Cornwallis Academy
Ambitions for All

SMILE
SUCCESSFUL | MOTIVATED | INSPIRED | LEARNING | EXCITED & ENGAGED

GCSE Combined Science Trilogy

B1 Cells

Learning Objectives

- Identify and describe the structure of plant, animal, and bacterial cells.
- Understand the functions of organelles: nucleus, cytoplasm, cell membrane, mitochondria, chloroplasts, vacuoles.
- Use a microscope to observe cells and calculate magnification.
- Explain cell specialisation and differentiation.
- Describe transport across cell membranes: diffusion, osmosis, active transport.
- Understand cell division (mitosis) and its role in growth and repair.

Key Facts & Examples:

- **Magnification formula:** Magnification = Image size ÷ Actual size
- Diffusion: movement of particles down a concentration gradient.
- Osmosis: water moves from high water potential → low water potential.
- Active transport: requires energy (ATP).
- Mitosis: Prophase → Metaphase → Anaphase → Telophase.
- Examples: Red blood cells (no nucleus), root hair cells (specialised for absorption).

What previous knowledge is required?

- KS3 cell structures.
- Particle theory (for diffusion/osmosis).
- Basic microscopy skills.

How will this topic content help with future learning?

- Forms the foundation for B2 Organisation (tissues, organs, systems).
- Essential for understanding B4 Bioenergetics (respiration/photosynthesis).
- Provides knowledge for B6 Inheritance (cell division and DNA replication).

Common Misconceptions

All cells have a nucleus

- Reality: Some cells, like red blood cells, lose their nucleus when mature.

Osmosis and diffusion are the same

- Reality: Diffusion is the movement of all particles from high → low concentration; osmosis specifically refers to **water** across a semi-permeable membrane.

Enzymes are "used up" during reactions

- Reality: Enzymes are **biological catalysts** and are **reused**.

Bacteria are always harmful

- Reality: Many bacteria are **beneficial** (gut bacteria, nitrogen-fixing bacteria).

Cells are empty spaces with a "dot" nucleus

- Reality: Cells are highly structured with organelles and cytoplasm; the nucleus is just one part.

Mitosis happens only in humans

- Reality: **All eukaryotic cells** divide by mitosis for growth and repair.

Osmosis always requires solutes to move

- Reality: Only water moves in osmosis; solutes may be left behind.

Cell membranes are solid barriers

- Reality: Membranes are **semi-permeable and fluid**, allowing selective transport.

Diffusion is active transport

- Reality: Diffusion is **passive**; no energy is required.

All cells are the same size

- Reality: Cell sizes vary greatly; e.g., egg cells are much larger than bacteria.

National Curriculum / Specification

- AQA 8464 B1 Cell Biology.
- KS4 Biology: Cell structure, microscopy, transport, cell division.
- Required practicals: Microscopy, investigating osmosis.

B2 Organisation

Learning Objectives

- Describe tissues, organs, and organ systems.
- Explain digestive system and enzyme roles.
- Describe circulatory system and blood functions.
- Explain plant transport (xylem, phloem).

Key Facts & Examples:

- Enzymes: amylase (starch → sugar), protease (protein → amino acids), lipase (fat → glycerol + fatty acids).
- Heart: atria, ventricles, valves.
- Blood components: red cells, white cells, platelets, plasma.
- Plant transport: xylem (water), phloem (sugars).

What previous knowledge is required?

- B1 Cells
- Basic nutrition and organs

How will this topic content help with future learning?

- Links to **B4 Bioenergetics** (energy transport), **B5 Homeostasis** (blood glucose regulation).

Common Misconceptions

Xylem transports food

- Reality: Xylem **transports water and minerals**; phloem transports sugars.

All blood in veins is deoxygenated and in arteries is oxygenated

- Reality: Pulmonary artery carries **deoxygenated blood** to lungs; pulmonary vein carries **oxygenated blood** to the heart.

The heart is a pump that only pushes blood one way

- Reality: Valves ensure **unidirectional flow**, but the heart has **two separate pumps**: right (lungs) and left (body).

Enzymes are "digestion machines" that destroy food

- Reality: Enzymes **break large molecules into smaller molecules**; they do not "eat" food.

All enzymes work in the stomach

- Reality: Different enzymes work at **different pH and temperatures** (e.g., amylase in mouth/pancreas, pepsin in stomach).

Bile digests fat

- Reality: Bile **emulsifies fat** (increases surface area) but **does not chemically digest** it.

Plants get their food directly from soil

- Reality: Plants make **glucose via photosynthesis**; soil provides **minerals** only.

Arteries always carry blood at high pressure

- Reality: Pressure **drops in capillaries and veins**; veins have valves to prevent backflow.

All blood is red

- Reality: Blood is **red due to haemoglobin**, but plasma is pale yellow; oxygenated vs deoxygenated blood differs in shade.

