaller the average force for a given change in momentum	**Momentum and Collisions**
9. use ideas about force and momentum to explain road safety measures, such as car seatbelts, crumple zones, air bags, and cycle and motorcycle helmets	**Car Safety**
10. understand how the vertical motion of objects (falling, or initially thrown upwards) can be analysed in terms of the forces acting (gravity, air resistance)	**Forces**
11. understand that, if the resultant force on an object is zero, its momentum does not change (if it is stationary, it stays at rest; if it is already moving, it continues at a constant velocity [a steady speed in a straight line]).	**Forces**

P4.4 How can we describe motion in terms of energy changes?	
1. recall that the energy of a moving object is called its kinetic energy	**Potential and Kinetic Energy**
2. recall that as an object is raised, its gravitational potential energy increases, and as it falls, its gravitational potential energy decreases	**Potential and Kinetic Energy**
3. recall that when a force moves an object, it does work	**Work and Power** **Potential and Kinetic Energy**
4. use the equation: work done by a force = force × distance moved in the direction of the force (joules, J) (newtons, N) (metres, m)	**Work and Power**
5. understand that when work is done on an object, energy is transferred to the object and when work is done by an object, energy is transferred from the object to something else, according to the relationship: amount of energy transferred = work done (joules, J) (joules, J)	**Work and Power**
6. understand that when an object is lifted to a higher position above the ground, work is done by the lifting force; this increases the gravitational potential energy	**Potential and Kinetic Energy**
7. use the equation: change in gravitational potential energy = weight × vertical height difference (joules, J) (newtons, N) (metres, m)	**Potential and Kinetic Energy**
8. understand that when a force acting on an object makes its velocity increase, the force does work on the object and this results in an increase in its kinetic energy	**Potential and Kinetic Energy**
9. understand that the greater the mass of an object and the faster it is moving, the greater its kinetic energy	**Potential and Kinetic Energy**
10. use the equation: kinetic energy = ½ × mass × [velocity]2 (joules, J) (kilograms, kg) ([metres per second]2, [m/s]2)	**Potential and Kinetic Energy**
11. understand that if friction and air resistance can be ignored, an object's kinetic energy changes by an amount equal to the work done on it by an applied force	**Potential and Kinetic Energy**
12. understand that air resistance or friction will cause the gain in an object's kinetic energy to be less than the work done on it by an applied force in the direction of motion, because some energy is dissipated through heating	**Potential and Kinetic Energy**
13. recall that energy is always conserved in any event or process	**Potential and Kinetic Energy**
14. calculate the gain in kinetic energy, ((HT) and the speed), of an object that has fallen through a given height	**Potential and Kinetic Energy**

Module P5: Electric circuits

P5.1 Electric current – a flow of what?	Boardworks Presentations
1. explain that when two objects are rubbed together they become charged, because electrons are transferred from one object to the other	Static Electricity
2. recall that objects with similar charges repel, and objects with opposite charges attract	Static Electricity
3. explain simple electrostatic effects in terms of attraction and repulsion of charges	Static Electricity
4. recall that electrons are negatively charged	Static Electricity
5. recall that electric current is a flow of charge	Electrical Circuits
6. recall that electric current is measured in amperes	Electrical Circuits
7. understand that in an electric circuit the metal conductors (the components and wires) contain many charges that are free to move	Electrical Circuits
8. understand that when a circuit is made, the battery causes these free charges to move, and that they are not used up but flow in a continuous loop	Electrical Circuits
9. recall that in metallic conductors an electric current is a movement of free electrons that are present throughout such materials	Electrical Circuits
10. understand that in metal conductors there are lots of charges free to move but in an insulator there are few charges free to move.	Electrical Circuits

P5.2 What determines the size of the current in an electric circuit and the energy it transfers?	
1. recall that the larger the voltage of the battery in a given circuit, the bigger the current	Current, Voltage and Resistance
2. recall that components (for example, resistors, lamps, motors) resist the flow of charge through them	Current, Voltage and Resistance
3. recall that the larger the resistance in a given circuit, the smaller the current will be	Current, Voltage and Resistance
4. recall that the resistance of connecting wires is so small that it can usually be ignored	Current, Voltage and Resistance
5. understand that when electric charge flows through a component (or device), work is done by the power supply, and energy is transferred from it to the component and/or its surroundings	Electrical Circuits
6. recall that power (in watts, W) is a measure of the rate at which an electrical power supply transfers energy to an appliance or device and/or its surroundings	Electrical Power
7. use the equation: power = voltage × current (watts, W) (volts, V) (amperes, A)	Electrical Power
8. recall that resistors get hotter when there is an electric current through them, (HT) and understand that this heating effect is caused by collisions between the moving charges and stationary ions in the wire	Circuit Components
9. recall that this heating effect makes a lamp □ lament hot enough to glow	Circuit Components
10. describe how the resistance of an LDR varies with light intensity	Circuit Components
11. describe how the resistance of a thermistor (ntc only) varies with temperature	Circuit Components
12. recognise and use the electrical symbols for a cell, power supply, filament lamp, switch, LDR, fixed and variable resistor, thermistor, ammeter and voltmeter	Electrical Circuits
13. understand that two (or more) resistors in series have more resistance than either one on its own, because the battery has to move charges through both of them	Series and Parallel Circuits

