

Grade 5 skills checklist

149 skills that set grade 5 apart. Do the lists for the grades below first. Tick each one when you can do it.

Atomic structure and the periodic table

- ☐ **Write word equations for reactions** Reactants on the left, products on the right, joined by an arrow, e.g. magnesium + oxygen → magnesium oxide. (Atoms, elements and compounds)
- ☐ **Describe simple distillation** The solvent boils off, is cooled and condensed in a condenser, and is collected, leaving the dissolved solid behind. (Mixtures)
- ☐ **Describe fractional distillation** Liquids with different boiling points are separated using a fractionating column; the lowest boiling point liquid is collected first. (Mixtures)
- ☐ **Describe the nuclear model** A tiny, positively charged nucleus that contains almost all the mass, with electrons outside it. (Development of the model of the atom)
- ☐ **Explain why atoms have no overall charge** The number of electrons equals the number of protons, so the charges cancel. (Relative charges of subatomic particles)
- ☐ **Identify an element from its proton number** Different elements have different numbers of protons, so the atomic number tells you the element. (Relative charges of subatomic particles)
- ☐ **Define isotopes** Atoms of the same element with different numbers of neutrons: same atomic number, different mass number. (Size and mass of atoms)
- ☐ **Recall the sizes of atoms and nuclei** Atom radius about 0.1 nm (1×10^{-10} m); nucleus radius less than 1/10 000 of that (about 1×10^{-14} m). (Size and mass of atoms)
- ☐ **Calculate A_r for two isotopes** Multiply each mass number by its percentage abundance, add the results, then divide by 100. (Relative atomic mass)
- ☐ **Explain why A_r is rarely whole** It is an average of isotopes with different mass numbers, weighted by how common each one is. (Relative atomic mass)
- ☐ **Link electronic structure to group and period** Outer electrons = group number (Groups 1 to 7); number of occupied shells = period. (Electronic structure)
- ☐ **Identify an element from its electronic structure** Add up the electrons to get the atomic number, e.g. 2,8,5 is 15, which is phosphorus. (Electronic structure)
- ☐ **Explain why group members react similarly** They have the same number of electrons in their outer shell. (The periodic table)
- ☐ **Link position to electronic structure** Group number = outer electrons (Groups 1 to 7); period = number of occupied shells. (The periodic table)
- ☐ **Describe what Mendeleev did** He left gaps for undiscovered elements and changed the order of some elements to fit their properties. (Development of the periodic table)
- ☐ **Compare the oxides of metals and non-metals** Metal oxides are basic; non-metal oxides are usually acidic. (Metals and non-metals)

- ☐ **Explain their unreactivity using electrons** Their atoms have stable arrangements of electrons: a full outer shell of 8 (2 for helium). (Group 0)

- ☐ **Describe the boiling point trend** Boiling points increase going down the group, as relative atomic mass increases. (Group 0)

- ☐ **Write equations for their reactions** With water, oxygen and chlorine, e.g. $2K + 2H_2O \rightarrow 2KOH + H_2$. (Group 1)

- ☐ **Describe the compounds halogens form** Ionic compounds with metals (halide ions, $1-$); covalent molecules with non-metals, e.g. HCl. (Group 7)

- ☐ **Predict whether a displacement reaction happens** A more reactive halogen displaces a less reactive one from a solution of its salt. (Group 7)

- ☐ **Compare reactivity with oxygen, water and halogens** Group 1 metals react vigorously; transition metals react slowly, or not at all, at room temperature. (Comparison with Group 1 elements)

- ☐ **Give examples of coloured compounds** e.g. copper(II) sulfate solution is blue; iron(III) compounds are orange-brown. (Typical properties)

- ☐ **Give examples of transition metal catalysts** Iron in the Haber process; nickel for adding hydrogen to alkenes; manganese(IV) oxide for decomposing hydrogen peroxide. (Typical properties)

Bonding, structure and the properties of matter

- ☐ **Decide the bond type from a formula** Use the periodic table to decide whether each element in, for example, KBr, SO_2 or Zn is a metal or a non-metal. (Chemical bonds)

- ☐ **Write the electronic structure of an ion** For example, Na (2,8,1) becomes Na^+ (2,8) and O (2,6) becomes O^{2-} (2,8). (Ionic bonding)

- ☐ **Draw dot and cross diagrams for ionic compounds** Show each ion in square brackets with its charge, using dots and crosses for electrons from different atoms. (Ionic bonding)

- ☐ **State that the forces act in all directions** Each ion is attracted to all the oppositely charged ions around it, throughout the lattice. (Ionic compounds)

- ☐ **Recognise an ionic structure from a diagram** Look for a regular lattice of two types of ion, often labelled with charges, and no separate molecules. (Ionic compounds)

