Extension

Biology Paper 1

Topic	Student Checklist	R	A	G
4.1.1 Cell structure	Use the terms 'eukaryotic' and 'prokaryotic' to describe types of cells			
	Describe the features of bacterial (prokaryotic) cells			
	Demonstrate an understanding of the scale and size of cells and be able to make order of magnitude calculations, inc standard form			
	Recall the structures found in animal and plant (eukaryotic) cells inc algal cells			
	Use estimations and explain when they should be used to judge the relative size or area of sub-cellular structures			
	Required practical 1: use a light microscope to observe, draw and label a selection of plant and animal cells			
	Describe the functions of the structures in animal and plant (eukaryotic) cells			
	Describe what a specialised cell is, including examples for plants and animals			
	Describe what differentiation is, including differences between animals and plants			
	Define the terms magnification and resolution			
	Compare electron and light microscopes in terms of their magnification and resolution			
	Carry out calculations involving magnification using the formula: magnification = size of image/ size of real object -inc standard form			
	Bio ONLY: Describe how bacteria reproduce and the conditions required			
	Bio ONLY: Describe how to prepare an uncontaminated culture			
	Bio ONLY: Calculate cross-sectional areas of colonies or clear areas around colonies using πr^2			
	Bio ONLY: Calculate the number of bacteria in a population after a certain time if given the mean division tie			
	Bio & HT ONLY: Express answers for last two points in standard form			
	Required practical 2: investigate the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition			
4.1.2 Cell division	Describe how genetic information is stored in the nucleus of a cell (inc genes & chromosomes)			
	Describe the processes that happen during the cell cycle, including mitosis (inc regcognise and describe where mitosis occurs)			
	Describe stem cells, including sources of stem cells in plants and animals and their roles			
	Describe the use of stem cells in the production of plant clones and therapeutic cloning			
	Discuss the potential risks, benefits and issues with using stem cells in medical research/treatments (inc diabetes and paralysis)			
4.1.3 Transport in cells	Describe the process of diffusion, including examples			
	Explain how diffusion is affected by different factors			
	Define and explain "surface area to volume ratio", and how this relates to single-celled and multicellular organisms (inc calculations)			
	Explain how the effectiveness of an exchange surface can be increased, inc examples of adaptations for small intestines, lungs, gills roots & leaves			
	Describe the process of osmosis (inc calculation of water uptake & percentage gain and loss of mass of plant tissue)			
	Required practical 3: investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue			
	Describe the process of active transport, including examples - gut and roots			
	Explain the differences between diffusion, osmosis and active transport			
4.2.1 Levels of organisation & 4.2.2 Animal tissues, organs and organ systems	Describe the levels of organisation within living organisms			
	Describe the digestive system and how it works as an organ system (from KS3)			
	Describe basic features of enzymes (inc rate calculations for chemical reactions)			
	Describe the lock and key theory as a model of enzyme action and explain how the shape a of the active sites makes the enzyme specific			
	Explain the effect of temperature and pH on enzymes			
	Describe the digestive enzymes, including their names, sites of production and actions			
	Describe how the products of digestion are used			
	Describe the features and functions of bile and state where it is produced and released from			
	Required practical 4: use qualitative reagents to test for a range of carbohydrates, lipids and proteins			
	Required practical 5: investigate the effect of pH on the rate of reaction of amylase enzyme			
	Describe the structure of the human heart and lungs (inc how lungs are adapted for gaseous exchange)			
	Explain how the heart moves blood around the body (inc role and position of the aorta, vena cava, pulmonary artery & vein and coronary arteries)			
	Explain how the natural resting heart rate is controlled and how irregularities can be corrected			
	Describe the structure and function of arteries, veins and capillaries			
	Use simple compound measures such as rate and carry out rate calculations for blood flow			
	Describe blood and identify its different components, inc identifying blood cells from photographs/diagrams			
	Describe the functions of blood components, including adaptations to function			

4.2.1 Principles	Describe what happens in coronary heart disease and what statins are used for			
	Describe and evaluate treatments for coronary heart disease and heart failure (inc drugs, mechanical devices or transplant)			
	Recall that heart valves can become faulty and describe the consequences of this			
	Describe how patients can be treated in the case of heart failure			
	Describe health and the explain causes of ill-health and the relationship between health and disease			
	Describe how different types of diseases may interact and translate disease incidence information between graphical and numerical forms			
	Describe what risk factors are and give examples discussing human and financial costs of non communicable diseases at local, national and global levels			
	Describe what cancer is and explain the difference between benign and malignant tumours			
	Describe the known risk factors for cancer, including genetic and lifestyle risk factors			
4.2.3 Plant tissues, organs and system	Describe plant tissues (epidermal, palisade mesophyll, spongy mesophyll, xylem, phloem and meristem) and describe their functions			
	Explain how the structure of plant tissues are related to their function within the leaf (plant organ) inc stomata and guard cells			
	Recall the palnt parts that form a plant organ system that transports substances around the plant			
	Explain how root hair cells, xylem and phloem are adapted to their functions			
	Describe the process of transpiration and translocation inluding the role of the different plant tissues			
	Explain how the rate of transpiration can be affected by different factors (inc naming the factors)			
	Describe the role of stomata and guard cells in the control of gas exchange and water loss			
4.3.1 Communicable diseases	Explain what a pathogen is and how pathogens are spread (inc how viruses, bacteria, protists and fungi are spread in animals and plants)			
	Explain how pathogenic bacteria and viruses cause damage in the body			
	Explain how the spread of diseases can be reduced or prevented			
	Describe measles, HIV and tobacco mosaic virus as examples of viral pathogens			
	Describe salmonella food poisoning and gonorrhoea as examples of bacterial pathogens			
	Describe the signs, transmission and treatment of rose black spot infection in plants as an example of fungal pathogens			
	Describe the symptoms, transmission and control of malaria, including knowledge of the mosquito vector as an example of a prototist pathogen			
	Describe defences that stop pathogens entering the human body (inc skin, nose, trachea & windpipe, stomach)			
	Recall the role of the immune system			
	Describe how white blood cells destroy pathogens			
	Describe how vaccination works, including at the population level			
	Explain how antibiotics and painkillers are used to treat diseases, including their limitations			
	Describe how sources for drugs have changed over time and give some examples			
	Describe how new drugs are tested, including pre-clinical testing and clinical trials (inc double blind trials and placebos)			
4.3.2 Monoclonal antibodies	***Bio & HT ONLY: Describe what monoclonal antibodies are and why they are useful***			
	Bio & HT ONLY: Describe how monoclonal antibodies are produced			
	Bio & HT ONLY: Explain how monoclonal antibodies are used for diagnosis, research, chemical testing and disease treatments			
	Bio & HT ONLY: Evaluate the advantages and disadvantages of monoclonal antibodies (inc side effects)			
	Bio & HT ONLY: Describe some observable signs of plant disease, and how plant diseases can be identified			
4.3.3 Plant disease	*Bio ONLY: Give examples of plant pathogens*			
	Bio ONLY: Give examples of plant ion deficiencies and their effects			
	Bio ONLY: Describe physical, chemical and mechanical defence responses of plants			
4.4.1 Photosynthesis	Describe what happens in photosynthesis, including using a word equation and recognise the chemical formulas for carbon dioxide, water, oxygen & glucose			
	Explain why photosynthesis is an endothermic reaction			
	Recall the limiting factors of photosynthesis			
	Explain how limiting factors affect the rate of photosynthesis, including graphical interpretation (limited to one factor)			
	HT ONLY: Explain how the limiting factors of photosynthesis interact, inc graphical interpretation (two/three factors)			
	HT ONLY: Explain how limiting factors are important to the economics of greenhouses, including data interpretation			
	HT ONLY: Explain and use inverse proportion in the context of photosynthesis			
	Required practical 6: investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed			
	Describe how the glucose produced in photosynthesis is used by plants			
ration	Describe what happens in respiration including using a word equation and recognise the chemical formulas for carbon dioxide, water, oxygen & glucose			
	Describe aerobic and anaerobic respiration with regard to the need for oxygen, the differing products and the relative amounts of energy transferred			
	Recognise the equations for aerobic respiration, anaerobic respiration in muscles and anaerobic respiration in plants and yeat cells.			
	Recall what type of respiration fermentation is and its economic importance.			

