KS3 (Years 7-9) Key constructs in Biology

Cells

- Animal cells are composed of 5 sub-cellular structures and plant cells of 8.
- A light microscope can be used to magnify and observe cells.
- Microorganisms including bacteria can cause disease in humans and other organisms.
- Substances such as oxygen and water move into and out of cells by diffusion and osmosis.

The Body and Health

- Respiration takes place in **all living organisms** to release **energy** for bodily functions.
- There are 7 life processes that all organisms must do to survive. They are movement, respiration, sensitivity, growth, reproduction, excretion and nutrition.
- Food is digested through a range of tissues and organs that together make up the human digestive system.
- The lungs, airways and blood vessels help to diffuse oxygen into and carbon dioxide out of red blood cells.

Plants and Ecosystems

- **Photosynthesis** is the **chemical reaction** that takes place in the **chloroplasts** of all plants to **produce glucose**.
- Plants are organised into **cells, tissues and organs** like other living organisms.
- Plants can **reproduce** using **sexual and asexual reproduction**, including **pollination**.
- An ecosystem is the interaction between the living (biotic) and non-living (abiotic) factors in a given habitat.

KS3 (Years 7-9) Key constructs in Biology

Life and Reproduction

- The male and female human reproductive systems are specifically adapted for sexual reproduction.
- Pregnancy is the result of **fertilisation** of an **egg and sperm cell**.
- **Evolution** is the result of **adaptions** due to changes in the environment.
- The probability of **inheritance** of certain **genetic characteristics** can be displayed in the form of **Punnett squares**.

<u>Homeostasis</u>

- Homeostasis is the maintenance of internal conditions, such as temperature and blood glucose control.
- The **nervous system** controls **conscious** and **sub-conscious actions**.
- The **endocrine system** controls the **hormonal responses** within the body.
- **Plants** have **hormones** which help them respond to changes in **light**.

KS3 (Years 7-9) Key constructs in Chemistry

Matter

- Substances can be in one of three states of matter, **solid**, **liquid or gas**. These states can change due to changes in the **energy of the particles**.
- All of the **elements** are arranged in order of **increasing atomic number** in the **periodic table**.
- Substances can be grouped into elements, compounds or mixtures.
- Substances which are **soluble** are able to **dissolve in a solvent**.
- Mixtures can be **separated** using one of the **5 separation techniques**.

Atoms, Elements, Compounds

- Atomic structure is arranged with protons and neutrons in a central nucleus and electrons in shells.
- Some elements can **bond** with the same or different elements which can form either **ionic, covalent or metallic** bonds.
- Ions form when atoms either gain or lose electrons.

Reactions 1

- pH is a measure of how acidic or alkaline a substance is. Neutralisation may occur when and acid and alkaline react with one another.
- Metals and non-metals can be determined by their properties, including conductivity, softness and dullness but there
 are some exceptions.
- Chemical reactions can be written as word equations or symbol equations. Symbol equations can be balanced to show the number of atoms involved.

KS3 (Years 7-9) Key constructs in Chemistry

Reactions 2

- The reactivity series is used to determine the products of electrolysis and displacement reactions.
- Combustion requires a fuel source and oxygen, it produces carbon dioxide and water and releases energy.
- The mass of the reactants of a reaction is equal to the mass of the products as per the law of the conservation of mass.
- During reactions energy is either taken in for the reaction to happen (endothermic) or energy is given out (exothermic).

<u>The Earth</u>

- The Earth is structured in layers, they are the crust, mantle, outer core and inner core.
- Igneous, sedimentary and metamorphic rocks are all formed as part of the rock cycle.
- Weathering can be either physical, chemical or biological and causes the breakdown of rock structures.

KS3 (Years 7-9) Key constructs in Physics

Electricity and Magnetism

- The **resistance** of a component is linked to the **potential difference** (energy difference around a component) and the **current** (the rate of electron flow).
- The **potential difference** and **current** are distributed differently in **series and parallel circuits**.
- The national grid is the network of wires and transformers that carry electricity from power stations to consumers.
- Magnets produce a magnetic field which can attract or repel magnetic objects.
- Electromagnets are formed from a solenoid, metal core and current.

