Subject: SCIENCE

Paper Format/Components

A: Biology (30 marks, 30 minutes)
B: Chemistry (30 marks, 30 minutes)
C: Physics (30 marks, 30 minutes)

Skills to be assessed alongside subject content

Application of syllabus ideas to an unfamiliar context
Assimilation of new ideas given in the exam and applying them to a question
Clear presentation of working
Correct use of units
Graph plotting, including constructing and labelling the axes
Use of a calculator
Drawing of suitable tables to collect experimental data
Rearranging equations of type a=b/c and a=b+c
Appreciation of the difference between observations and conclusions
Appreciation that there are uncertainties associated with experimental measurements

Common Entrance subtopics omitted

Nutrition and digestion
Reproduction in animals
Energy resources
Hearing
Electromagnets

Topic/ subtopic	Assumed knowledge at end of topic/Pupil should know	Common Entrance syllabus statement
A1a	how to observe, interpret and record cell structure using a light microscope; that in multi-cellular organisms, cells are massed together to form tissues, and tissues can be massed together to form organs; that organs work together in systems; organ systems work together in an organism; examples of organ systems in humans (e.g. digestive system, gaseous exchange system) and in flowering plants (e.g. leaves)	that cells are the fundamental unit of living organisms; the hierarchical organisation of multicellular organisms: from cells to tissues to organs to systems to organisms
A1b	that a typical animal or plant cell has a nucleus, cytoplasm, mitochondria and cell surface membrane; that plant cells contain permanent fluid-filled vacuoles; the function of each component, stated briefly; that the nucleus contains genes which control the production of protein in the cell; that genes are made of DNA which determines an organism's characteristics; how to use a microscope to observe plant and animal cells and how to prepare a temporary microscope slide, e.g. using methylene blue as a stain for nuclei	the similarities and differences between plant and animal cells; the functions of chloroplasts and cell walls in plant cells and the functions of the cell surface membrane, cytoplasm, mitochondria and nucleus in both plant and animal cells; the vacuole in plant cells
A1c	in humans, about the movement of oxygen, glucose into cells and the movement of carbon dioxide out of cells; about diffusion across the membranes of alveoli; in plants, about gas exchanges in leaves	the role of diffusion in the movement between plant and animal cells
A2a	about the structure of the lungs in outline only, i.e. the lung surface is greatly folded, creating a large surface area for gaseous exchange, and that they have thin walls and an extensive blood supply; that oxygen is taken into the lungs by breathing, and transported to the tissues by the circulatory system	the structure and functions of the gas exchange system in humans, including adaptations to function

A2b	the terms inspiration and expiration; about the role of the diaphragm and the intercostal muscles in the rib cage; that vital capacity is a measure of lung volume	the mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume
A2c	that smoking is one of the causes of lung cancer and heart disease; that smoking reduces the surface area of the lungs, leading to severe breathing difficulties; about the importance of inhalers in treating asthma; the effects of athletic training on lung volume and heart rate; about pulse rate as a measure of heart rate	the impact of exercise, asthma and smoking on the human gas exchange system
A3a	that fertilisation in flowering plants occurs when a male nucleus in a pollen tube fuses with a nucleus in a female egg cell (ovum) in an ovule about sexual reproduction in flowering plants including details of flower structure; the terms carpel (stigma, style, ovary, ovule), stamen (anther, filament), petal, sepal; that pollination is the transfer of pollen from an anther to a stigma; fertilisation is the fusing together of the male and female sex cells to produce a fertilised egg leading to the formation of a seed; fruit formation and seed dispersal; the germination of seeds; the main parts of a germinating seed: embryo shoot, embryo root, food store and seed coat	reproduction in plants, including flower structure; wind and insect pollination, fertilisation; seed and fruit formation and dispersal, including quantitative investigation of some dispersal mechanisms
A4a	about one example of a bacterial disease and one example of a viral disease; about the importance of cleanliness at personal and community levels as a defence against disease; that the body's natural defences can be supplemented by medicines	that the growth and reproduction of bacteria and the replication of viruses can affect health; how the body's natural defences may be enhanced by medicines
A5a	that photosynthesis is summarised by the word equation: carbon dioxide + water (with light energy and chlorophyll) ® glucose + oxygen; that in most plants the glucose is then converted into starch which can be tested, using iodine solution	the reactants in, and products of, photosynthesis, and a word summary for photosynthesis; that plants need carbon dioxide, water and light for photosynthesis, and produce biomass and oxygen