4.4.2 Respir	Describe what happens to heart rate, breathing rate and breath volume during exercise and why these changes occur			
	Explain what happens when muscles do not have enough oxygen and define the term oxygen dept			
	HT ONLY: Explain what happens to accumulated lactic acid in the body			
	Explain the importance of sugars, amino acids, fatty acids and glycerol in the synthesis and breakdown of carbohydrates, proteins and lipids			
	Explain what metabolism is, including examples			

Extension

Biology Paper 2

Topic	Student Checklist	R	A	G
4.5.1 Homeostasis	Describe what homeostasis is and why it is important stating specific examples from the human body			
	Describe the common features of all control systems			
4.5.2 The human nervous system	State the function of the nervous system and name its important components			
	Describe how information passes through the nervous system			
	Describe what happens in a reflex action and why reflex actions are important			
	Explain how features of the nervous system are adapted to their function, including a reflex arc (inc all types of neurone and the synapse)			
	Required practical 7: plan and carry out an investigation into the effect of a factor on human reaction time			
	Bio ONLY: State the function of the brain and how it is structured, including identifying he cerebral cortex, cerebellum and medulla on a diagram of the brain			
	Bio ONLY: Describe the functions of different regions of the brain			
	Bio & HT ONLY: Explain how neuroscientists have been able to map regions of the brain to particular functions			
	Bio ONLY: State the function of the eye and how it is structured, including names of specific parts			
	Bio ONLY: Describe the functions of different parts of the eye, including relating structure to function			
	Bio ONLY: Describe what accommodation is, and how it is carried out			
	Bio ONLY: Explain what myopia and hyperopia are and how they are treated, including interpreting ray diagrams			
	Bio ONLY: Describe how body temperature is monitored and controlled			
	Bio & HT ONLY: Explain how the body's responses act to raise or lower temperature in a given context			
4.5.3 Hormonal coordination in humans	Describe the endocrine system, including the location of the pituitary, pancreas, thyroid, aderenal gland, ovary and testis and the role of hormones			
	State that blood glucose concentration is monitored and controlled by the pancreas			
	Describe the body's response when blood glucose concentration is too high			
	Explain what type 1 and type 2 diabetes are and how they are treated			
	HT ONLY: Describe the body's response when blood glucose concentration is too low			
	HT ONLY: Explain how glucagon interacts with insulin to control blood glucose levels in the body			
	Describe how water, ions and urea are lost from the body			
	Describe the consequences of losing or gaining too much water for body cells			
	HT ONLY: Recall that protein digestion leads to excess amino acids inside the body and describe what happens to these			
	Describe how the kidneys produce urine			
	HT ONLY: Describe the effect of ADH on the permeability of the kidney tubules and explain how the water level in the body is controlled by ADH			
	Describe how kidney failure can be treated by organ transplant or dialysis and recall the basic principles of dialysis			
	Describe what happens at puberty in males and females, inc knowledge of reproductive hormones			
	Describe the roles of the hormones involved in the menstrual cycle (FSH, LH and oestrogen)			
	HT ONLY: Explain how the different hormones interact to control the menstrual cycle and ovulation			
	Describe how fertility can be controlled by hormonal and non-hormonal methods of contraception (giving specific examples from the spec)			
	HT ONLY: Explain how hormones are used to treat infertility, inc the steps in IVF			
	HT ONLY: Evaluate the risks and benefits of fertility treatments			
	HT ONLY: Describe the functions of adrenaline and thyroxine in the body, and recall where they are produced			
	HT ONLY: Explain the roles of thyroxine and adrenaline in the body as negative feedback systems			
.4 Plant hormones	*Bio ONLY: Describe hormone-linked plant responses, to include phototropism and gravitropism and the role of auxin*			
	Bio & HT ONLY: Describe the functions of gibberellins and ethene in plants			
	Required practical 8: investigate the effect of light or gravity on the growth of newly germinated seedling			

4.5	**HT ONLY: Explain the use of plant growth hormones are used in agriculture and horticulture (auxins, ethene and gibberellins)**			
4.6.1 Reproduction	Describe features of sexual and asexual reproduction			
	Describe what happens during meiosis and compare to mitosis			
	Describe what happens at fertilisation			
	Bio ONLY: Explain advantages of sexual and asexual reproduction			
	Bio ONLY: Describe examples of organisms that reproduce both sexually and asexually (malarial parasites, fungi, strawberry plants and daffodils)			
	Describe the structure of DNA and its role in storing genetic information inside the cell			
	Explain the term 'genome' and the importance of the human genome (specific examples from spec only)			
	Bio ONLY: Describe the structure of DNA, including knowledge of nucleotide units			
	Bio & HT ONLY: Explain complementary base pairing in DNA			
	Bio & HT ONLY: Explain the relationship between DNA bases (ATCG) , amino acids and proteins			
	Bio & HT ONLY: Describe how proteins are synthesised on ribosomes, including protein folding and its importance for protein function			
	Bio & HT ONLY: Explain what mutations are, and the possible effects of mutations			
	Bio & HT ONLY: Explain what non-coding parts of DNA are, and why they are important			
	Describe how characteristics are controlled by one or more genes, including examples			
	Explain important genetic terms: gamete, chromosome, gene, allele, genotype, phenotype, dominant, recessive, homozygous and heterozygous			
	Explain and use Punnet square diagrams, genetic crosses and family trees			
	HT ONLY: Construct Punnet square diagrams to predict the outcomes of a monohybrid cross			
	Describe cystic fibrosis and polydactyly as examples of inherited disorders			
	Evaluate social, economic and ethical issues concerning embryo screening when given appropriate information			
	Describe how the chromosomes are arranged in human body cells, including the function of the sex chromosomes			
	Explain how sex is determined and carry out a genetic cross to show sex inheritance			
4.6.2 Variation and evolution	Describe what variation is and how it can be caused within a population			
	Describe mutations and explain their influence on phenotype and changes in a species			
	Explain the theory of evolution by natural selection			
	Describe how new species can be formed			
	Describe what selective breeding is			
	Explain the process of selective breeding, including examples of desired characteristics and risks associated with selective breeding			
	Describe what genetic engineering is, including examples, and how it is carried out			
	Explain some benefits, risks and concerns related to genetic engineering			
	HT ONLY: Explain the process of genetic engineering, to include knowledge of enzymes and vectors			
	Bio ONLY: Describe different cloning techniques, to include: tissue culture, cuttings, embryo transplants and adult cell cloning			
4.6.3 The development of understanding of genetics and evolution	*Bio ONLY: Describe the ideas proposed by Darwin in his theory of natural selection and explain why this theory was only gradually accepted*			
	Bio ONLY: Describe other inheritance-based theories that existed (apart from the theory of natural selection), and the problems with these theories			
	Bio ONLY: Describe the work of Alfred Russel Wallace			
	Bio ONLY: Explain how new species can be formed			
	Bio ONLY: Describe how our understanding of genetics has developed over time, to include knowledge of Mendel			
	Describe some sources of evidence for evolution			
	Describe what fossils are, how they are formed and what we can learn from them			
	Explain why there are few traces of the early life forms, and the consequences of this in terms of our understanding of how life began			
	Describe some of the causes of extinction			
	Describe how antibiotic-resistant strains of bacteria can arise and spread (inc MRSA)			