Forces

- Forces act on all objects and can be **balanced or unbalanced** depending on if the object is **stationary or in motion**.
- Speed can be calculated by the distance travelled divided by the time taken.
- Gravity is a non-contact force by which a planet or other body pulls objects towards its centre.
- Friction and air resistance are contact forces that slow moving objects and produce heat.

KS3 (Years 7-9) Key constructs in Physics

<u>Waves</u>

- The frequency and volume of a sound wave can be determined using the wavelength and amplitude.
- Visible light can be split into the colours; red, orange, yellow, green, blue, indigo and violet.
- Waves can be reflected when they hit a surface and bounce back or refracted when the wave bends through a different medium.
- The electromagnetic spectrum is made up of waves of different frequencies which have different everyday applications.

<u>Energy</u>

- Energy cannot be **created or destroyed**, only **transferred from one store to another** or **dissipated** to the surroundings.
- Thermal energy can be transferred through different substances by the means of conduction, convection and radiation.
- Efficiency is the measure of how much of an appliances input energy has been transferred to useful output energy.
- Energy resources can be **renewable** (will not run out) and **non-renewable** (will run out).

<u>Space</u>

- Our solar system is made up of the Sun and eight planets (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune).
- The orbit of the Moon around the Earth and the Earth around the Sun determines the tides, day, month and year lengths.

KS4 (Years 9-11) Key constructs in Biology (paper 1)

4.1 Cell Biology	4.2 Organisation
Cells can be classified as prokaryotic or eukaryotic.	The levels of organisation within multi-cellular organisms includes cells, tissues, organs and organ systems.
Animal and plant cells are made up of sub cellular structures.	Food is digested through a range of tissues and organs that form
Stem cells differentiate into specialised cells that are adapted to their function.	the digestive system.
Microscopes are used to look at microscopic organisms.	The presence of nutrients can be tested for using different qualitative reagents.
Mitosis is the process of cell division for growth and repair.	Enzymes are proteins of a specific shape which break
Stem cells can be used to treat some diseases.	down substrates into products. The heart is a muscle that acts as a double pump.
Substances such as water and oxygen, can move into and out of cells by either diffusion, osmosis or active transport.	The three types of blood vessels are adapted for specific roles within the circulatory system.
	Blood is made up of 4 components. Diseases can be communicable or non-communicable.
	Plants are organised into cells, tissues, organs and organ system like animals.

KS4 (Years 9-11) Key constructs in Biology (paper 1)

4.3 Infection and response

- Pathogens are microorganisms that cause disease.
- Communicable diseases are spread by 4 types of pathogens these are Viruses, Bacteria , Fungi and Protist.
- Our bodies have non-specific lines of defence to protect us from pathogens.
- Our specific defences come from our white blood cells.
- Bacteria can develop antibiotic resistance.
- Many drugs are extracted from plants and microorganisms.
- Vaccination prevents the onset of a disease.
- Antibiotics and painkillers have different roles in treating disease and easing symptoms.
- Drug trials test for efficacy, toxicity and dosage

4.4 Bioenergetics

- Photosynthesis is an endothermic reaction which takes in energy from the Sun.
- •
- The rate of photosynthesis is affected by factors including light intensity, concentration of CO2 and temperature.
- Respiration is an exothermic reaction which releases energy for the life processes.
- •
- The reactants and products of aerobic and anaerobic respiration are different depending on the presence of oxygen.
- - Metabolism is the sum of chemical reactions in an organism.
- - The body responds to exercise by increasing heart rate, breathing rate and breathing volume.

5.1 Atomic Structure and the Periodic Table

- An atom is the smallest part of an element that can exist.
- Atoms are made up of sub-atomic particles called protons, neutrons, and electrons.
- Ideas about atoms have changed over time and atomic models change based on experimental evidence.
- Elements can be chemically bonded together to make compounds.
- Mixtures (substance NOT chemically bonded) can be separated using physical processes such as filtration, evaporation/crystallation, simple distillation, fractional distillation, and chromatography.

- All the elements can be found on The Periodic Table.
- The elements in the periodic table are arranged in order of atomic (proton) number.
- •
- The number of protons, neutrons and electrons in an atom can be worked out from the information in the element box.
- •
- Elements with similar properties are in groups (vertical columns).
- •
- Horizontal rows of elements are called Periods.
- Non-metallic elements are on the right side of the Periodic Table, the others are all metallic elements.