Organ systems work independently

- Reality: Systems are **interdependent** (e.g., circulatory + digestive + respiratory).

National Curriculum / Specification

- AQA 8464 B2
- KS4: human/plant systems
- Required practical: enzyme investigations.

B3 Infection and response

Learning Objectives

- Identify pathogens: bacteria, viruses, fungi, protists.
- Describe immune response, antibodies, vaccines.
- Understand antibiotics and resistance.
- Plant disease and defence mechanisms.

Key Facts & Examples:

- Antibiotics: kill bacteria but not viruses.
- Vaccines: stimulate immune system.
- Skin, mucus, cilia, hydrochloric acid: first-line defence.
- Examples: measles (virus), salmonella (bacteria), rose black spot (fungus).

What previous knowledge is required?

- B1 Cells, B2 Organisation.

How will this topic content help with future learning?

- Foundation for **B5 Homeostasis**, **B6 Inheritance**, medical biology.

Common Misconceptions

All bacteria and viruses are harmful

- Reality: Many bacteria are **beneficial** (gut flora, nitrogen-fixing bacteria). Viruses can also be harmless in some contexts (e.g., bacteriophages used in research).

Antibiotics kill viruses

- Reality: Antibiotics **only target bacteria**; antiviral drugs are needed for viruses.

Vaccines cure diseases

- Reality: Vaccines **prevent infections** by stimulating the immune system; they do **not cure** an existing infection.

The body can produce new antibiotics for resistance

- Reality: Bacteria can **evolve resistance**, but the human body **cannot generate antibiotics**.

White blood cells attack any foreign object

- Reality: White blood cells target **specific pathogens** and produce antibodies specific to antigens.

All fungi are harmful

- Reality: Some fungi are useful (e.g., yeast in bread/alcohol, penicillin production).

Infections are always visible (symptoms appear immediately)

- Reality: Many infections are **asymptomatic** or have delayed onset.

Pathogens are only spread by direct contact

- Reality: Pathogens can be spread **through air, water, vectors, and contaminated surfaces**.

Immunity is permanent for all diseases

- Reality: Some immunity **can be temporary**; some pathogens mutate (e.g., flu virus).

Handwashing is only important for visibly dirty hands

- Reality: Handwashing **removes microbes** even if hands look clean; it's crucial to prevent disease transmission.

National Curriculum / Specification

- AQA 8464 B3
- KS4: infection, immunity
- Required practical: antimicrobial investigation.

B4 Bioenergetics

Learning Objectives

- Understand photosynthesis and factors affecting it.
- Describe aerobic and anaerobic respiration.
- Energy transfer in organisms.

Key Facts & Examples:

- Photosynthesis: $\mathbf{6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2}$
- Limiting factors: light intensity, CO_2, temperature.
- Respiration: glucose → energy (ATP).
- Aerobic: glucose + O_2 → CO_2 + H_2O + energy.
- Anaerobic: glucose → lactic acid + energy (humans).

What previous knowledge is required?

- B1 Cells, B2 Organisation.
- Cells, enzymes, gas exchange basics

How will this topic content help with future learning?

- Supports **B5 Homeostasis** (energy use), **B7 Ecology** (energy flow in ecosystems).

Common Misconceptions

Students often confuse:

- Respiration vs Breathing
- Photosynthesis vs Respiration equations
- Aerobic vs Anaerobic respiration
- Limiting factors in photosynthesis
- Where plant mass comes from
- Plants respire as well as photosynthesise
- Energy is transferred, not created

National Curriculum / Specification

- AQA 8464 B4
- KS4: photosynthesis, respiration, energy in biology
- Required practicals: light intensity and photosynthesis.

B5 Homeostasis and Response

Learning Objectives

- Nervous system: reflexes, synapses.
- Hormonal system: insulin, adrenaline.
- Blood glucose regulation.

Key Facts & Examples:

- Negative feedback controls body systems.
- Reflex arc: stimulus → receptor → CNS → effector → response.
- Blood glucose: insulin lowers, glucagon raises.

What previous knowledge is required?

- B2 Organisation, B4 Bioenergetics.

How will this topic content help with future learning?

- Links to **B6 Inheritance** (genetic disorders), medical biology, pharmacology.

Common Misconceptions

- **Nervous vs Hormonal control** – speed and duration are different.
- **Insulin vs glucagon** – complementary roles in blood glucose regulation.
- **Reflex vs voluntary actions** – reflexes bypass conscious control.
- **Kidneys do more than filter water** – they maintain ions, water, and pH.
- **Negative feedback is dynamic** – it restores balance, can increase or decrease a variable.

National Curriculum / Specification

- AQA 8464 B5
- KS4: control systems, homeostasis
- Required practical: reaction time investigations.