A5b	about the global importance of photosynthesis in producing food and maintaining the composition of the atmosphere; about gas production during photosynthesis in, e.g. Elodea; how to perform a controlled experiment to show that light is needed for starch production by a potted plant, e.g. Pelargonium	the dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules which are an essential energy source to maintain levels of oxygen and carbon dioxide in the atmosphere
A5c	in outline only: about the role of cells containing chloroplasts as the sites of photosynthesis; the role of xylem in transporting water to the leaf; the role of phloem transporting sugar to the growing parts of the plant; the role of stomata in gas exchange during daylight	the adaptations of leaves for photosynthesis; the role of stomata in gas exchange in plants
A5d	that root hairs increase the surface area for absorption of water and minerals such as nitrates; that nitrates are needed for healthy growth; that magnesium is needed for the production of chlorophyll	the role of root hairs in absorbing water and minerals from the soil; that nitrogen and other elements, in addition to carbon, oxygen and hydrogen, are required for plant growth
A6a	about the difference between breathing and respiration; that respiration in living organisms enables all the other chemical processes necessary for life; that aerobic respiration takes place in mitochondria that energy is made available by aerobic respiration, summarised by the word equation: glucose + oxygen ® carbon dioxide + water + energy how to test exhaled air for carbon dioxide using limewater	that aerobic respiration involves a reaction in cells between oxygen and food, in which glucose is broken down to carbon dioxide and water to summarise aerobic respiration in a word equation
A6b	glucose ® ethanol + carbon dioxide + some energy (plants and yeast) glucose ® lactic acid + some energy (animals)	the process of anaerobic respiration in humans, including fermentation, and a word summary for anaerobic respiration
A6c	that for each molecule of glucose respired, aerobic respiration yields more energy than anaerobic respiration	the differences between aerobic and anaerobic respiration; the implications for the organism
A6d	that oxygen and carbon dioxide are carried in the blood and exchanged with the atmosphere through the lungs	that the reactants and products of respiration are transported throughout the body in the bloodstream

A6e	that animals and plants respire and plants photosynthesise; how the carbon cycle maintains a balance between respiration and photosynthesis and the effect of this on the atmosphere; the impact of burning fossil fuels on the level of carbon dioxide in the atmosphere	the global significance of photosynthesis and respiration in maintaining the levels of carbon dioxide in the atmosphere
A7a	how to study one simple food chain in a habitat; the differences between a food chain and a food web	the interdependence of organisms in an ecosystem, including food webs
A7b	about the importance of conserving local habitats; that the resources of the Earth are limited and need to be managed	about ways in which living things and the environment can be protected, and the importance of sustainable development
A7c	about simple methods of estimating the population size of one type of organism by means of a quadrat; that population size is affected by predation and competition	how predation and competition for resources affect the size of populations (e.g. bacteria, growth of vegetation)
A8a	similarities and differences between the Great Apes (including chimpanzees and gorillas) and humans; about the environmental and inherited causes of variation within a species	that differences exist between species
A8b	how to use a simple key to identify the group to which a specimen belongs; that animals and plants are classified into separate kingdoms; that bacteria, fungi and single- celled organisms are placed in other kingdoms; the characteristic features of the animal and plant kingdoms and why fungi are not included with plants; the diagnostic features of: single-celled organisms, fungi, arthropods (knowing the difference between insects and spiders), fish, amphibians, reptiles, birds, mammals and flowering plants	the classification of living things into the major taxonomic groups
B1a	the variation in the arrangement and movement of particles associated with changes of state about the abundance of water in nature, including its existence as vapour in the air; the water cycle; the effect of air flow and temperature changes on evaporation from oceans or in laboratory experiments; how to make predictions about the amount of water lost	changes of state in terms of the particle model; similarities and differences, including density differences, between solids, liquids and gases; changes with temperature in motion and spacing of particles