5.2 Structure, Bonding & Properties of Matter

The three types of chemical bond are ionic, covalent and metallic Ionic bonding occurs between a metal and a non-metal atom; electrons are transferred Covalent bonding occurs between two non-metal atoms; electrons are shared. Metallic bonding occurs between atoms of a metal.

Ionic compounds are held together by strong electrostatic forces, forming giant ionic structures.

Covalent structures can be small molecules, polymers or giant covalent structures. Covalent bonds are very strong but small molecules and polymers have weak intermolecular forces.

Metals conduct heat and electricity due to delocalised electrons.

Metals form giant structures with strong bonds.

Alloys are mixtures of metals; they are harder than pure metals because different sized atoms disrupt the layers of atoms.

Carbon can form different structures; graphite, diamond, graphene and fullerenes.

5.3 Quantitative Chemistry

- Relative formula masses can be calculated and used in conservation of mass calculations.
- •
- The concentration of a solution is the mass (g) of solute in a given volume of solution (F) or the amount (M) of solute per dm3 (H)
- Whenever a measurement is made there is always some uncertainty about the results obtained.
- The mass of product depends upon the mass of limiting reactant.
- The mole is the unit for amount of substance.
- The number of particles in a substance can be found using the Avogadro constant.
- 6.02 × 1023 particles per mole.
- A mole can be the amount of atoms, molecules, ions or electrons.
- The Ar or Mr converted into grams is the mass of 1 mole of that substance.

5.4 Chemical Changes

- The reactivity series shows metals in order of reactivity.
- The reactivity of a metal is related to its tendency to form positive ions.
- Indicators are used to determine whether a solution is acidic or alkaline.
- Acids react with metals, bases and carbonates to produce salts.
- Neutralisation is the reaction between an acid and a base.
- Elements less reactive than Carbon can be extracted by Carbon reduction.
- Elements more reactive than Carbon can be extracted by electrolysis.
- Electrolysis uses electricity to break down electrolytes to form elements.
- The products of electrolysis can be predicted for a given electrolyte.
- To prepare a soluble metal salt, an insoluble metal oxide or carbonate is added to an acid, stirred, filtered, heated and dried

5.5 Energy Changes

- Energy is conserved in chemical reactions.
- •
- An exothermic reaction transfers energy to the surroundings.
- •
- An endothermic reaction takes in energy from the surroundings.
- •

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- Chemical reactions can be drawn as simple reaction profile diagrams.
- Energy must be supplied to break bonds.
- Energy is released when bonds are formed.

6.1 Energy

- Energy can be stored or transferred.
- •
- The law of conservation of energy states that energy cannot be created or destroyed only transferred.
- Specific heat capacity is the energy needed to increase the temperature of 1kg of a substance by 1 degree celcius.
- Power is a measure of work done or energy transferred in a given time.
- Efficiency is a measure of useful power/energy output against the total input.
- •
- Energy resources can be used to generate electricity.
- Energy resources can be renewable, these are infinite.
- •
- Energy resources can be non-renewable, these are finite resources.

6.2 Electricity

- Electrical circuits are drawn using symbols to represent components.
- Electric current is a flow of electric charge, measured in amps.
- •

•

- Potential difference is a measure of how much energy is transferred between two points in a circuit, measured in volts.
- Resistance is a measure of the opposition to current flow in a circuit, measured in ohms.
- Current through a component depends on both the resistance and potential difference.
- The resistance of an ohmic conductor remains constant as the current changes.
- The resistance of a filament lamp, diode, thermistor and an LDR changes as the current changes.
- Components can be connected in circuits in either series or parallel.
- Current, potential difference and resistance vary in series and parallel circuits.

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- Mains electricity is an alternating current (ac) supply, whereas batteries use direct current (dc).
- Most electrical appliances use a three-core cable consisting of a live, neutral and earth wire.
- •

•

- The power of an appliance is the rate that energy is transferred to it, or the rate that work is done, measured in watts.
- •
- The power of a device is related to the potential difference across it and the current through it.
- •
- The National Grid is a system of cables and transformers linking power stations to consumers.