14. understand that two (or more) resistors in parallel provide more paths for charges to move along than either resistor on its own, so the total resistance is less	**Series and Parallel Circuits**
15. use the equation: resistance (ohms,) = voltage (volts, V) / current (amperes, A)	**Current, Voltage and Resistance**
16. describe in words, or using a sketch graph, how the current through a component varies with voltage across it when the resistance stays constant.	**Current, Voltage and Resistance**

P5.3 How do parallel and series circuits work?	
1. describe how a voltmeter should be connected to measure the potential difference between any two chosen points	**Electrical Circuits**
2. recall that the voltage across a battery (measured in V) provides a measure of the 'push' of the battery on the charges in the circuit	**Electrical Circuits**
3. recall that potential difference is another term for voltage	**Electrical Circuits**
4. 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	**Electrical Circuits**
5. describe the effect on potential difference and current of adding further identical batteries in series ((HT) and in parallel) with an original single one	**Series and Parallel Circuits**
6. understand that when two ((HT) (or more)) components are connected in series to a battery: a. the current through each component is the same b. the potential differences across the components add up to the potential difference across the battery (HT)(because the work done on each unit of charge by the battery c. the potential difference is largest across the component with the greatest resistance, (HT)because more work is done by the charge moving through a large resistance than through a small one d. (HT) a change in the resistance of one component (variable resistor, LDR or thermistor) will result in a change in the potential differences across all the components	**Series and Parallel Circuits**
7. understand that when several components are connected in parallel directly to a battery: a. (HT) the potential difference across each component is equal to the potential difference of the battery b. (HT) the current through each component is the same as if it were the only c. the total current from (and back to) the battery is the sum of the currents through each of the parallel components d. the current is largest through the component with the smallest resistance, (HT) because the same battery voltage causes a larger current to flow through a smaller resistance than through a bigger one.	**Series and Parallel Circuits**

P5.4 How is mains electricity produced? How are voltages and currents induced?	
1. recall that mains electricity is produced by generators	**Generators**
2. recall that generators produce a voltage by a process called electromagnetic induction	**Generators**
3. understand that when a magnet is moving into a coil of wire a voltage is induced across the ends of the coil	**Generators**
4. understand that if the magnet is moving out of the coil, or the other pole of the magnet is moving into it, there is a voltage induced in the opposite direction	**Generators**
5. understand that if the ends of the coil are connected to make a closed circuit, a current will flow round the circuit	**Generators**

6. understand that a changing magnetic field caused by changes in the current in one coil of wire can induce a voltage in a neighbouring coil	Generators
7. describe the construction of a transformer as two coils of wire wound on an iron core	Generators
8. (HT) understand that a changing current in one coil of a transformer will cause a changing magnetic field in the iron core, which in turn will induce a changing potential magnetic field in the iron core, which in turn will induce a changing potential magnetic field in the iron core, which in turn will induce a changing potential difference across the other transformer coil	Generators
9. recall that a transformer can change the size of an alternating voltage	Generators
10. (HT) use the equation: $\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$	Generators
11. describe how, in a generator, a magnet or electromagnet is rotated within a coil of wire to induce a voltage across the ends of the coil	Generators
12. understand that the size of this induced voltage can be increased by: a. increasing the speed of rotation of the magnet or electromagnet b. increasing the strength of its magnetic field c. increasing the number of turns on the coil d. placing an iron core inside the coil	Generators
13. (HT) describe how the induced voltage across the coil of an a.c. generator (and hence the current in an external circuit) changes during each revolution of the magnet or electromagnet	Generators
14. understand that when the current is always in the same direction, it is a direct current (d.c.), eg the current from a battery	Electricity Supply
15. recall that mains electricity is an a.c. supply	Electricity Supply
16. (HT) understand that a.c. is used because it is easier to generate than d.c., and is easier and simpler to distribute over long distances	Generators
17. recall that the mains domestic supply in the UK is 230 volts.	Electricity Supply

P5.5 How do electric motors work?