- ☐ **Draw dot and cross diagrams for simple molecules** Hydrogen, chlorine, hydrogen chloride, water, ammonia and methane, which have single bonds only. (Covalent bonding)

- ☐ **Describe the metallic bond** Strong electrostatic attraction between positive metal ions and the shared delocalised electrons. (Metallic bonding)

- ☐ **Predict states from melting and boiling points** Below the melting point: solid; between the melting and boiling points: liquid; above the boiling point: gas. (The three states of matter)

- ☐ **Add state symbols to a simple equation** For example, $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$. (State symbols)

- ☐ **Explain high melting points using electrostatic forces** A lot of energy is needed to overcome the many strong electrostatic forces between oppositely charged ions. (Properties of ionic compounds)

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- ☐ **Explain low boiling points using intermolecular forces** Only weak intermolecular forces must be overcome, which needs little energy. (Properties of small molecules)
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- ☐ **Describe the bonds in a polymer chain** The atoms in each chain are linked to each other by strong covalent bonds. (Polymers)
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- ☐ **Recognise a polymer from a diagram** Look for a repeating unit in brackets with bonds through the brackets and n after them. (Polymers)
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- ☐ **Explain their very high melting points** Many strong covalent bonds must be broken, which needs a lot of energy. (Giant covalent structures)
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- ☐ **Explain why most metals have high melting points** Giant structures with strong metallic bonding need a lot of energy to overcome. (Properties of metals and alloys)
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- ☐ **Explain why pure metals are soft** The layers of atoms can slide over each other easily. (Properties of metals and alloys)
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- ☐ **Explain electrical conduction in metals** The delocalised electrons are free to move through the structure, carrying charge. (Metals as conductors)
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- ☐ **Explain why diamond is very hard** Many strong covalent bonds hold the atoms rigidly in a 3D network. (Diamond)
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- ☐ **Explain diamond's very high melting point** A lot of energy is needed to break the many strong covalent bonds. (Diamond)
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- ☐ **Explain why graphite is soft and slippery** There are no covalent bonds between the layers, so the layers can slide over each other. (Graphite)
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- ☐ **Give uses of fullerenes and nanotubes** Fullerenes: drug delivery, lubricants, catalysts; nanotubes: nanotechnology, electronics and strengthening materials. (Graphene and fullerenes)
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- ☐ **Convert between nanometres and metres** $1\text{ nm} = 1 \times 10^{-9}\text{ m}$, so $50\text{ nm} = 5 \times 10^{-8}\text{ m}$. (Sizes of particles and their properties)
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- ☐ **Classify particles as nano, fine or coarse** Nano 1–100 nm; fine (PM_{2.5}) 100–2500 nm; coarse (PM₁₀) 2500–10 000 nm. (Sizes of particles and their properties)
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- ☐ **Give advantages of using nanoparticles** Their high surface area to volume ratio makes them effective, so smaller quantities are needed. (Uses of nanoparticles)
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Quantitative chemistry

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- ☐ **Balance a symbol equation** Change only the big numbers in front of formulae until every element has the same number of atoms on both sides. (Conservation of mass and balanced equations)
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- ☐ **Calculate M_r for formulae with brackets** Multiply everything inside the bracket, e.g. $\text{Ca}(\text{OH})_2 = 40 + 2 \times (16 + 1) = 74$. (Relative formula mass)
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- ☐ **Explain why a heated metal gains mass** Oxygen atoms from the air combine with the metal, so the metal oxide has a greater mass than the metal. (Mass changes when a reactant or product is a gas)
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- ☐ **Identify an anomalous result** A result that clearly does not fit the pattern of the others; leave it out of the mean. (Chemical measurements and uncertainty)
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- ☐ **Calculate concentration in g/dm³** Concentration = mass of solute (g) ÷ volume of solution (dm³).
(Concentration of solutions)
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- ☐ **Calculate percentage yield** % yield = mass of product actually made ÷ maximum theoretical mass × 100.
(Percentage yield)
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- ☐ **Give reasons why yield is below 100%** The reaction is reversible, some product is lost when it is separated, or some reactants react in unexpected ways. (Percentage yield)
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- ☐ **Calculate atom economy from an equation** Atom economy = M_r of desired product ÷ sum of M_r of all reactants × 100. (Atom economy)
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Chemical changes