KS4 (Years 9-11) Key constructs in Biology (paper 1)

4.1 Cell Biology

- Cell structure & sub-cellular structure functions (Eukaryotes Prokaryotes), cell differentiation starts with stem cells to form specialised cells. Cell division by mitosis. Cells, tissues, organs, organ systems
- Using a light microscope RPA & equation (electron microscope comparison)
- Movement of substances into & out of cells: diffusion, osmosis, active transport

4.2 Organisation

- Human digestive system & Qualitative food tests RPA
- Specific nature of enzymes (Lock & Key). Effect of pH on enzyme activity RPA
- Heart & blood vessels, blood components & functions & CHD
- Health definition, non-communicable & communicable diseases and their interaction. (Risk & causal factors)
- Plant organ system, plant tissues/functions, root hair cell, xylem & phloem adaptations to function.

4.3 Infection & Response

- Pathogens definition & 4 groups, examples of diseases
- Human non-specific defence systems & specific (immune) system responses.
- Vaccination, antibiotics & painkillers, discovery & development of new drugs

4.4 Bioenergetics

- Photosynthesis word & balanced symbol equation. Endothermic. Limiting factors. Light intensity RPA
- Respiration equations: Aerobic (cellular respiration), anaerobic in muscle cells, anaerobic in plant & yeast cells.

KS4 (Years 9-11) Key constructs in Biology (paper 2)

4.5 Homeostasis & response

- Homeostasis definition and control systems (receptors, coordination centres and effectors)
- Structure & function of the nervous system, reflex arc and reaction time RPA
- Endocrine (hormone) system, endocrine glands, blood glucose control
- Human reproductive hormones, contraception, infertility & IVF

4.6 Inheritance, variation & evolution

- Asexual and sexual reproduction, gametes and cell division by meiosis.
- DNA, the human genome, genetic inheritance (diagrams), inherited disorders Cystic Fibrosis (recessive) & Polydactyly (dominant).
- Variation (genetic, environment, both), sex determination
- Evolution by natural selection & the survival of the fittest, including evidence. Selective breeding.
- Classification of organisms; Linnaeus and Carl Woese .

4.7 Ecology key topics

- Ecosystems, communities, habitats, interdependence. Abiotic & biotic factors. Levels of organization, food chains, producers, photosynthesis
- Adaptations, extremophiles
- RPA Measure population size of a common species in a habitat (quadrat & transect line).
- How materials are cycled through an ecosystem; carbon cycle and water cycle (role of microorganisms in cycling carbon & mineral ions)
- Biodiversity and human activities affecting biodiversity (waste management, land use, deforestation, global warming)

5.1 Atomic structure & the periodic table

- Atoms, elements, compounds & mixtures. Separation of mixtures.
- Sub-atomic particles. Relative masses & charges. Atomic structure diagrams (energy levels/shells).
- First 20 elements: names, symbols, atomic (proton) number, relative atomic mass number.
- Development of atomic model & the periodic table.
- Metal and non-metal atoms/ions. Position of elements on the periodic table. Groups 1, 7 & 0.

5.2 Structure, bonding & the properties of matter

- Ionic bonding. Sodium chloride dot & cross diagram. Group number and the charge on ions.
- Ionic compounds, giant lattice structures and forces of attraction.
- Covalent bonding; small molecules, polymers and giant covalent structures. Dot and cross diagrams.
- Metallic bonding, delocalised electrons and electrical conductivity.
- Three states of matter, particle model diagrams. Changes of state. Strong bonds = high mp & bp. State symbols.

5.3 Quantitative chemistry

- Law of conservation of mass, balancing equations, relative formula mass.
- Mass changes when a reactant or product is a gas?
- Chemical measurements & uncertainty
- Chemical amounts are measured in moles (mol). (HT) Amounts of substances in equations (HT) Using moles to balance equations (HT)
- Limiting reactants (HT)
- Concentrations of solutions.