B6 Inheritance, variation and Evolution

Learning Objectives

- Structure of DNA, genes, chromosomes.
- Patterns of inheritance.
- Variation and evolution by natural selection.
- Fossils and selective breeding.

Key Facts & Examples:

- DNA: double helix, bases A-T, C-G.
- Alleles: dominant/recessive.
- Punnett squares for monohybrid crosses.
- Evolution: advantageous traits increase survival.

What previous knowledge is required?

- B1 Cells, B2 Organisation
- Cell division, reproduction

How will this topic content help with future learning?

- Basis for **B7 Ecology**, biotechnology, and A-level biology genetics.

Common Misconceptions

- Evolution occurs **over generations**, not in individuals.
- Variation arises from **genes and environment**.
- Mutations are **random**; natural selection is **non-random**.
- Fossils and selective breeding provide **evidence for evolution**.
- Dominant vs recessive alleles affect traits differently.
- Extinction can occur **independently of "strength"**.

National Curriculum / Specification

- AQA 8464 B6
- KS4: inheritance, variation, evolution
- Required practical: genetic crosses simulations.

B7 Ecology

Learning Objectives

- Ecosystems: abiotic & biotic factors.
- Food chains and webs.

- Nutrient cycles: carbon, water.
- Biodiversity and human impact.

Key Facts & Examples:

- Energy transfer efficiency: ~10% per trophic level.
- Decomposers recycle nutrients.
- Human impact: pollution, deforestation, climate change.

What previous knowledge is required?

- B4 Bioenergetics (energy flow)
- Photosynthesis, respiration

How will this topic content help with future learning?

- Environmental science, conservation biology, sustainability topics.

Common Misconceptions

- **Energy flow vs nutrient cycling** – energy is lost, nutrients are recycled.
- **Population changes** – ecosystems are dynamic, not static.
- **Human impact** – pollution, climate change, deforestation can alter ecosystems.
- **Decomposers** – vital for recycling nutrients from all dead matter.
- **Food chains vs food webs** – interconnected vs linear pathways.
- **Biomass and energy pyramids** – energy and biomass decrease at higher trophic levels.

National Curriculum / Specification

- AQA 8464 B7
- KS4: ecology and ecosystems
- Required practical: quadrat sampling, transects.

C1 Atomic Structure and the Periodic table

Learning Objectives

- Describe atomic structure (protons, neutrons, electrons).
- Explain isotopes and relative atomic mass.
- Understand electronic structure and the periodic table.
- Explain how elements are arranged by properties.

Key Facts & Examples:

- Proton = +1, neutron = 0, electron = -1.
- Atomic number = number of protons.
- Mass number = protons + neutrons.
- Isotopes = same protons, different neutrons.
- Electronic structure example: oxygen = 2,6.
- Group 1 = very reactive metals; Group 0 = noble gases (inert).

What previous knowledge is required?

- KS3 particles and elements.

How will this topic content help with future learning?

- Foundation for bonding (C2), reactions (C4), and quantitative chemistry (C3).

- Essential for understanding chemical properties.

Common Misconceptions

- Atoms are indivisible → actually made of **protons, neutrons, electrons**.
- Electrons are in the nucleus → actually in **shells/orbitals**.
- Protons and neutrons have the same charge → protons **+1**, neutrons **0**.
- Neutrons determine the element → **protons (atomic number)** do.
- Isotopes are different elements → isotopes are **same element, different neutrons**.
- All atoms of an element are identical → isotopes differ in **neutron number**.
- Mass number = atomic number → mass = **protons + neutrons**.
- Relative atomic mass is always a whole number → usually **decimal (average of isotopes)**.
- Electrons orbit like planets → electrons occupy **energy levels/shells**.
- Nucleus takes up most of the atom → nucleus is tiny; **most of the atom is empty space**.
- Atoms are created/destroyed in reactions → atoms are **rearranged**.
- Elements in the same period have similar properties → elements in the **same group** do.
- Group number = number of shells → group = **outer electrons**; period = **shells**.
- Noble gases are reactive → they are **very unreactive** (full outer shell).
- Group 1 metals less reactive down group → reactivity **increases**.
- Halogens more reactive down group → reactivity **decreases**.
- Periodic table always looked like modern → it **evolved over time**, Mendeleev left gaps.
- Metals and non-metals are randomly arranged → metals **left/centre**, non-metals **right**.

National Curriculum / Specification

- AQA 8464 C1
- KS4 atomic structure & periodic table.

C2 Bonding, structure and properties of matter

Learning Objectives

- Explain ionic, covalent, and metallic bonding.
- Relate structure to properties.
- Describe giant structures and molecules.

Key Facts & Examples:

- Ionic: metal + non-metal (NaCl).
- Covalent: non-metal + non-metal (H_2O, CO_2).
- Metallic: sea of delocalised electrons.
- Diamond = very hard, no conduction.
- Graphite = conducts electricity.