1. understand that a current-carrying wire or coil can exert a force on a permanent magnet, or on another current-carrying wire or coil nearby	Motors
2. understand that a current-carrying wire, if placed in a magnetic field whose lines of force are at right-angles to the wire, experiences a force at right angles to both the current direction and the lines of force of the field	Motors
3. recall that a current-carrying wire that is parallel to the lines of force of a magnetic field experiences no force	Motors
4. explain how the motor effect can result in a turning force on a rectangular current-carrying coil placed in a uniform magnetic field	Motors
5. understand that the motor effect can be used to produce continuous rotation of the coil, by using a commutator to ensure that the direction of the current in the coil is reversed at an appropriate point in each revolution	Motors
6. explain the role and use of motors in devices including domestic appliances, hard disc drives, DVD players and electric motor vehicles.	Motors

P6.1 Why are some materials radioactive?	
1. recall that some elements emit ionising radiation all the time and are called radioactive	Radioactive Substances
2. understand that radioactive elements are naturally found in the environment, contributing to background radiation	Radioactive Substances
3. understand that an atom has a nucleus, made of protons and neutrons, which is surrounded by electrons	Atoms and Isotopes
4. understand that the results of the Rutherford-Geiger-Marsden alpha particle scattering experiment provided evidence that a gold atom contains a small, massive, positive region (the nucleus)	Atoms and Isotopes
5. (HT) understand that protons and neutrons are held together in the nucleus by a strong force which balances the repulsive electrostatic force between the protons	Atoms and Isotopes
6. understand that, if brought close enough together, hydrogen nuclei can fuse into helium nuclei releasing energy, and that this is called nuclear fusion	Nuclear Fusion
7. (HT) understand that Einstein's equation E = mc2 is used to calculate the energy released during nuclear fusion and fission (where E is the energy produced, m is the mass lost and c is the speed of light in a vacuum)	Nuclear Fuels and Fission
8. (HT) understand that every atom of any element has the same number of protons but the number of neutrons may differ, and that forms of the same element with different numbers of neutrons are called isotopes	Atoms and Isotopes
9. understand that the behaviour of radioactive materials cannot be changed by chemical or physical processes	Radioactive Substances
10. recall that three types of ionising radiation (alpha, beta and gamma) are emitted by radioactive materials (HT) and that alpha particles consist of two protons and two neutrons, and that beta particles are identical to electrons	Radioactive Decay
11. recall the penetration properties of each type of radiation	Ionizing Radiation
12. (HT) describe radioactive materials in terms of the instability of the nucleus, radiation emitted and the element left behind	Radioactive Decay
13. (HT) complete nuclear equations for alpha and beta decay	Radioactive Decay
14. understand that, over time, the activity of radioactive sources decreases	Half-life
15. understand the meaning of the term half-life	Half-life
16. understand that radioactive elements have a wide range of half-life values	Half-life
17. (HT) carry out simple calculations involving half-life.	Half-life

P6.2 How can radioactive materials be used and handled safely, including wastes?	
1. understand that ionising radiation can damage living cells and these may be killed or may become cancerous	Ionizing Radiation
2. understand that ionising radiation is able to break molecules into bits (called ions), (HT) which can then take part in other chemical reactions	Ionizing Radiation
3. recall ((HT) and explain) how ionising radiation can be used: a. to treat cancer b. to sterilise surgical instruments c. to sterilise food d. as a tracer in the body	Ionizing Radiation
4. recall that radiation dose (in sieverts) (based on both amount and type of radiation) is a measure of the possible harm done to your body	Ionizing Radiation
5. interpret given data on risk related to radiation dose	Ionizing Radiation
6. understand that radioactive materials expose people to risk by irradiation and contamination	Ionizing Radiation

7. understand that we are irradiated and contaminated by radioactive materials all the time and recall the main sources of this background radiation	**Ionizing Radiation**
8. relate ideas about half-life and background radiation to the time taken for a radioactive source to become safe	**Half-life**
9. recall categories of people who are regularly exposed to risk of radiation and that their exposure is carefully monitored, including radiographers and workers in nuclear power stations	**Ionizing Radiation**
10. understand that a nuclear fuel is one in which energy is released by changes in the nucleus	**Nuclear Fuels and Fission**
11. (HT) know that in nuclear fission a neutron splits a large and unstable nucleus (limited to uranium and plutonium) into two smaller parts, roughly equal in size, releasing more neutrons	**Nuclear Fuels and Fission**
12. recall that the amount of energy released during nuclear fission is much greater than that released in a chemical reaction involving a similar mass of material released in a chemical reaction involving a similar mass of material	**Nuclear Fuels and Fission**
13. (HT) understand how the nuclear fission process in nuclear power stations is controlled, and use the terms chain reaction, fuel rod, control rod and coolant and use the terms chain reaction, fuel rod, control rod and coolant	**Nuclear Fuels and Fission**
14. understand that nuclear power stations produce radioactive waste	**Nuclear Fuels and Fission**
15. understand that nuclear wastes are categorised as high level, intermediate level and low level, and relate this to disposal methods.	**Nuclear Fuels and Fission**