B2a	the meaning of the words atom and molecule; about the term element as used in chemistry and the idea that samples of the same element contain the same type of atom	the simple (Dalton) atomic model
B2b	the symbols for the elements H, C, O, N, S, Mg, Na, Cl, Ca, Cu, Fe and He; that the symbol can represent one atom of that element; simple formulae: H_2O, CO_2, O_2, CH_4, NaCl, HCl, NaOH, $CaCO_3$, $CuSO_4$, H_2SO_4	chemical symbols and formulae for elements and compounds
B2c	that the elements are organised in the periodic table; that compounds have different properties from the elements from which they are made	the differences between atoms, elements and compounds
B2d	the terms conductor and insulator both in electrical and thermal contexts; about the grouping of elements into metals and non- metals according to physical characteristics such as electrical conductivity, shininess, malleability	how elements vary widely in their physical properties, including appearance, state at room temperature, magnetic properties and thermal and electrical conductivity, and to how use these properties to classify elements as metals or non-metals
B3a	that pure substances comprise particles of the same type	the concept of a pure substance
B3b	that a pure substance melts and boils at a particular temperature and this can be used to identify it	the identification of pure substances
B3c	the terms melting, freezing, boiling, condensation, evaporation and sublimation; that most solids, liquids and gases expand on heating and contract on cooling, e.g. the use of mercury or alcohol in thermometers; that evaporation can occur at any temperature but boiling occurs at a specific temperature for a particular substance; about the anomalous behaviour of water when freezing	to relate changes of state to energy transfers
B3d	that when physical changes (e.g. changes of state, formation of solutions) take place, mass is conserved	conservation of mass for physical changes
B3e	that the properties of a mixture are the same as its components; in a solution, the solute and solvent particles are arranged randomly	mixtures, including dissolving

B3f	about the following methods of separation: about filtration to remove insoluble solids from a suspension; the terms filtrate and residue; evaporation to recover a solute and the testing of water purity by measurement of its boiling point and freezing point; how to purify rock salt; the differences between sea, tap and distilled water, demonstrated by evaporation; the importance of water as a solvent; that ethanol and propanone are alternative solvents to water chlorinated hydrocarbons must not be used; about simple distillation to recover a solvent from a solution, e.g. how to obtain a sample of pure water from sea water or washable ink; of the need to prevent suck-back of the distilled sample if simple apparatus is used, and how to prevent it; about use of the Liebig condenser; paper chromatography to separate a mixture of two or more coloured solutes from a solution, e.g. coloured inks, food dyes, Smartie-type sweets; how to interpret simple chromatograms	simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography
B3g	that when soluble solids form a solution, a chemical change is not involved; that a solution is a mixture which may be separated using physical techniques	about the variation of solubility with temperature, the formation of saturated solutions and the differences in solubility of solutes in different solvents

B4a	how mass is conserved when chemical reactions take place because the same atoms are present, although combined in different ways; about the experiment to demonstrate the conservation of mass in which lead iodide, or another suitable solid, is produced by mixing two solutions in a stoppered conical flask; that virtually all materials, including those in living systems, are made through chemical reactions; about the importance of chemical change in everyday situations, (e.g. ripening fruit, setting superglue, cooking food) magnesium oxide (previously dried in an oven) may be used to illustrate that some substances do not change chemically when heated	conservation of mass in chemical reactions
B4b	how to use the Bunsen burner for gentle warming, vigorous heating etc.; about the effect of air supply on the flame and relative temperatures of different parts of the roaring flame; that when things burn in air they react with oxygen; the glowing splint test for oxygen and the limewater test for carbon dioxide; how to identify the products of combustion, e.g. of a candle; how to construct word equations for simple chemical reactions; about recognising chemical change by the new substances which are formed	combustion reactions
B4c	how metals react with oxygen, water and acids and oxides of other metals, and the products of these reactions; how to apply the lighted splint test for hydrogen; about the rusting of iron; that oxygen in the air is involved in the rusting process; simple rusting experiments should be extended to show that air contains 20% oxygen the displacement reactions which take place between metals and solutions of salts (e.g. sulfates) of other metals copper, iron, magnesium and zinc are suitable examples for experiments	oxidation and displacement reactions