	Describe how the emergence of antibiotic-resistant bacteria can be reduced and controlled, to include the limitations of antibiotic development			
4.6.4 Classification	Describe how organisms are named and classified in the Linnaean system			
	Explain how scientific advances have led to the proposal of new models of classification, inc three-domain system			
	Describe and interpret evolutionary trees			
4.7.1 Adaptations, interdependence and competition	Recall what an ecosystem is			
	Describe which resources animals and plants compete for, and why they do this			
	Explain the terms 'interdependence' and 'stable community'			
	Name some abiotic and biotic factors that affect communities			
	Explain how a change in an abiotic or biotic factor might affect a community			
	Describe structural, behavioural and functional adaptations of organisms			
	Describe what an extremophile is			
4.7.2 Organisation of an ecosystem	Represent the feeding relationships within a community using a food chain and describe these relationships			
	Explain how and why ecologists use quadrats and transects			
	Describe and interpret predator-prey cycles			
	Required practical 9: measure the population size of a common species in a habitat. Use sampling to investigate the effect of one factor on distribution			
	Describe the processes involved in the carbon cycle			
	Describe the processes involved in the water cycle			
	Bio ONLY: Explain how temperature, water and availability of oxygen affect the rate of decay of biological material			
	Bio ONLY: Explain how the conditions for decay are optimised by farmers and gardeners, and the reasons for this			
	Bio ONLY: Describe how methane gas can be produced from decaying materials for use as a fuel			
	Bio ONLY: Required practical 10: investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change			
	Bio ONLY: Explain how environmental changes can affect the distribution of species in an ecosystem (temperature, water and atmospheric gases)			
4.7.3 Biodiversity and the effect of human interaction on ecosystems	Describe what biodiversity is, why it is important, and how human activities affect it			
	Describe the impact of human population growth and increased living standards on resource use and waste production			
	Explain how pollution can occur, and the impacts of pollution			
	Describe how humans reduce the amount of land available for other animals and plants			
	Explain the consequences of peat bog destruction			
	Describe what deforestation is and why it has occurred in tropical areas			
	Explain the consequences of deforestation			
	Describe how the composition of the atmosphere is changing, and the impact of this on global warming			
	Describe some biological consequences of global warming			
	Describe both positive and negative human interactions in an ecosystem and explain their impact on biodiversity			
	Describe programmes that aim to reduce the negative effects of humans on ecosystems and biodiversity			
4.7.4 Trophic levels in an ecosystem	*Bio ONLY: Describe the different trophic levels and use numbers and names to represent them*			
	Bio ONLY: Describe what decomposers are and what they do			
	Bio ONLY: Construct a pyramids of biomass accurately from data and explain what they represents			
	Bio ONLY: State how much energy producers absorb from the Sun and how much biomass is transferred			
	Bio ONLY: Explain how biomass is lost between trophic levels, including the consequences of this and calculate efficiency between trophic levels			
ood production	*Bio ONLY: Explain the term 'food security' and describe biological factors that threaten it*			
	Bio ONLY: Explain how the efficiency of food production can be improved			
	Bio ONLY: Explain the term 'factory farming', including examples, and ethical objections			
	Bio ONLY: Explain the importance of maintaining fish stocks at a level where breeding continues			

4.7.5 Fo	*Bio ONLY: Explain some methods that can help to conserve fish stocks*			
	Bio ONLY: Describe how modern biotechnology is used in food production, including the fungus Fusarium as an example			
	Bio ONLY: Describe the uses of genetically modified organisms in insulin and food production			

Extension

Chemistry Paper 1

Topic	Student Checklist	R	A	G
4.1.1 A simple model of the atom, symbols, relative atomic mass, electronic charge and isotopes	State that everything is made of atoms and recall what they are			
	Describe what elements and compounds are			
	State that elements and compounds are represented by symbols; and use chemical symbols and formulae to represent elements and compounds			
	Write word equations and balanced symbol equations for chemical reactions, including using appropriate state symbols			
	HT ONLY: Write balanced half equations and ionic equations			
	Describe what a mixture is			
	Name and describe the physical processes used to separate mixtures and suggest suitable separation techniques			
	Describe how the atomic model has changed over time due to new experimental evidence, inc discovery of the atom and scattering experiments (inc the work of James Chadwick)			
	Describe the difference between the plum pudding model of the atom and the nuclear model of the atom			
	State the relative charge of protons, neutrons and electrons and describe the overall charge of an atom			
	State the relative masses of protons, neutrons and electrons and describe the distribution of mass in an atom			
	Calculate the number of protons, neutrons and electrons in an atom when given its atomic number and mass number			
	Describe isotopes as atoms of the same element with different numbers of neutrons			
	Define the term relative atomic mass and why it takes into account the abundance of isotopes of the element			
	Calculate the relative atomic mass of an element given the percentage abundance of its isotopes			
	Describe how electrons fill energy levels in atoms, and represent the electron structure of elements using diagrams and numbers			
4.1.2 The periodic table	Recall how the elements in the periodic table are arranged			
	Describe how elements with similar properties are placed in the periodic table			
	Explain why elements in the same group have similar properties and how to use the periodic table to predict the reactivity of elements			
	Describe the early attempts to classify elements			
	Explain the creation and attributes of Mendeleev's periodic table			
	Identify metals and non-metals on the periodic table, compare and contrast their properties			
	Explain how the atomic structure of metals and non-metals relates to their position in the periodic table			
	Describe nobel gases (group 0) and explain their lack of reactivity			
	Describe the properties of noble gases, including boiling points, predict trends down the group and describe how their properties depend on the outer shell of electrons			
	Describe the reactivity and properties of group 1 alkali metals with reference to their electron arrangement and predict their reactions			
	Describe the properties of group 7 halogens and how their properties relate to their electron arrangement, including trends in molecular mass, melting and boiling points and reactivity			
	Describe the reactions of group 7 halogens with metals and non-metals			
	Chem ONLY: Describe the properties of transition metals and compare them with group 1 elements, including melting points and densities, strength and hardness, and reactivity (for CR, Mn Fe, Co, Ni & Cu)			
4.2.1 Chemical bonds, ionic, covalent and metallic	Describe the three main types of bonds: ionic bonds, covalent bonds and metallic bonds in terms of electrostatic forces and the transfer or sharing of electrons			
	Describe how the ions produced by elements in some groups have the electronic structure of a noble gas and explain how the charge of an ion relates to its group number			
	Describe the structure of ionic compounds, including the electrostatic forces of attraction, and represent ionic compounds using dot and cross diagrams			
	Describe the limitations of using dot and cross, ball and stick, two and three-dimensional diagrams to represent a giant ionic structure			
	Work out the empirical formula of an ionic compound from a given model or diagram that shows the ions in the structure			
	Describe covalent bonds and identify different types of covalently bonded substances, such as small molecules, large molecules and substances with giant covalent structures			
	Represent covalent bonds between small molecules, repeating units of polymers and parts of giant covalent structures using diagrams			
	Draw dot and cross diagrams for the molecules of hydrogen, chlorine, oxygen, nitrogen, hydrogen chloride, water, ammonia and methane			
	Deduce the molecular formula of a substance from a given model or diagram in these forms showing the atoms and bonds in the molecule			
	Describe the arrangement of atoms and electrons in metallic bonds and draw diagrams the bonding in metals			
nding and structure are related to the properties of substances	Name the three States of matter, identify them from a simple model and state which changes of state happen at melting and boiling points			
	Explain changes of state using particle theory and describe factors that affect the melting and boiling point of a substance			
	HT ONLY: Discuss the limitations of particle theory			
	Recall what (s), (l), (g) and (aq) mean when used in chemical equations and be able to use them appropriately			
	Explain how the structure of ionic compounds affects their properties, including melting and boiling points and conduction of electricity (sodium chloride structure only)			
	Explain how the structure of small molecules affects their properties			
	Explain how the structure of polymers affects their properties			
	Explain how the structure of giant covalent structures affects their properties			
	Explain how the structure of metals and alloys affects their properties, including explaining why they are good conductors			
	Explain why alloys are harder than pure metals in terms of the layers of atoms			
	Explain the properties of graphite, diamond and graphene in terms of their structure and bonding			