5.4 Chemical changes

- Metal oxides
- The reactivity series, extraction of metals and reduction. OILRIG (HT)
- Reactions of acids with metals, neutralisation of acids and salt production
- Soluble salts RPA preparing a pure dry sample of a soluble salt from an insoluble oxide or carbonate.
- pH scale & neutralisation, strong & weak acids (HT)
- Electrolysis process, electrolysis of molten ionic compounds, using electrolysis to extract metals, electrolysis of aqueous solutions

5.5 Energy changes

- Exothermic & endothermic reactions.
- RPA investigating the variables that can affect temperature changes in reacting solutions.
- Reaction profiles for endothermic & exothermic reactions.
- Energy change of reactions. Breaking bonds, making bonds, bond energies (HT)

5.6 Rate and extent of chemical change

- Calculating rates of reactions (g/s or cm³/s). Quantity of reactant used/time taken or quantity of product formed/time taken
- Draw rate of reaction graphs and calculate mean rate of reaction from graphs (straight line section)
- 5 factors which affect the rate of reaction
- RPA investigate how concentration affects rates of reaction (the volume of gas produced or involving a colour change)
- Collision theory: increasing the frequency and energy of particle collisions
- Reversible reactions. Definition and symbol.

5.7 Organic chemistry

- Crude oil and hydrocarbons (properties).
- Fractional distillation and petrochemicals.
- Cracking & alkenes.

5.8 Chemical analysis

- Chemically pure substances & their identification.
- Formulations and some uses.
- Paper chromatography & RPA
- Gas tests

5.9 Chemistry of the atmosphere

- Composition of today's atmosphere compared to Earth's early atmosphere (4.6 billion years)
- Atmosphere changed over time Why oxygen increased & carbon dioxide decreased
- CO₂ and CH₄ and global warming: interaction with short & long wavelength radiation contribute to the greenhouse effect?
- human activities that increase the amounts of greenhouse gases & global climate change effects
- Define carbon footprint. Reducing carbon footprint.
- Atmospheric pollutants and acid rain, global warming, global dimming & their potential impacts

5.10 Using resources

- Earth's resources, uses and sustainable development
- Obtaining potable water. Analysis & purification methods
- Waste water treatment
- Alternative methods of extracting metals (phytomining and bioleaching)
- Life cycle assessments (LCAs) of products
- Reducing the use of resources

6.1 Energy

- Energy stores & systems
- Changes in energy: kinetic energy, elastic potential energy, gravitational potential energy.
- Energy changes in systems. Specific heat capacity & RPA
- Power. Energy transfers in a system. Efficiency.
- National and global energy resources.

6.2 Electricity

- Circuit diagram symbols. Electrical charge & current. Q=It
- Current, resistance and potential difference. V=IR
- RPA investigating the factors which affect resistance.
- V-I sketch graphs for an ohmic device, filament lamp & a diode (RPA circuit diagrams)
- Components in a series circuit (I, V & R) and in a parallel circuit (I, V & R)
- Direct & alternating current. UK ac supply frequency & voltage (potential difference), wiring a plug. The National Grid
- Electrical power. P=VI. P=I²R Electrical energy transferred. E=Pt. E=QV.

6.3 The Particle model

Draw particle diagrams for a solid, liquid & a gas.

Density. Density=mass/volume

RPA. Determine the density of regular and irregular solid objects & liquids by determining volume first. Changes of state.

Internal energy.

Energy transferred for temperature change and specific heat capacity,

Energy transferred for a change of state and specific latent heat of fusion/vaporisation.

Particle motion in gases.

6.4 Atomic structure key topics

Structure of an atom. Radius of an atom (m).

Mass number, atomic number & isotopes.

Development of the model of the atom.

Radioactive decay and nuclear radiation. Alpha, beta & gamma radiation. Penetration, distance travelled in air, ionising capability.

Nuclear equations.

Random radioactive decay. Half-lives.

Radioactive contamination & irradiation.

KS4 (Years 9-11) Key constructs in Physics (paper 2)

6.5 Forces

- Scalar/vector, contact, non-contact forces including gravity and resultant forces
- Work done & energy transfer.
- Forces & elasticity
- Distance, displacement, speed (distance time relationship), velocity
- Acceleration. Newtons First, Second and Third Laws
- Forces & breaking, factors affecting stopping distances
- Momentum

6.6 Waves

- Transverse & longitudinal waves & their properties
- Electromagnetic waves & their properties
- Uses and applications of EM waves
- Absorption/radiation of IR radiation by different surfaces

6.7 Magnetism & electromagnetism

- Permanent & induced magnetism
- Poles of a magnet & magnetic fields
- Electromagnetism & solenoids
- The motor effect & Fleming's LH rule, electric motors (HT)

4.8 Space Physics (8463)

- Solar System
- Life cycle of a star
- Orbital motion, natural & artificial satellites
- Red shift