B4d	how a reactivity series of metals can be determined by considering these reactions, and used to make predictions about other reactions; how to use the reactivity series of metals to deduce that those higher in the series might burn more vigorously in air, react faster with water and dilute acids, and displace a lower metal from its oxide; the uses of metals low down the series, such as lead and copper, for roofing and piping; about the need for methods of covering the surface when the more reactive iron is used; about the exceptional lack of reactivity of silver and gold which makes them useful for jewellery and electrical contacts	the order of metals and carbon in the reactivity series
B4e	about the use of indicators such as Universal Indicator and litmus to classify solutions as acidic, neutral or alkaline and to use the pH scale as a measure of the acidity of a solution	the pH scale for measuring acidity/alkalinity and indicators
C1a	That energy is a quantity which can be measured and that the unit of energy is the joule	energy as a quantity that can be quantified and calculated
C1b	that energy can exist in many different forms: chemical, electrical, gravitational, kinetic, light, sound, strain (elastic) and thermal (internal); the form in which energy is stored in a particular situation (e.g. a stretched spring stores energy as strain energy) how to describe the energy transformation taking place in simple situations (e.g. a lamp transforming electrical energy into light and thermal energy) how different processes result in energy transfers	ways in which energy can be usefully transferred and stored, comparing the starting with the final conditions of a system and describing increases and decreases in the amounts of energy associated with movements, temperatures, changes in positions in a field, in elastic distortions and in chemical compositions
C1c	that the total energy is conserved but that in doing work, energy is always spread out or diluted so as to become less useful	that the total energy has the same value before and after a change
C1d	about the significance of the Law of Conservation of Energy	that although energy is always conserved, it may be dissipated, reducing its availability as a resource

C2a	about the timing of moving bodies to measure speed; the relationship between speed, distance and time; how to use this for simple quantitative work; how to draw and interpret a distance-time graph for a journey; that speeds for vehicles approaching or passing each other in a straight line would add or subtract as seen from one vehicle	how to determine the speed of a moving object and to use the quantitative relationship between speed, distance and time; relative motion: trains and cars passing one another
C2b	that the unit of force is the newton and that forces can be measured using a force meter (newton meter)	forces as pushes or pulls, arising from the interaction between two objects; forces measured in newtons, measurements of stretch or compression as force is changed
C2c	the concept of constant speed and of speeding up and of slowing down, without a formal definition of acceleration; about the effects of forces on an object; that forces can act in different directions	forces being needed to cause objects to stop or start moving, or to change their speed or direction of motion
C2d	that forces can be represented by arrows which can show both the size of the force by the length of arrow and the direction of the force by the direction of the arrow	using force arrows in diagrams, adding forces in one dimension, balanced and unbalanced forces
C2e	that when forces are added, both size and direction need to be taken into account; calculations will only involve forces acting in a straight line	that unbalanced forces change the speed or direction of objects and that balanced forces produce no change in the movement of an object
C2f	that there is an unbalanced force on an object when the result of adding the forces on the object is non-zero	opposing forces and equilibrium: weight held by stretched spring or supported on a compressed surface
C2g	that an unbalanced force can cause either a change in speed or a change in direction of motion and that both of these changes are acceleration; that if the result of adding the forces on an object is zero, the forces are balanced and there will be no change in the motion of the object; that an object is in equilibrium when the forces on it are balanced about experiments and calculations with springs and combinations of springs that obey Hooke's Law	forces: associated with deforming objects; stretching and squashing – springs; force-extension linear relation; Hooke's Law as a special case
C3a	about the use of levers to change direction and magnitude of a force	that forces can cause objects to turn about a pivot

C3b	about the use of levers in simple machines, e.g. crowbars, pliers, scissors	that simple machines give bigger force but at the expense of smaller movement (and vice versa) – product of force and displacement unchanged
C3c	about simple quantitative examples involving moments about a single pivot; that the unit of a moment is a newton metre (or newton centimetre)	moment as the turning effect of a force; the principle of moments and its application to situations involving one pivot
C3d	the relationship between force, area and pressure	pressure measured by ratio of force over area – acting normal to any surface
C3e	how to use this relationship for simple quantitative work; that the unit of pressure is N/m2 or N/cm2	the quantitative relationship between force, area and pressure and its application (e.g. the use of skis and snowboards, the effect of sharp blades)
C4a	about the relationship between density, mass and volume; how to use this for simple quantitative work that the unit of density is kg/m3 or g/cm3; about the measurement of the mass and volume of regularly- shaped solids and of irregularly-shaped solids (using the displacement of water to find a volume), and of liquids to calculate their density; that air has mass and that it is possible to measure its density	density and its measurement
C5a	that sound travels through solids, liquids and air, but not through a vacuum; that an event observed from a distance is seen before it is heard; that sound can be reflected from a boundary, like all waves, and that an example of reflection of sound is an echo; that some materials will absorb sound; that sound is produced by a vibrating object which produces a sound wave which is able to travel through a medium; candidates will not be expected to memorise the numerical values for the speeds of sound and light but merely the comparison between the two	that sound needs a medium to travel; the speed of sound in air, in water, in solids; echoes, reflection and absorption of sound; that sound is produced by vibrations of objects, in loud speakers, detected by their effects on a microphone diaphragm