What previous knowledge is required?

- C1 atomic structure.

How will this topic content help with future learning?

- Essential for materials science and reactions in C4–C7.

Common Misconceptions

- All solids are the same → solids can be **giant lattice (ionic/covalent/metallic)** or **simple molecular**.
- Ionic compounds are made of molecules → ionic compounds form a **giant lattice of ions**, not discrete molecules.
- Covalent compounds conduct electricity → only **graphite** or ionic compounds in solution/molten conduct.
- Metals are soft → most metals are **strong and malleable**.
- Covalent bonds are weak → **strong bonds** between atoms in molecules or lattices.
- Electrons in metallic bonding are fixed → electrons are **delocalised**, allowing conductivity.
- All molecular compounds have low melting points → depends on **bonding and intermolecular forces**.
- Solids always conduct electricity → only **metallic or ionic (when molten/aqueous)** do.
- Liquids do not have particles in motion → particles **move past each other**.
- Gases do not exert pressure → gas particles **collide with container walls**, causing pressure.
- Covalent bonding only occurs in small molecules → **giant covalent structures** exist (diamond, graphite, silicon dioxide).
- All metals are shiny → depends on **surface and type of metal**.
- Ionic compounds dissolve in any solvent → only **polar solvents like water** dissolve them well.
- Covalent molecules are always soft → depends on **intermolecular forces** (e.g., diamond is extremely hard).
- Boiling/melting is due to breaking atoms → actually **bonds or intermolecular forces**.

National Curriculum / Specification

- AQA 8464 C2
- KS4 bonding and structure

C3 Quantitative Chemistry

Learning Objectives

- Use moles and balanced equations.
- Calculate reacting masses and concentration.
- Determine limiting reactants and yield.

Key Facts & Examples:

- Moles = mass ÷ Mr
- Concentration = moles ÷ volume (dm^3)
- Conservation of mass applies in reactions.

What previous knowledge is required?

- C1 atoms, KS3 maths (ratios, equations).

How will this topic content help with future learning?

- Essential for all chemistry calculations (C4–C10).
- Used in industry and lab work.

Common Misconceptions

- Mass is lost in chemical reactions → **mass is conserved in closed systems**.
- Atoms disappear during reactions → atoms are **rearranged, not destroyed**.
- Balanced equations mean equal masses → they show **correct ratios of particles**, not masses.
- Moles are the same as mass → moles measure **amount of substance**, not weight.

- You can add concentrations directly without units → units must be **consistent (mol/dm³, dm³, g)**.
- Relative formula mass is the same as mass in grams → Mr is a **ratio value**, not a measured mass.
- 1 mole always equals 1 gram → 1 mole depends on **Mr of the substance**.
- You always need a calculator for moles → some simple mole ratios can be done **mentally using equations**.

National Curriculum / Specification

- AQA 8464 C3
- KS4 quantitative chemistry

C4 Chemical Changes

Learning Objectives

- Reactivity series and displacement reactions.
- Acids, bases, salts, neutralisation.
- Electrolysis of ionic compounds.

Key Facts & Examples:

- Acid + base → salt + water.
- More reactive metal displaces less reactive metal.
- Electrolysis splits ionic compounds using electricity.
- Oxidation = loss of electrons.

What previous knowledge is required?

- C1–C3.

How will this topic content help with future learning?

- Links to industrial chemistry and C6 rates/equilibrium.

Common Misconceptions

- Acids always burn or are dangerous → many acids are **weak and safe (e.g. vinegar)**.
- Neutralisation always produces gas → it produces **salt + water (sometimes no gas)**.
- All acids have the same strength → acids vary in **strength and concentration**.
- Strong acid = concentrated acid → strength is about **ionisation**, not amount.
- Alkalis are just "opposite acids" → alkalis are **bases that dissolve in water and produce OH^- ions**.
- Metals in acids always explode → reaction rate depends on **reactivity of metal**.
- Hydrogen is only produced in all acid reactions → only with **metals**, not all reactions.
- Electrolysis is the same as heating → electrolysis uses **electric current**, not heat.
- Ions are only formed in electrolysis → ions exist in **ionic compounds all the time**.
- Atoms gain or lose protons in reactions → chemical reactions involve **electrons only**.
- Oxidation is only adding oxygen → oxidation is **loss of electrons (OIL RIG)**.
- Reduction is only removing oxygen → reduction is **gain of electrons**.
- Metals always form positive ions → generally true, but depends on **electron loss in reactions**.
- Displacement reactions are random → they follow the **reactivity series**.
- All salts are neutral → salts can be **acidic, neutral, or alkaline** depending on parent acid/base.
- Electrolysis only happens in molten substances → it can also occur in **aqueous solutions**.
- More reactive metals react faster in all conditions → rate depends on **acid, temperature, surface area too**.