4.2.2 How bo	Describe the structure of fullerenes, and their uses, including Buckminsterfullerene and carbon nanotubes			
	Chem ONLY: Compare the dimensions of nanoparticles to other particles and explain the affect of their surface area to volume ratio on their properties			
	Chem ONLY: Discuss the applications of nanoparticles and their advantages and disadvantages, including uses in medicine, cosmetics, fabrics and the development of catalysts			
4.3.1 Chemical measurements, conservation of mass and the quantitative interpretation	State that mass is conserved and explain why, including describing balanced equations in terms of conservation of mass			
	Explain the use of the multipliers in equations in normal script before a formula and in subscript within a formula			
	Describe what the relative formula mass (Mr) of a compound is and calculate the relative formula mass of a compound, given its formula			
	Calculate the relative formula masses of reactants and products to prove that mass is conserved in a balanced chemical equation			
	Explain observed changes of mass during chemical reactions in non-enclosed systems using the particle model when given the balanced symbol equation			
	Explain why whenever a measurement is made there is always some uncertainty about the result obtained			
4.3.2 Use of amount of substance in relation to masses of pure substances	**HT ONLY: State that chemical amounts are measured in moles (mol) and explain what a mol is with reference to relative formula mass and Avogadro's constant**			
	HT ONLY: Use the relative formula mass of a substance to calculate the number of moles in a given mass of the substance			
	HT ONLY: Calculate the masses of reactants and products when given a balanced symbol equation			
	HT ONLY: Use moles to write a balanced equation when given the masses of reactants and products (inc changing the subject of the equation)			
	HT ONLY: Explain the effect of limiting the quantity of a reactant on the amount of products in terms of moles or masses in grams			
	Calculate the mass of solute in a given volume of solution of known concentration in terms of mass per given volume of solution			
	HT ONLY: Explain how the mass of a solute and the volume of a solution is related to the concentration of the solution			
4.3.3 Yield and atom economy of chemical reactions	*Chem ONLY: Explain why it is not always possible to obtain the calculated or expected amount of a product*			
	Chem ONLY: Calculate the theoretical amount of a product and percentage yield of a product using the formula ***% yield = mass of product made/max theoretical masss of product x 100***			
	Chem & HT ONLY: Calculate the theoretical mass of a product from a given mass of reactant and the balanced equation for the reaction			
	Chem ONLY: Describe atom economy as a measure of the amount of reactants that end up as useful products			
	Chem ONLY: Calculate the percentage atom economy of a reaction to form a desired product using the equation ***% atom economy =RfM of desired product/sum of RfM of all reactants x 100***			
	Chem & HT ONLY: Explain why a particular reaction pathway is chosen to produce a specified product, given appropriate data			
4.3.4 Using concentrations of solutions in mol/dm^3	***Chem & HT ONLY: Calculate the amount of solute (in moles or grams) in a solution from it's concentration in mol/dm^3***			
	Chem & HT ONLY: Calculate the concentration of a solution when it reacts completely with another solution of a known concentration			
	Chem & HT ONLY: Describe how to carry out titrations of strong acids and strong alkalis and calculate quantities in titrations involving concentrations in mol/dm^3 and g/dm^3			
	Chem & HT ONLY: Explain how the concentration of a solution in mol/dm3 is related to the mass of the solute and the volume of the solution			
	Chem & HT ONLY: Explain what the volume of one mole of any gas at room temperature is			
	Chem & HT ONLY: Calculate the volume of a gas at room temperature and pressure from its mass and relative formula mass			
4.4.1 Reactivity of metals	Describe how metals react with oxygen and state the compound they form, define oxidation and reduction			
	Describe the arrangement of metals in the reactivity series, including carbon and hydrogen, and use the reactivity series to predict the outcome of displacement reactions			
	Recall and describe the reactions, if any, of potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper with water or dilute acids			
	Relate the reactivity of metals to its tendency to form positive ions and be able to deduce an order of reactivity of metals based on experimental results			
	Recall what native metals are and explain how metals can be extracted from the compounds in which they are found in nature by reduction with carbon			
	Evaluate specific metal extraction processes when given appropriate information and identify which species are oxidised or reduced			
4.4.2 Reactions of acids	**HT ONLY: Describe oxidation and reduction in terms of loss and gain of electrons**			
	HT ONLY: Write ionic equations for displacement reactions, and identify which species are oxidised and reduced from a symbol or half equation			
	HT ONLY: Explain in terms of gain or loss of electrons that the reactions between acids and some metals are redox reactions, and identify which species are oxidised and which are reduced (Mg,Zn, Fe + HCl &			
	Explain that acids can be neutralised by alkalis, bases and metal carbonates and list the products of each of these reactions			
	Predict the salt produced in a neutralisation reaction based on the acid used and the positive ions in the base, alkali or carbonate and use the formulae of common ions to deduce the formulae of the salt			
	Describe how soluble salts can be made from acids and how pure, dry samples of salts can be obtained			
	Required practical 1: *preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution*			
	Recall what the pH scale measures and describe the scale used to identify acidic, neutral or alkaline solutions			
	Define the terms acid and alkali in terms of production of hydrogen ions or hydroxide ions (in solution), defiine the term base			
	Describe the use of universal indicator to measure the approximate pH of a solution and use the pH scale to identify acidic or alkaline solutions			
	Chem ONLY: Describe how to carry out titrations using strong acids and strong alkalis only (sulfuric, hydrochloric and nitric acids to find the reacting volumes accurately			
	Chem & HT ONLY: Calculate the chemical quantities in titrations involving concentrations in mol/dm^3 and in g/dm^3			
	Chem ONLY: ***Required practical 2:*** *determination of the reacting volumes of solutions of a strong acid and a strong alkali by titration*			
	HT ONLY: Use and explain the terms dilute and concentrated (in terms of amount of substance) and weak and strong (in terms of the degree of ionisation) in relation to acids			
	HT ONLY: Explain how the concentration of an aqueous solution and the strength of an acid affects the pH of the solution and how pH is related to the hydrogen ion concentration of a solution			
Electrolysis	Describe how ionic compounds can conduct electricity when dissolved in water and describe these solutions as electrolytes			
	Describe the process of electrolysis			
	Describe the electrolysis of molten ionic compounds and predict the products at each electrode of the electrolysis of binary ionic compounds			
	Explain how metals are extracted from molten compounds using electrolysis and use the reactivity series to explain why some metals are extracted with electrolysis instead of carbon			

4.4.3	Describe the electrolysis of aqueous solutions and predict the products of the electrolysis of aqueous solutions containing single ionic compounds			
	Required practical 3: *investigate what happens when aqueous solutions are electrolysed using inert electrodes*			
	HT ONLY: Describe the reactions at the electrodes during electrolysis as oxidation and reduction reactions and write balanced half equations for these reactions			
4.5.1 Exothermic and endothermic reactions	Describe how energy is transferred to or from the surroundings during a chemical reaction			
	Explain exothermic and endothermic reactions on the basis of the temperature change of the surroundings and give examples of everyday uses			
	Required practical 4 *: investigate the variables that affect temperature changes in reacting solutions*			
	Describe what the collision theory is and define the term activation energy			
	Interpret and draw reaction profiles of exothermic and endothermic reactions, inc identifying the relative energies of reactants and products, activation energy and overall energy change			
	HT ONLY: Explain the energy changes in breaking and making bonds and calculate the overall energy change using bond energies			
4.5.2 Chemical cells and fuel cells	*Chem ONLY: Describe what a simple cell and a battery is and how they produce electricity*			
	Chem ONLY: Describe why alkaline batteries are non-rechargeable, state why some cells are rechargeable and evaluate the use of cells			
	Chem ONLY: Describe fuel cells and compare fuel cells to rechargeable cells and batteries			
	Chem ONLY: Describe the overall reaction in a hydrogen fuel cell			
	Chem & HT ONLY: Write half equations for the electrode reactions in a hydrogen fuel cell			