C6a	that light comes from a luminous source and travels in straight lines; that light travels much faster than sound or any other mechanical wave; that the ultimate speed is the speed of light in a vacuum	that light travels in a straight line at a finite speed in a uniform medium; that light can travel through a vacuum but sound cannot, and that light travels much faster than sound; that light waves can travel through a vacuum; speed of light (qualitative only)
C6b	that some objects give out light but that light is reflected from non-luminous objects and this is how we are able to see them; details of the structure of the eye will not be examined	that non-luminous objects are seen because light scattered from them enters the eye
C6c	how a plane mirror alters the path of a ray of light; the meaning of the angle of incidence and angle of reflection; how to measure these angles using a protractor, and that they are equal	how light is reflected at plane surfaces; the use of a ray model to explain imaging in mirrors; the pinhole camera
C6d	that, on a qualitative basis, light changes direction when it reaches the boundary between two different materials and that this phenomenon is called refraction	how light is refracted at the boundary between two different materials
C6e	that light will be transmitted through a material if it is not absorbed; such a material is transparent; some materials will absorb light and re-emit it in all directions, called scattering, and that such a material is translucent	the transmission of light through materials: absorption, diffuse scattering
C6f	that white light is a mixture of all colours; that different colours have different frequencies; how a prism disperses white light and that a similar effect occurs naturally in a rainbow	that white light can be dispersed to give a range of colours; colours and the different frequencies of light, white light and prisms (qualitative only)
C7a	about parallel and series circuits, involving cells, lamps, switches, resistors, variable resistors	to design and construct series and parallel circuits, and how to measure current
C7b	that the unit of current is the ampere (amp); that current is measured with an ammeter and that it should be connected in series in the circuit	about electric current, measured in amperes, series and parallel circuits, currents add where branches meet; that the current in a series circuit depends on the number of cells and the number and nature of other components; current as flow of charge that is not 'used up' by components; differences in resistance between conducting and insulating components (qualitative only)

C7c	that a battery or cell transforms chemical energy into electrical energy and that electrical energy is converted into other forms in electrical components	that energy is transferred from batteries and other sources to other components in electrical circuits
C8a	that like poles repel and unlike poles attract; that magnetic forces occur even without contact between the magnets that both poles will attract unmagnetised iron; that the Earth has a magnetic field, and that a freely-suspended bar magnet will align itself north– south	about magnetic fields as regions of space where magnetic materials experience forces, and that like magnetic poles repel and unlike magnetic poles attract; magnetic fields by plotting with a compass; representation by field lines Earth's magnetism, compass and navigation
C9a	that the Earth is one of several planets which orbit the Sun; the reasons for the changes causing night and day, seasons and eclipses of the Sun and Moon	how the movement of the Earth causes the apparent daily and annual movement of the Sun and other stars; the seasons and the Earth's tilt; day length at different times of year, in different hemispheres
C9b	about the concept of a moon as a satellite, as shown by our Moon and the moons of other planets; that the solar system is part of the Milky Way galaxy, and that the Universe contains many such groups of stars or galaxies about the scale of astronomical distances planetary and stellar distances need not be remembered	the relative positions of the Earth, Sun and planets in the solar system the light year as a unit of astronomical distance
C9c	that there is a gravitational force of attraction between any two masses; that this force causes bodies to fall towards the centre of the Earth; that the weight of a body is the pull of gravity on it weight = mass x gravitational field strength (g) on Earth: g = 10 N/kg	gravity forces acting at a distance on Earth and in space; that the weight of an object on Earth is the result of the gravitational attraction between its mass and that of the Earth
C9d	why the planets and our Moon are visible even though they are not light sources	that the Sun and other stars are light sources and that the planets and other bodies are seen by reflected light