- Acid strength and pH are the same thing → pH measures **hydrogen ion concentration**, not just strength.

National Curriculum / Specification

- AQA 8464 C4
- KS4 chemical reactions

C5 Energy Changes

Learning Objectives

- Exothermic and endothermic reactions.
- Energy profiles and bond energy calculations.

Key Facts & Examples:

- Exothermic: releases energy (combustion).
- Endothermic: absorbs energy (thermal decomposition).
- Breaking bonds = energy absorbed.
- Making bonds = energy released.

What previous knowledge is required?

- C3 calculations, C4 reactions.

How will this topic content help with future learning?

- Essential for kinetics (C6) and industrial chemistry.

Common Misconceptions

- Exothermic means "hot" → exothermic **releases energy**; may not always feel hot.
- Endothermic means "cold" → endothermic **absorbs energy**; may not always feel cold.
- Energy is created or destroyed → energy is **conserved**, only transferred.
- Activation energy is the same as total energy → it is the **minimum energy needed to start a reaction**.
- Reversible reactions always go to completion → reversible reactions reach **equilibrium**.
- Bonds are broken to release energy → **breaking bonds requires energy**; **forming bonds releases energy**.
- Exothermic reactions produce heat only → they **release energy in any form** (light, sound, heat).
- Endothermic reactions absorb only heat → they absorb **energy in general**, not just heat.
- Catalysts provide energy → catalysts **lower activation energy** but are not consumed.
- Exothermic reactions are always fast → reaction speed depends on **temperature, concentration, and surface area**, not just energy change.

National Curriculum / Specification

- AQA 8464 C5
- KS4 energy changes

C6 Rate and extent of chemical reactions

Learning Objectives

- Collision theory.
- Factors affecting reaction rates.
- Dynamic equilibrium in reversible reactions.

Key Facts & Examples:

- Rate increases with temperature, concentration, surface area, catalysts.
- Equilibrium: forward and reverse rates equal.
- Catalysts lower activation energy.

What previous knowledge is required?

- C4 reactions, C5 energy.

How will this topic content help with future learning?

- Links to industrial chemistry

Common Misconceptions

- Faster reactions always produce more product → **rate affects speed, not total amount**.
- High temperature always makes reactions safer → higher temperature usually makes reactions **faster and more energetic**, not safer.
- Catalysts increase the amount of product → catalysts **only increase rate, not yield**.
- Equilibrium means reactions stop → at equilibrium, reactions are **still happening forward and backward**.
- At equilibrium, amounts are equal → equilibrium means **rates are equal, not concentrations**.
- Only temperature affects rate → rate is affected by **temperature, concentration, surface area, and catalysts**.
- Crushing solids changes the chemical nature → it only increases **surface area**, not substance identity.
- Gases don't affect reaction rate → gas concentration/pressure **affects collision frequency**.
- Reactions in equilibrium cannot be changed → changing conditions **shifts equilibrium position**.
- More collisions always mean successful reactions → collisions must have **enough energy and correct orientation**.

National Curriculum / Specification

- AQA 8464 C6
- KS4 rates and equilibrium

C7 Organic Chemistry

Learning Objectives

- Crude oil and fractional distillation.
- Alkanes and alkenes.
- Cracking and polymers

Key Facts & Examples:

- Hydrocarbons = hydrogen + carbon only.
- Alkanes = single bonds.
- Alkenes = double bonds (reactive).
- Cracking produces smaller useful molecules.

What previous knowledge is required?

- C2 bonding, C3 calculations.

How will this topic content help with future learning?

- Fuels, materials science, polymers industry.

Common Misconceptions

- Organic chemistry is only about living things → it studies **carbon-containing compounds**, not just biological ones.
- All hydrocarbons are liquids → hydrocarbons can be **gases, liquids, or solids** depending on chain length.
- Saturated = safe → "saturated" just means **single bonds only**, not safer or healthier.
- Unsaturated = double bonds make them reactive → true, but not all unsaturated compounds are highly reactive under normal conditions.
- Cracking produces energy → cracking is **a physical/chemical breakdown**; energy is absorbed for bond breaking.
- Combustion of hydrocarbons only produces energy → also produces **CO_2 and H_2O**, and possibly pollutants.
- All organic reactions are slow → some reactions can be **very fast**, especially with catalysts.

National Curriculum / Specification

- AQA 8464 C7
- KS4 organic chemistry

C8 Chemical Analysis

Learning Objectives

- Chromatography and Rf values.
- Gas tests and flame tests.
- Purity and instrumental analysis.

Key Facts & Examples:

- Oxygen = relights glowing splint.
- Hydrogen = squeaky pop.
- CO_2 = limewater turns milky.
- Rf = distance moved ÷ solvent front.

What previous knowledge is required?

- C1–C3.

How will this topic content help with future learning?

- Forensics, medicine, industrial quality control.