Extension

Chemistry Paper 2

Topic	Student Checklist	R	A	G
4.6.1 Rate of reaction	Calculate the rate of a chemical reaction over time, using either the quantity of reactant used or the quantity of product formed, measured in g/s, cm^3/s or mol/s			
	Draw and interpret graphs showing the quantity of product formed or reactant used up against time and use the tangent to the graph as a measure of the rate of reaction			
	HT ONLY: Calculate the gradient of a tangent to the curve on the graph of the quantity of product formed or reactant used against time and use this as a measure of the rate of reaction			
	Describe how different factors affect the rate of a chemical reaction, including the concentration, pressure, surface area, temperature and presence of catalysts			
	Required practical 5: *investigate how changes in concentration affect the rates of reactions by a method involving measuring the volume of a gas produced, change in colour or turbidity*			
	Use collision theory to explain changes in the rate of reaction, including discussing activation energy			
	Describe the role of a catalyst in a chemical reaction and state that enzymes are catalysts in biological systems			
	Draw and interpret reaction profiles for catalysed reactions			
4.6.2 Reversible reactions and dynamic equilibrium	Explain what a reversible reaction is, including how the direction can be changed and represent it using symbols: A + B ⇌ C + D			
	Explain that, for reversible reactions, if a reaction is endothermic in one direction, it is exothermic in the other direction			
	Describe the State of dynamic equilibrium of a reaction as the point when the forward and reverse reactions occur at exactly the same rate			
	HT ONLY: Explain that the position of equilibrium depends on the conditions of the reaction and the equilibrium will change to counteract any changes to conditions			
	HT ONLY: Explain and predict the effect of a change in concentration of reactants or products, temperature, or pressure of gases on the equilibrium position of a reaction			
4.7.1 Carbon compounds as fuels and feedstock	Describe what crude oil is and where it comes from, including the basic composition of crude oil and the general chemical formula for the alkanes			
	State the names of the first four members of the alkanes and recognise substances as alkanes from their formulae			
	Describe the process of fractional distillation, state the names and uses of fuels that are produced from crude oil by fractional distillation			
	Describe trends in the properties of hydrocarbons, including boiling point, viscosity and flammability and explain how their properties influence how they are used as fuels			
	Describe and write balanced chemical equations for the complete combustion of hydrocarbon fuels			
	Describe the process of cracking and state that the products of cracking include alkanes and alkenes and describe the test for alkenes			
	Balance chemical equations as examples of cracking when given the formulae of the reactants and products			
	Explain why cracking is useful and why modern life depends on the uses of hydrocarbons			
4.7.2 Reactions of alkenes and alcohols	*Chem ONLY: State the names and draw structural formulae of the first four members of the alkenes and recognise substances as alkenes from their formulae*			
	Chem ONLY: Describe the basic composition of alkenes, including the C=C functional group, the general chemical formula for the alkanes and describe what unsaturated means			
	Chem ONLY: Describe the combustion reactions of alkenes and the reactions of alkenes with hydrogen, water and the halogens			
	Chem ONLY: Draw fully displayed structural formulae of the first four members of the alkenes and the products of their addition reactions with hydrogen, water, chlorine, bromine and iodine			
	Chem ONLY: State the functional group of alcohols and the first four members of the homologous series of alcohols and represent alcohols using formulae			
	Chem ONLY: Describe some properties and reactions of the first four members of alcohols, including dissolving in water, reacting with sodium, burning in air, oxidation and uses			
	Chem ONLY: State the functional group of carboxylic acids and the first four members of the homologous series of carboxylic acids and represent them using diagrams and formulae			
	Chem ONLY: Describe some properties and reactions of carboxylic acids, including dissolving in water, reacting with carbonates and reacting with alcohols			
4.7.3 Synthetic and naturally occurring polymers	*Chem ONLY: Describe how alkenes can be used to make polymers by addition polymerisation*			
	Chem ONLY: Identify addition polymers and monomers from diagrams and from the presence of the functional group and draw diagrams to represent the formation of an addition polymers			
	Chem & HT ONLY: Describe the process of condensation polymerisation and explain the basic principles of condensation polymerisation			
	Chem & HT ONLY: State that amino acids have two different functional groups in a molecule and they react by condensation polymerisation to produce polypeptides			
	Chem & HT ONLY: Explain that different amino acids can be combined in a chain to produce proteins			
	Chem ONLY: Describe DNA as a large molecule of two polymer chains made from four different monomers called nucleotides in the form of a double helix			
	Chem ONLY: State and describe some other naturally occurring polymers such as proteins, starch and cellulose			

4.8.1 Purity, formulations and chromatograph & 4.8.2 ID of gases	Define a pure substance and identify pure substances and mixtures from data about melting and boiling points			
	Describe a formulation and identify formulations given appropriate information			
	Describe chromatography, including the terms stationary phase and mobile phase and identify pure substances using paper chromatography			
	Explain what the Rf value of a compound represents, how the Rf value differs in different solvents and interpret and determine Rf values from chromatograms			
	Required practical 6: *investigate how paper chromatography can be used to separate and tell the difference between coloured substances (inc calculation of Rf values)*			
	Explain how to test for the presence of hydrogen, oxygen, carbon dioxide and chlorine			
4.8.3 Identification of ions by chemical and spectroscopic means	*Chem ONLY: Identify some metal ions from the results of flame tests and describe how to conduct a flame test*			
	Chem ONLY: Describe how sodium hydroxide solution can be used to identify some metal ions and identify metal ions from the results of their reactions with sodium hydroxide solution			
	Chem ONLY: Write balanced equations for the reactions between sodium hydroxide solution and some metal ions to produce insoluble hydroxides			
	Chem ONLY: Describe how to identify carbonates using limewater			
	Chem ONLY: Describe how to identify negative ions, including halide ions using silver nitrate and sulfate ions using barium chloride			
	Required practical 7: *use of chemical tests to identify the ions in unknown single ionic compounds*			
	Chem ONLY: State the advantages of using instrumental methods to identify elements and compounds compared to chemical tests			
	Chem ONLY: Describe the process of and how to use flame emission spectroscopy to identify metal ions; interpret the results of a flame emission spectroscopy tests			
4.9.1 The composition and evolution of the Earth's atmosphere	Describe the composition of gases in the Earth's atmosphere using percentages, fractions or ratios			
	Describe how early intense volcanic activity may have helped form the early atmosphere and how the oceans formed			
	Explain why the levels of carbon dioxide in the atmosphere changes as the oceans were formed			
	State the approximate time in Earth's history when algae started producing oxygen and describe the effects of a gradually increasing oxygen level			
	Explain the ways that atmospheric carbon dioxide levels decreased			
4.9.2 Carbon dioxide and methane as greenhouse gases	Name some greenhouse gases and describe how they cause an increase in Earth's temperature			
	List some human activities that produce greenhouse gases			
	Evaluate arguments for and against the idea that human activities cause a rise in temperature that results in global climate change			
	State some potential side effects of global climate change, including discussing scale, risk and environmental implications			
	Define the term carbon footprint and list some actions that could reduce the carbon footprint			
4.9.3 Common atmospheric pollutants and their sources	Describe the combustion of fuels as a major source of atmospheric pollutants and name the different gases that are released when a fuel is burned			
	Predict the products of combustion of a fuel given appropriate information about the composition of the fuel and the conditions in which it is used			
	Describe the properties and effects of carbon monoxide, sulfur dioxide and particulates in the atmosphere			
	Describe and explain the problems caused by increased amounts of these pollutants in the air			
4.10.1 Using the Earth's resources and obtaining potable water	State what humans use Earth's resources for, give some examples of natural resources that they use			
	Define the term finite and distinguish between finite and renewable resources			
	Explain what sustainable development is and discuss the role chemistry plays in sustainable development, including improving agricultural and industrial processes			
	State examples of natural products that are supplemented or replaced by agricultural and synthetic products			
	Discuss the importance of water quality for human life, including defining potable water			
	Describe methods to produce potable water, including desalination of salty water or sea water and the potential problems of desalination			
	Required practical 8: *analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.*			
	Describe waste water as a product of urban lifestyles and industrial processes that includes organic matter, harmful microbes and harmful chemicals			
	Describe the process of sewage treatment and compare the ease of obtaining potable water from waste water as opposed to ground or salt water			
	HT ONLY: Name and describe alternative biological methods for extracting metals, including phytomining and bioleaching			
	HT ONLY: Evaluate alternative methods for extracting metals			

4.10.2 Life cycle assessment and recycling	Describe, carry out and interpret a simple comparative life cycle assessment (LCA) of materials or products			
	Discuss the advantages and disadvantages of LCAs			
	Carry out simple comparative LCAs for shopping bags made from plastic and paper			
	Discuss how to reduce the consumption of raw resources and explain how reusing and recycling reduces energy use (inc environmental impacts)			
4.10.3 Using materials	*Chem ONLY: Define corrosion and describe rusting as an example of corrosion*			
	Chem ONLY: Describe ways to prevent corrosion, including providing coatingsm, sacrificial protecti and explain how sacrificial protection works			
	Chem ONLY: Describe the following alloys bronze, gold, steels and aluminium, their uses and describe the benefits of using alloys instead of pure metals			
	Chem ONLY: Compare the properties of materials, including glass and clay ceramics, polymers and composites and explain how their properties are related to their uses			
	Chem ONLY: Discuss the different types of polymers and how their composition affects their properties, including thermosoftening and thermosetting polymers			
	Chem ONLY: Explain what composites are and provide examples of composites and their benefits over other types of materials			
4.10.4 The Haber process and the use of NPK fertilisers	*Chem ONLY: Describe the Haber process, including the reactants and products, recycling of remaining hydrogen and nitrogen and the chemical equation*			
	Chem & HT ONLY: For the Haber process interpret graphs of reaction conditions versus rate			
	Chem ONLY: Apply the principles of dynamic equilibrium to the Haber process and discuss the trade-off between the rate of production and the position of equilibrium			
	Chem ONLY: Explain how the commercially used conditions for the Haber process are related to the availability and cost of raw materials and energy supplies			
	Chem ONL: Recall the names of the salts produced when phosphate rock is treated with nitric acid, sulfuric acid and phosphoric acid			
	Chem ONLY: Describe NPK fertilisers and the compounds they are composed of and compare the industrial production of fertilisers with the laboratory preparations			