Common Misconceptions

- Pure substances and mixtures are the same → **pure substances have fixed melting/boiling points**, mixtures do not.
- Chromatography separates only liquids → it separates **components based on solubility and mobility**, not limited to liquids.
- Rf values are constant everywhere → Rf values **depend on solvent, temperature, and method**.
- Filtration removes all dissolved substances → filtration **only removes insoluble solids**.
- Crystallisation always produces pure crystals → **impurities may remain**, sometimes multiple recrystallisations needed.
- Distillation always produces pure water → depends on **boiling points and careful setup**.
- Tests for ions always give clear results → some ions give **similar colors or precipitates**, need confirmatory tests.
- Flame tests are quantitative → flame tests are **qualitative, only detect presence**.

- Paper chromatography tells you concentrations → it **only separates and identifies substances**, not their amount.
- Mixtures don't have chemical properties → mixtures **still contain substances with their individual properties**.

National Curriculum / Specification

- AQA 8464 C8
- KS4 chemical analysis

C9 Chemistry of the Atmosphere

Learning Objectives

- Composition and evolution of atmosphere.
- Greenhouse gases and climate change.
- Pollutants and their effects.

Key Facts & Examples:

- Early atmosphere = CO_2, methane, ammonia.
- Greenhouse gases trap heat.
- CO_2 is not the only greenhouse gas (methane, water vapour).

What previous knowledge is required?

- C4 combustion, C7 hydrocarbons.

How will this topic content help with future learning?

- Environmental science and sustainability.

Common Misconceptions

- The atmosphere has always been the same → Earth's atmosphere has **changed over time**.
- Oxygen has always been the most abundant gas → early atmosphere had **very little oxygen**.
- Carbon dioxide is only harmful → CO_2 is **essential for photosynthesis** but harmful in excess.
- The greenhouse effect is bad → the **natural greenhouse effect is necessary for life**.
- Global warming and greenhouse effect are the same → greenhouse effect is **natural**, global warming is **enhanced by human activity**.
- Pollution only affects air quality → pollution also affects **water, soil, and ecosystems**.
- Acid rain only damages plants → it also damages **buildings, soil, and aquatic life**.
- Oxygen in the atmosphere comes mainly from volcanoes → most oxygen is produced by **photosynthesis**.
- Nitrogen is unimportant because it is unreactive → nitrogen is **essential in proteins and DNA via the nitrogen cycle**.
- Climate change is only caused by CO_2 → other gases like **methane and water vapour also contribute**.

National Curriculum / Specification

- AQA 8464 C9
- KS4 atmosphere chemistry

C10 Using Resources

Learning Objectives

- Finite vs renewable resources.

- Water treatment and sewage processes.
- Life cycle assessment and recycling.

Key Facts & Examples:

- Potable water = safe to drink.
- LCA compares environmental impact.

What previous knowledge is required?

- C1–C9 chemistry foundations.

How will this topic content help with future learning?

- Sustainability, engineering, environmental science.

Common Misconceptions

- All water is safe to drink → water must be **treated and tested** before drinking.
- Potable water is pure → it is **safe to drink**, but may contain dissolved minerals.
- Freshwater is unlimited → freshwater is a **limited resource**, not evenly distributed.
- Metals are naturally pure → metals are often **extracted from ores and refined**.
- Recycling metals is optional → recycling **saves energy and resources** and reduces environmental impact.
- All materials are sustainable → some require **finite resources or energy-intensive processes**.
- Life cycle assessment is always precise → LCA **gives approximate environmental impacts**, not exact numbers.
- Desalination is cheap and unlimited → desalination is **expensive and energy-intensive**, not a limitless solution.

National Curriculum / Specification

- AQA 8464 C10
- KS4 using resources

P1 Energy

Learning Objectives

- Describe energy stores (kinetic, thermal, chemical, gravitational, elastic, nuclear).
- Explain energy transfers (mechanical, electrical, heating, radiation).
- Calculate work done, power, and efficiency.
- Apply conservation of energy principles.

Key Facts & Examples:

- Work done: $W = F \times d$ (force × distance).
- Kinetic energy: $KE = \frac{1}{2}mv^2$.
- Gravitational potential energy: $GPE = mgh$.
- Efficiency = $\frac{useful\ energy}{total\ energy} \times 100\%$.
- Energy cannot be created or destroyed, only transferred.

What previous knowledge is required?

- KS3 energy concepts, basic forces.

How will this topic content help with future learning?

- Foundation for electricity (P2), waves (P6), motion (P5).