Extension

Physics Paper 1

Topic	Student Checklist	R	A	G
4.1.1 Energy changes in a system, and the ways energy is stored before and after such changes	Define a system as an object or group of objects and state examples of changes in the way energy is stored in a system			
	Describe how all the energy changes involved in an energy transfer and calculate relative changes in energy when the heat, work done or flow of charge in a system changes			
	Use calculations to show on a common scale how energy in a system is redistributed			
	Calculate the kinetic energy of an object by recalling and applying the equation: ***[$E_k = ½ mv^2$]***			
	Calculate the amount of elastic potential energy stored in a stretched spring by applying, but not recalling, the equation: ***[$E_e = ½ke^2$]***			
	Calculate the amount of gravitational potential energy gained by an object raised above ground level by recalling and applying, the equation: ***[$E_e = mgh$]***			
	Calculate the amount of energy stored in or released from a system as its temperature changes by applying, but not recalling, the equation: ***[$\Delta E = mc\Delta\theta$]***			
	Define the term 'specific heat capacity'			
	Required practical 1: *investigation to determine the specific heat capacity of one or more materials.*			
	Define power as the rate at which energy is transferred or the rate at which work is done and the watt as an energy transfer of 1 joule per second			
	Calculate power by recalling and applying the ***equations: [P = E/t & P = W/t]***			
	Explain, using examples, how two systems transferring the same amount of energy can differ in power output due to the time taken			
4.1.2 Conservation and dissipation of energy	State that energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed and so the total energy in a system does not change			
	Explain that only some of the energy in a system is usefully transferred, with the rest 'wasted', giving examples of how this wasted energy can be reduced			
	Explain ways of reducing unwanted energy transfers and the relationship between thermal conductivity and energy transferred			
	Describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls			
	Required practical 2: *investigate the effectiveness of different materials as thermal insulators and the factors that may affect the thermal insulation properties of a material.*			
	Calculate efficiency by recalling and applying the equation: ***[efficiency = useful power output / total power input]***			
	HT ONLY: Suggest and explain ways to increase the efficiency of an intended energy transfer			
4.1.3 National and global energy resources	List the main renewable and non-renewable energy resources and define what a renewable energy resource is			
	Compare ways that different energy resources are used, including uses in transport, electricity generation and heating			
	Explain why some energy resources are more reliable than others, explaining patterns and trends in their use			
	Evaluate the use of different energy resources, taking into account any ethical and environmental issues which may arise			
	Justify the use of energy resources, with reference to both environmental issues and the limitations imposed by political, social, ethical or economic considerations			
4.2.1 Current, potential difference and resistance	Draw and interpret circuit diagrams, including all common circuit symbols			
	Define electric current as the rate of flow of electrical charge around a closed circuit			
	Calculate charge and current by recalling and applying the formula: ***[Q = It]***			
	Explain that current is caused by a source of potential difference and it has the same value at any point in a single closed loop of a circuit			
	Describe and apply the idea that the greater the resistance of a component, the smaller the current for a given potential difference (p.d.) across the component			
	Calculate current, potential difference or resistance by recalling and applying the equation: ***[V = IR]***			
	Required practical 3: *Use circuit diagrams to set up and check circuits to investigate the factors affecting the resistance of electrical circuits*			
	Define an ohmic conductor			
	Explain the resistance of components such as lamps, diodes, thermistors and LDRs and sketch/interpret IV graphs of their characteristic electrical behaviour			
	Explain how to measure the resistance of a component by drawing an appropriate circuit diagram using correct circuit symbols			
	Required practical 4: *use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements*			
4.2.2 Series and parallel circuits	Show by calculation and explanation that components in series have the same current passing through them			
	Show by calculation and explanation that components connected in parallel have the same the potential difference across each of them			
	Calculate the total resistance of two components in series as the sum of the resistance of each component using the equation: ***[$R_{total} = R_1 + R_2$]***			
	Explain qualitatively why adding resistors in series increases the total resistance whilst adding resistors in parallel decreases the total resistance			
	Solve problems for circuits which include resistors in series using the concept of equivalent resistance			
4.2.3 Domestic uses and safety	Explain the difference between direct and alternating voltage and current, stating what UK mains is			
	Identify and describe the function of each wire in a three-core cable connected to the mains			
	State that the potential difference between the live wire and earth (0 V) is about 230 V and that both neutral wires and our bodies are at, or close to, earth potential (0 V)			
	Explain that a live wire may be dangerous even when a switch in the mains circuit is open by explaining the danger of providing any connection between the live wire and earth			
	Explain how the power transfer in any circuit device is related to the potential difference across it and the current through it			
	Calculate power by recalling and applying the equations: ***[P = VI]*** and ***[$P = I^2 R$]***			

4.2.4 Energy transfers	Describe how appliances transfer energy to the kinetic energy of motors or the thermal energy of heating devices			
	Calculate and explain the amount of energy transferred by electrical work by recalling and applying the equations: ***[E = Pt]*** and ***[E = QV]***			
	Explain how the power of a circuit device is related to the potential difference across it, the current through it and the energy transferred over a given time.			
	Describe, with examples, the relationship between the power ratings for domestic electrical appliances and the changes in stored energy when they are in use			
	Identify the National Grid as a system of cables and transformers linking power stations to consumers			
	Explain why the National Grid system is an efficient way to transfer energy, with reference to change in potential difference reducing current			
4.2.5 Static electricity	*PHY ONLY: Describe the production of static electricity by the rubbing of insulating surfaces*			
	PHY ONLY: Describe evidence that charged objects exert forces of attraction or repulsion on one another when not in contact			
	PHY ONLY: Explain how the transfer of electrons between objects can explain the phenomenon of static electricity, including how insulators are charged and sparks are created			
	PHY ONLY: Draw the electric field pattern for an isolated charged sphere			
	PHY ONLY: Explain the concept of an electric field and the decrease in its strength as the distance from it increases			
	PHY ONLY: Explain how the concept of an electric field helps to Explain the non-contact force between charged objects as well as other electrostatic phenomena such as sparking			
4.3.1 Changes of state and the particle model	Calculate the density of a material by recalling and applying the equation: [ρ = m/V]			
	Recognise/draw simple diagrams to model the difference between solids, liquids and gases			
	Use the particle model to explain the properties of different states of matter and differences in the density of materials			
	Required practical 5: *use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids*			
	Recall and describe the names of the processes by which substances change state			
	Use the particle model to explain why a change of state is reversible and affects the properties of a substance, but not its mass			
4.3.2 Internal energy and energy transfers	State that the internal energy of a system is stored in the atoms and molecules that make up the system			
	Explain that internal energy is the total kinetic energy and potential energy of all the particles in a system			
	Calculate the change in thermal energy by applying but not recalling the equation ***[ΔE =m c Δ θ]***			
	Calculate the specific latent heat of fusion/vaporisation by applying, but not recalling, the equation: ***[E = mL]***			
	Interpret and draw heating and cooling graphs that include changes of state			
	Distinguish between specific heat capacity and specific latent hea			
4.3.3 Particle model and pressur	Explain why the molecules of a gas are in constant random motion and that the higher the temperature of a gas, the greater the particles' average kinetic energy			
	Explain, with reference to the particle model, the effect of changing the temperature of a gas held at constant volume on its pressure			
	Calculate the change in the pressure of a gas or the volume of a gas (a fixed mass held at constant temperature) when either the pressure or volume is increased or decreased			
	PHY ONLY: Explain, with reference to the particle model, how increasing the volume in which a gas is contained can lead to a decrease in pressure when the temperature is constant			
	PHY ONLY: Calculate the pressure for a fixed mass of gas held at a constant temperature by applying, but not recalling, the equation: [pV = constant]			
	PHY & HT ONLY: Explain how work done on an enclosed gas can lead to an increase in the temperature of the gas, as in a bicycle pump			
4.4.1 Atoms and isotopes	Describe the basic structure of an atom and how the distance of the charged particles vary with the absorption or emission of electromagnetic radiation			
	Define electrons, neutrons, protons, isotopes and ions			
	Relate differences between isotopes to differences in conventional representations of their identities, charges and masses			
	Describe how the atomic model has changed over time due to new experimental evidence, inc discovery of the atom and scattering experiments (inc the work of James Chadwick)			
4.4.2 Atoms and nuclear radiation	Describe and apply the idea that the activity of a radioactive source is the rate at which its unstable nuclei decay, measured in Becquerel (Bq) by a Geiger-Muller tube			
	Describe the penetration through materials, the range in air and the ionising power for alpha particles, beta particles and gamma rays			
	Apply knowledge of the uses of radiation to evaluate the best sources of radiation to use in a given situation			
	Use the names and symbols of common nuclei and particles to complete balanced nuclear equations, by balancing the atomic numbers and mass numbers			
	Define half-life of a radioactive isotope			
	HT ONLY: Determine the half-life of a radioactive isotope from given information and calculate the net decline, expressed as a ratio, in a radioactive emission after a given number of half-lives			
	Compare the hazards associated with contamination and irradiation and outline suitable precautions taken to protect against any hazard the radioactive sources may present			
	Discuss the importance of publishing the findings of studies into the effects of radiation on humans and sharing findings with other scientists so that they can be checked by peer review			
4.4.3 Hazards and uses of radioactive emissions and of background radiation	*PHY ONLY: State, giving examples, that background radiation is caused by natural and man-made sources and that the level of radiation may be affected by occupation and/or location*			
	PHY ONLY: Explain the relationship between the instability and half-life of radioactive isotopes and why the hazards associated with radioactive material differ according to the half-life involved			
	PHY ONLY: Describe and evaluate the uses of nuclear radiation in exploration of internal organs and controlling or destroying unwanted tissue			
	PHY ONLY: Evaluate the perceived risks of using nuclear radiation in relation to given data and consequences			
	PHY ONLY: Describe nuclear fission			
	PHY ONLY: Draw/interpret diagrams representing nuclear fission and how a chain reaction may occur			
	PHY ONLY: Describe nuclear fusion			

Extension

Physics Paper 2

Topic	Student Checklist	R	A	G
4.5.1 Forces and their interactions	Identify and describe scalar quantities and vector quantities			
	Identify and give examples of forces as contact or non-contact forces			
	Describe the interaction between two objects and the force produced on each as a vector			
	Describe weight and explain that its magnitude at a point depends on the gravitational field strength			
	Calculate weight by recalling and using the equation: ***[W = mg]***			
	Represent the weight of an object as acting at a single point which is referred to as the object's 'centre of mass'			
	Calculate the resultant of two forces that act in a straight line			
	HT ONLY: describe examples of the forces acting on an isolated object or system			
	HT ONLY: Use free body diagrams to qualitatively describe examples where several forces act on an object and explain how that leads to a single resultant force or no force			
	HT ONLY: Use free body diagrams and accurate vector diagrams to scale, to resolve multiple forces and show magnitude and direction of the resultant			
	HT ONLY: Use vector diagrams to illustrate resolution of forces, equilibrium situations and determine the resultant of two forces, to include both magnitude and direction			
4.5.2 Work done and energy transfer	Describe energy transfers involved when work is done and calculate the work done by recalling and using the equation: *[W = Fs]*			
	Describe what a joule is and state what the joule is derived from			
	Convert between newton-metres and joules.			
	Explain why work done against the frictional forces acting on an object causes a rise in the temperature of the object			
4.5.3 Forces and elasticity	Describe examples of the forces involved in stretching, bending or compressing an object			
	Explain why, to change the shape of an object (by stretching, bending or compressing), more than one force has to be applied – this is limited to stationary objects only			
	Describe the difference between elastic deformation and inelastic deformation caused by stretching forces			
	Describe the extension of an elastic object below the limit of proportionality and calculate it by recalling and applying the equation: ***[F = ke]***			
	Explain why a change in the shape of an object only happens when more than one force is applied			
	Describe and interpret data from an investigation to explain possible causes of a linear and non-linear relationship between force and extension			
	Calculate work done in stretching (or compressing) a spring (up to the limit of proportionality) by applying, but not recalling, the equation: ***[$E_e = ½ke^2$]***			
	Required practical 6: *investigate the relationship between force and extension for a spring.*			
4.5.4 Moments, levers and gears	*PHY ONLY: State that a body in equilibrium must experience equal sums of clockwise and anticlockwise moments, recall and apply the equation:* ***[M = Fd]***			
	PHY ONLY: Apply the idea that a body in equilibrium experiences an equal total of clockwise and anti-clockwise moments about any pivot			
	PHY ONLY: Explain why the distance, d, must be taken as the perpendicular distance from the line of action of the force to the pivot			
	PHY ONLY: Explain how levers and gears transmit the rotational effects of forces			
4.5.5 Pressure and pressure differences in fluid	*PHY ONLY: Describe a fluid as either a liquid or a gas and explain that the pressure in a fluid causes a force to act at right angles (normal) to the surface of its container*			
	PHY ONLY: Recall and apply the equation: ***[p = F/A]***			
	PHY & HT ONLY: Explain why the pressure at a point in a fluid increases with the height of the column of fluid above and calculate differences in pressure in a liquid by applying [p = h ρ g]			
	PHY & HT ONLY: Describe upthrust an object and explain why the density of the fluid has an effect on the upthrust experienced by an object submerged in it			
	PHY & HT ONLY: Explain why an object floats or sinks, with reference to its weight, volume and the upthrust it experiences			
	PHY ONLY: Describe a simple model of the Earth's atmosphere and of atmospheric pressure, explaining why atmospheric pressure varies with height above a surface			
4.	Define distance and displacement and explain why they are scalar or vector quantities			
	Express a displacement in terms of both the magnitude and direction			
	Explain that the speed at which a person can walk, run or cycle depends on a number of factors and recall some typical speeds for walking, running, cycling			
	Make measurements of distance and time and then calculate speeds of objects in calculating average speed for non-uniform motion			
	Explain why the speed of wind and of sound through air varies and calculate speed by recalling and applying the equation: ***[s = v t]***			
	Explain the vector–scalar distinction as it applies to displacement, distance, velocity and speed			
	HT ONLY: Explain qualitatively, with examples, that motion in a circle involves constant speed but changing velocity			
	Represent an object moving along a straight line using a distance-time graph, describing its motion and calculating its speed from the graph's gradient			
	Draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs,			
	Describe an object which is slowing down as having a negative acceleration and estimate the magnitude of everyday accelerations			
	Calculate the average acceleration of an object by recalling and applying the equation: ***[a = Δv/t]***			
	Represent motion using velocity–time graphs, finding the acceleration from its gradient and distance travelled from the area underneath			
	HT ONLY: Interpret enclosed areas in velocity–time graphs to determine distance travelled (or displacement)			
	HT ONLY: Measure, when appropriate, the area under a velocity– time graph by counting square			
	Apply, but not recall, the equation: ***[$v^2 - u^2 = 2as$]***			