Common Misconceptions

- Energy can be created or destroyed → **energy is conserved**, only transferred or transformed.
- Objects "contain" energy → objects **store energy in forms** (kinetic, chemical, gravitational, etc.), not as a substance.
- Kinetic energy always equals potential energy → KE and PE **depend on motion and position** separately.
- Energy transfer always produces movement → energy can transfer as **heat, light, sound, or electrical energy**, not just motion.
- Machines create energy → machines **transfer or transform energy**, they do not create it.
- Heat always flows from cold to hot → heat **flows from hot to cold spontaneously**.
- Fuel is energy → fuel **stores chemical energy** that is released in reactions.
- Efficiency can be over 100% → efficiency **cannot exceed 100%**; energy is lost as waste heat.
- Energy is only needed when something moves → energy can be **stored (e.g., chemical, elastic, gravitational)** even if not moving.
- Power and energy are the same → power = **rate of energy transfer**, not total energy.

National Curriculum / Specification

- AQA 8464 P1
- KS4: energy, work, power

P2 Electricity

Learning Objectives

- Explain current, voltage, resistance.
- Series and parallel circuits.
- Calculate electrical power and energy transferred.
- Understand domestic electricity, mains supply, and safety.

Key Facts & Examples:

- Ohm's Law: $V=I\times R$
- Power: $P=V\times I$I
- Energy transferred: $E=P\times$t
- Series: current same, voltage shared.
- Parallel: voltage same, current shared.

What previous knowledge is required?

- P1 energy, particle theory (P3).

How will this topic content help with future learning?

- Foundation for P7 Magnetism & Electromagnetism, circuits in Physics & Engineering.

Common Misconceptions

- Current is used up in a circuit → **current is conserved** in a series circuit.
- Batteries store current → batteries store **chemical energy**, not current.
- Voltage is used up in a circuit → voltage is **shared in series circuits**, not used up.
- Bigger voltage means more current always → current depends on both **voltage and resistance**.

- Electricity is electrons moving fast like bullets → electrons **drift slowly** through a conductor.
- All materials conduct electricity → only **conductors with free electrons/ions** conduct well.
- Resistance is always bad → resistance is useful (e.g. **heaters, lamps, safety devices**).
- Parallel circuits use more current from each component equally → current **splits between branches**.
- Current is the same everywhere in all circuits → current is only the same in **series circuits**.
- Power and energy are the same → power is the **rate of energy transfer**, not total energy.

National Curriculum / Specification

- AQA 8464 P2
- KS4 electricity

Topic Title: P3 Particle model of matter

Learning Objectives

- Describe solids, liquids, gases using the particle model.
- Explain density, pressure.
- Understand internal energy and state changes.
- Apply specific heat capacity and specific latent heat calculations.

- Density: $\rho = \frac{m}{V}$
- Pressure in gases: increases with temperature or decreases volume.
- Specific heat capacity: $\Delta E = mc\Delta\theta$
- Energy required for melting/boiling: $E = mL$

What previous knowledge is required?

- KS3 particle model, basic energy (P1).

How will this topic content help with future learning?

- Foundation for P4 Atomic Structure, P5 Forces, P6 Waves.

Common Misconceptions

- Particles are touching in all states → in gases, particles are **far apart**.
- Particles change size when a substance changes state → particle size **does not change**.
- Solids have no particle movement → particles in solids **vibrate in fixed positions**.
- Gases have no mass → gas particles **have mass and exert pressure**.
- Heating makes particles bigger → heating increases **particle energy and movement**, not size.
- Temperature measures heat → temperature measures **average kinetic energy of particles**.
- Melting and boiling break particles apart → they only **overcome forces between particles**, not atoms.
- Liquids are compressible → liquids are **very difficult to compress** because particles are close.
- Pressure in gases is caused by heat only → pressure is caused by **collisions of particles with container walls**.
- Diffusion only happens in gases → diffusion happens in **all states of matter**, just fastest in gases.

National Curriculum / Specification

- AQA 8464 P3
- KS4 particle model and states of matter

Cornwallis Academy
Ambitions for All

SMILE
SUCCESSFUL | MOTIVATED | INSPIRED | LEARNING | EXCITED & ENGAGED

P4 Atomic Structure

Learning Objectives

- Describe structure of atoms, isotopes, and ions.
- Explain radiation types: alpha, beta, gamma.
- Calculate half-life and radioactive decay rates.
- Understand uses and dangers of radiation

Key Facts & Examples:

- Proton = +1, neutron = 0, electron = -1.
- Atomic number = protons; Mass number = protons + neutrons.
- Half-life: time for half the nuclei to decay.
- Uses: medical imaging, carbon dating, smoke detectors.

What previous knowledge is required?

- P3 particle model, C1 Atomic Structure.

How will this topic content help with future learning?

- Nuclear physics, radiation safety, energy generation.