4.5.6 Forces and motion	*PHY ONLY: Draw and interpret velocity-time graphs for objects that reach terminal velocity*			
	PHY ONLY: Interpret and explain the changing motion of an object in terms of the forces acting on it			
	PHY ONLY: Explain how an object falling from rest through a fluid due to gravity reaches its terminal velocity			
	Explain the motion of an object moving with a uniform velocity and identify that forces must be in effect if its velocity is changing, by stating and applying Newton's First Law			
	Define and apply Newton's second law relating to the acceleration of an object			
	Recall and apply the equation: ***[F = ma]***			
	HT ONLY: Describe what inertia is and give a definition			
	Estimate the speed, accelerations and forces of large vehicles involved in everyday road transport			
	Required practical 7: *investigate the effect of varying the force on the acceleration of an object of constant mass, and the effect of varying the mass of an object on the acceleration*			
	Apply Newton's Third Law to examples of equilibrium situations			
	Describe factors that can effect a drivers reations time			
	Explain methods used to measure human reaction times and recall typical results			
	Interpret and evaluate measurements from simple methods to measure the different reaction times of students			
	Evaluate the effect of various factors on thinking distance based on given data			
	PHY ONLY: Estimate the distance required for an emergency stop in a vehicle over a range of typical speeds			
	PHY ONLY: Interpret graphs relating speed to stopping distance for a range of vehicles			
	State typical reaction times and describe how reaction time (and therefore stopping distance) can be affected by different factors			
	Explain methods used to measure human reaction times and take, interpret and evaluate measurements of the reaction times of students			
	Explain how the braking distance of a vehicle can be affected by different factors, including implications for road safety			
	Explain how a braking force applied to the wheel does work to reduce the vehicle's kinetic energy and increases the temperature of the brakes			
	Explain and apply the idea that a greater braking force causes a larger deceleration and explain how this might be dangerous for drivers			
	HT ONLY: Estimate the forces involved in the deceleration of road vehicles			
4.5.7 Momentum	**HT ONLY: Calculate momentum by recalling and applying the equation: *[p = mv]***			
	HT ONLY: Explain and apply the idea that, in a closed system, the total momentum before an event is equal to the total momentum after the event			
	HT ONLY: Describe examples of momentum in a collision			
	PHY & HT ONLY: Complete conservation of momentum calculations involving two objects			
	PHY & HT ONLY: Explain that when a force acts on an object that is moving, or able to move, a change in momentum occurs			
	PHY & HT ONLY: Calculate a force applied to an object, or the change in momentum it causes, by applying but not recalling the equation: [F = m Δv / Δt]			
	PHY & HT ONLY: Explain that an increased force delivers an increased rate of change of momentum			
	PHY & HT ONLY: Apply the idea of rate of change of momentum to explain safety features such as air bags, seat belts, helmets and cushioned surfaces			
4.6.1 Waves in air, fluids and solids	Describe waves as either transverse or longitudinal, defining these waves in terms of the direction of their oscillation and energy transfer and giving examples of each			
	Define waves as transfers of energy from one place to another, carrying information			
	Define amplitude, wavelength, frequency, period and wave speed and Identify them where appropriate on diagrams			
	State examples of methods of measuring wave speeds in different media and Identify the suitability of apparatus of measuring frequency and wavelength			
	Calculate wave speed, frequency or wavelength by applying, but not recalling, the equation: ***[v = f λ]*** and calculate wave period by recalling and applying the equation: ***[T = 1/f]***			
	Identify amplitude and wavelength from given diagrams			
	Describe a method to measure the speed of sound waves in air			
	Describe a method to measure the speed of ripples on a water surface			
	PHY ONLY: Demonstrate how changes in velocity, frequency and wavelength are inter-related in the transmission of sound waves from one medium to another			
	Required practical 8: *make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid*			
	PHY ONLY: Discuss the importance of understanding both mechanical and electromagnetic waves by giving examples, such as designing comfortable and safe structures and technologies			
	PHY ONLY: Describe a wave's ability to be reflected, absorbed or transmitted at the boundary between two different materials			
	PHY ONLY: Draw the reflection of a wave at a surface by constructing ray diagrams			
	Required practical 9 *(physics only): investigate the reflection of light by different types of surface and the refraction of light by different substances.*			
	PHY & HT ONLY: Describe, with examples, processes which convert wave disturbances between sound waves and vibrations in solids			
	PHY & HT ONLY: Explain why such processes only work over a limited frequency range and the relevance of this to the range of human hearing, which is from 20 Hz to 20 kHz			
	PHY & HT ONLY: Define ultrasound waves and explain how these are used to form images of internal structures in both medical and industrial imaging			
	PHY & HT ONLY: Compare the two types of seismic wave produced by earthquakes with reference to the media they can travel in and the evidence they provide of the structure of the Earth			
	PHY & HT ONLY: Describe how echo sounding using high frequency sound waves is used to detect objects in deep water and measure water depth			
	Describe what electromagnetic waves are and explain how they are grouped			
	List the groups of electromagnetic waves in order of wavelength			

4.6.2 Electromagnetic waves	Explain that because our eyes only detect a limited range of electromagnetic waves, they can only detect visible light			
	HT ONLY: Explain how different wavelengths of electromagnetic radiation are reflected, refracted, absorbed or transmitted differently by different substances and types of surface			
	Illustrate the refraction of a wave at the boundary between two different media by constructing ray diagrams			
	HT ONLY: Describe what refraction is due to and illustrate this using wave front diagrams			
	Required practical activity 10: *investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface.*			
	HT ONLY: Explain how radio waves can be produced by oscillations in electrical circuits, or absorbed by electrical circuits			
	Explain that changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated or absorbed over a wide frequency range			
	State examples of the dangers of each group of electromagnetic radiation and discuss the effects of radiation as depending on the type of radiation and the size of the dose			
	State examples of the uses of each group of electromagnetic radiation, explaining why each type of electromagnetic wave is suitable for its applications			
	PHY ONLY: State that a lens forms an image by refracting light and that the distance from the lens to the principal focus is called the focal length			
	PHY ONLY: Explain that images produced by a convex lens can be either real or virtual, but those produced by a concave lens are always virtual			
	PHY ONLY: Construct ray diagrams for both convex and concave lenses			
	PHY ONLY: Calculate magnification as a ratio with no units by applying, but not recalling, the formula: [magnification = image height / object height]			
	PHY ONLY: Explain how the colour of an object is related to the differential absorption, transmission and reflection of different wavelengths of light by the object			
	PHY ONLY: Describe the effect of viewing objects through filters or the effect on light of passing through filters and the difference between transparency and translucency			
	PHY ONLY: Explain why an opaque object has a particular colour, with reference to the wavelengths emitted			
	PHY ONLY: State that all bodies, no matter what temperature, emit and absorb infrared radiation and that the hotter the body, the more infrared radiation it radiates in a given time			
	PHY ONLY: Describe a perfect black body as an object that absorbs all the radiation incident on it and explain why it is the best possible emitter			
	PHY ONLY: Explain why when the temperature is increased, the intensity of every wavelength of radiation emitted increases, but the intensity of the shorter wavelengths increases more rapidly			
	PHY & HT ONLY: Explain and apply the idea that the temperature of a body is related to the balance between incoming radiation absorbed and radiation emitted			
	PHY & HT ONLY: Describe how the temperature of the Earth as dependent on the rates of absorption and emission of radiation and draw and interpret diagrams that show this			
4.7.1 Permanent and induced magnetism, magnetic forces and fields	Describe the attraction and repulsion between unlike and like poles of permanent magnets and explain the difference between permanent and induced magnets			
	Draw the magnetic field pattern of a bar magnet, showing how field strength and direction are indicated and change from one point to another			
	Explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic			
	Describe how to plot the magnetic field pattern of a magnet using a compass			
4.7.2 The motor effect	State examples of how the magnetic effect of a current can be demonstrated and explain how a solenoid arrangement can increase the magnetic effect of the current			
	Draw the magnetic field pattern for a straight wire carrying a current and for a solenoid (showing the direction of the field)			
	PHY ONLY: Interpret diagrams of electromagnetic devices in order to explain how they work			
	HT ONLY: State and use Fleming's left-hand rule and explain what the size of the induced force depends on			
	HT ONLY: Calculate the force on a conductor carrying a current at right angles to a magnetic field by applying, but not recalling, the equation: *[F = BIL]*			
	HT ONLY: Explain how rotation is caused in an electric motor			
	PHY & HT ONLY: Explain how a moving-coil loudspeaker and headphones work			
4.7.3 Induced potential, transformers and the National Grid	***PHY & HT ONLY: Describe the principles of the generator effect, including the direction of induced current, effects of Lenz' Law and factors that increase induced p.d.***			
	PHY & HT ONLY: Explain how the generator effect is used in an alternator to generate a.c. and in a dynamo to generate d.c.			
	PHY & HT ONLY: Draw/interpret graphs of potential difference generated in the coil against time			
	PHY & HT ONLY: Explain how a moving-coil microphone works			
	PHY & HT ONLY: Explain how the effect of an alternating current in one coil inducing a current in another is used in transformers			
	PHY & HT ONLY: Explain how the ratio of the potential differences across the two coils depends on the ratio of the number of turns on each			
	PHY & HT ONLY: Apply the equation linking the p.d.s and number of turns in the two coils of a transformer to the currents and the power transfer			
	PHY & HT ONLY: Apply but not recalling the equations: [Vs × Is = Vp × Ip] and [vp / vs = np / ns] for transformers			
4.8.1 Solar system; stability of orbital motions; satellites	*PHY ONLY: List the types of body that make up the solar system and describe our solar system as part of a galaxy*			
	PHY ONLY: Explain how stars are formed			
	PHY ONLY: Describe the life cycle of a star the size of the Sun and of a star which is much more massive than the Sun			
	PHY ONLY: Explain how fusion processes lead to the formation of new elements and how supernovas have allowed heavy elements to appear in later solar systems			
	PHY & HT ONLY: Explain that, for circular orbits, the force of gravity leads to a constantly changing velocity but unchanged speed			
	PHY & HT ONLY: Explain that, for a stable orbit, the radius must change if the speed changes			
4.8.2 Red-shift	*PHY ONLY: Explain, qualitatively, the red-shift of light from galaxies that are receding and how this red-shift changes with distance from Earth*			
	PHY ONLY: Explain why the change of each galaxy's speed with distance is evidence of an expanding universe			
	PHY ONLY: Explain how scientists are able to use observations to arrive at theories, such as the Big Bang theory and discuss that there is still much about the universe that is not understood			