Common Misconceptions

- Atoms are indivisible → atoms contain **protons, neutrons, and electrons**.
- Radiation only comes from man-made sources → radiation is also **naturally occurring**.
- All radiation is the same → alpha, beta, and gamma radiation have **different properties and penetration**.
- Radiation always travels in straight lines → some forms can be **deflected by magnetic or electric fields**.
- Radiation is always dangerous → it depends on **type, dose, and exposure**.
- Alpha particles are the most penetrating → alpha particles are **least penetrating** but most ionising.
- Gamma rays are the most ionising → gamma rays are **least ionising** but most penetrating.
- Radioactive decay can be controlled → it is **random and spontaneous**.
- Radiation only affects living things → radiation can also **damage materials and equipment**.
- Half-life means the radiation stops → half-life is the **time for half the nuclei to decay**, not complete decay.

National Curriculum / Specification

- AQA 8464 P4
- KS4 radioactivity, nuclear physics

P5 Forces

Learning Objectives

- Describe different forces: weight, friction, drag, tension, normal contact.
- Apply Newton's laws.
- Calculate resultant force, moments, pressure, and momentum.
- Understand motion graphs.

Key Facts & Examples:

- Weight: $W = mg$
- Momentum: $p = mv$
- Pressure in liquids: $P = \rho gh$
- Moments: $M = F \times d$
- Newton's 2nd law: $F = ma$

What previous knowledge is required?

- P1 energy, KS3 motion.

How will this topic content help with future learning?

- Mechanics, engineering, energy transfer, P7 electromagnetism.

Common Misconceptions

- Heavier objects fall faster → in a vacuum, **all objects fall at the same rate**.
- A force is needed to keep something moving → objects move at constant velocity with **no resultant force**.
- Speed and velocity are the same → velocity includes **direction**, speed does not.
- Mass and weight are the same → mass is **amount of matter**, weight is a **force (W = mg)**.
- Forces only act when objects are moving → forces can act on **stationary objects** too.
- Friction is always bad → friction is **useful** (walking, brakes, gripping).
- Resultant force is always zero in motion → non-zero resultant force causes **acceleration or deceleration**.
- Objects in space have no gravity → gravity acts **everywhere**, just weaker with distance.

National Curriculum / Specification

- AQA 8464 P5
- KS4 motion, forces, momentum

P6 Waves

Learning Objectives

- Describe transverse and longitudinal waves.
- Calculate wave speed, frequency, wavelength.
- Explain EM spectrum and its uses.

Key Facts & Examples:

- Wave equation: $v=f\lambda$
- Sound = longitudinal; Light = transverse.
- EM spectrum: radio → microwave → infrared → visible → UV → X-ray → gamma.
- Applications: communications, medical imaging, heating.

What previous knowledge is required?

- P1 energy, P3 particle model.

How will this topic content help with future learning?

- Communication technology, EM applications.

Common Misconceptions

- Waves transport matter → waves **transfer energy, not matter**.

- Sound can travel in a vacuum → **sound needs a medium**; light does not.
- Light always travels slower in all materials → speed depends on the **medium**; light is fastest in a vacuum.
- Frequency changes when a wave moves between mediums → **frequency stays the same**, wavelength changes.
- Amplitude affects speed → amplitude affects **energy of the wave**, not speed.
- All waves are the same → there are **transverse and longitudinal waves** with different particle motions.
- Waves bend because they hit objects → bending (refraction) occurs due to **speed change in a different medium**.
- Electromagnetic waves need a medium → EM waves **can travel through a vacuum**.
- Sound waves are transverse → sound waves are **longitudinal**, particles oscillate parallel to energy transfer.

National Curriculum / Specification

- AQA 8464 P6
- KS4 wave properties, EM spectrum

Topic Title: P7 Magnetism and electromagnetism

Learning Objectives

- Describe magnetic fields and field patterns.
- Explain forces on current-carrying wires.
- Understand motors.
- Explain electromagnetic induction.

Key Facts & Examples:

- Right-hand rule for force direction.
- Electromagnetic induction = voltage induced when a wire moves in a magnetic field.
- Transformers: step-up and step-down for power transmission.
- Applications: electric motors, power stations, MRI scanners.

What previous knowledge is required?

- P2 electricity, P5 forces.

How will this topic content help with future learning?

- Power generation, electrical engineering, EM applications.

Common Misconceptions

- Only certain materials are affected by magnets → only **ferromagnetic materials (iron, nickel, cobalt)** are strongly affected.
- Magnetic fields are visible lines → field lines are **invisible representations** of field direction and strength.
- Magnetic force only works when magnets touch → magnetic forces act **at a distance**.
- All metals are magnetic → most metals (e.g. aluminium, copper) are **not magnetic**.
- Electromagnets are always on → electromagnets only work when **current flows**.
- Increasing current always makes a motor faster instantly → speed depends on **current, load, and resistance**.
- Generators produce electricity from nothing → generators **convert mechanical energy into electrical energy**.

- Magnetic field strength is the same everywhere → fields are **strongest near poles and weaker further away**.

National Curriculum / Specification

- AQA 8464 P7
- KS4 magnetism, EM induction