- ☐ **Identify what is oxidised or reduced** In an equation, the substance that gains oxygen is oxidised and the substance that loses oxygen is reduced. (Metal oxides)
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- ☐ **Deduce an order of reactivity from results** The more vigorous the reaction (more bubbles, bigger temperature rise), the more reactive the metal. (The reactivity series)
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- ☐ **Predict whether a displacement reaction happens** A metal displaces another metal from its compound only if it is more reactive. (The reactivity series)
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- ☐ **Write equations for reduction with carbon** For example, $2\text{ZnO} + \text{C} \rightarrow 2\text{Zn} + \text{CO}_2$. (Extraction of metals and reduction)
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- ☐ **Tell the difference between bases and alkalis** A base neutralises an acid; an alkali is a base that dissolves in water, such as a soluble metal hydroxide. (Neutralisation and salt production)
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- ☐ **Explain why excess solid is added** Excess solid makes sure all the acid reacts, so the salt solution contains no leftover acid. (Soluble salts)
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- ☐ **Tell when the solid is in excess** Solid stays undissolved at the bottom, and for a carbonate the fizzing stops. (Soluble salts)
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- ☐ **Name the ions in acids and alkalis** Acids produce H^+ ions in water and alkalis produce OH^- ions in water. (The pH scale and neutralisation)
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- ☐ **Compare universal indicator with a pH probe** A pH probe gives a more precise numerical reading; universal indicator gives an approximate value from a colour. (The pH scale and neutralisation)
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- ☐ **Describe the pH change during neutralisation** As alkali is added to acid, the pH rises to 7 at neutralisation and above 7 when alkali is in excess. (The pH scale and neutralisation)
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- ☐ **Describe how to carry out a titration** Add acid from a burette to a measured volume of alkali with indicator until the colour just changes. (Titrations)
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- ☐ **Choose concordant results and find the mean** Use titres within 0.10 cm^3 of each other and leave out the rough titre. (Titrations)
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- ☐ **Predict which electrode each ion moves to** Positive ions move to the cathode and negative ions move to the anode. (The process of electrolysis)
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- ☐ **Describe what is seen at each electrode** For lead bromide, silvery lead forms at the cathode and brown bromine vapour at the anode. (Electrolysis of molten ionic compounds)
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- ☐ **Name the products from aluminium oxide** Aluminium forms at the cathode and oxygen forms at the anode. (Using electrolysis to extract metals)

- ☐ **Explain why electrolysis is expensive** Large amounts of energy are needed to melt the compound and to produce the electric current. (Using electrolysis to extract metals)

- ☐ **Predict the product at the cathode** Hydrogen forms if the metal is more reactive than hydrogen; otherwise the metal forms. (Electrolysis of aqueous solutions)

- ☐ **Predict the product at the anode** The halogen forms if halide ions are present; otherwise oxygen forms. (Electrolysis of aqueous solutions)

Energy changes

- ☐ **Explain energy conservation in a reaction** Energy is not created or destroyed, so in an exothermic reaction the products have less energy than the reactants by the amount transferred. (Energy transfer in exothermic and endothermic reactions)

- ☐ **Read energy values from a profile** Activation energy = peak – reactants; overall energy change = products – reactants. (Reaction profiles)

- ☐ **Explain why non-rechargeable cells stop working** The chemical reactions stop when one of the reactants has been used up. (Cells and batteries)

- ☐ **Describe how fuel cells produce a potential difference** The fuel is oxidised electrochemically inside the cell, which produces a potential difference. (Fuel cells)

The rate and extent of chemical change

- ☐ **Interpret graphs of product formed against time** The steeper the curve, the faster the rate; a horizontal line means the reaction has stopped. (Calculating rates of reactions)

- ☐ **Describe the gas-volume method for rates** Measure the volume of gas given off at regular time intervals with a gas syringe or an upturned measuring cylinder. (Factors which affect the rate of reaction)

- ☐ **Describe the disappearing-cross (turbidity) method** Time how long it takes for a cross under the flask to disappear as a cloudy precipitate forms. (Factors which affect the rate of reaction)

- ☐ **Explain concentration and pressure effects** There are more particles in the same volume, so collisions are more frequent. (Collision theory and activation energy)

- ☐ **Explain the effect of surface area** More particles of the solid are exposed to the other reactant, so collisions are more frequent. (Collision theory and activation energy)

- ☐ **Identify a catalyst from experimental data** It speeds up the reaction, has the same mass at the end and is not in the equation. (Catalysts)

- ☐ **Describe heating and cooling ammonium chloride** Heating decomposes it into ammonia and hydrogen chloride; cooling makes these gases re-form the white solid. (Reversible reactions)

- ☐ **Write equations for reversible reactions** Use $\rightleftharpoons$ in word and balanced symbol equations, e.g. $\text{NH}_4\text{Cl} \rightleftharpoons \text{NH}_3 + \text{HCl}$. (Reversible reactions)

- ☐ **State that equal energy is transferred each way** The energy taken in one way is exactly the same as the energy given out the other way. (Energy changes and reversible reactions)

- ☐ **Describe the copper sulfate reversible reaction** Heating blue hydrated copper sulfate gives white anhydrous copper sulfate and water; adding water reverses it. (Energy changes and reversible reactions)
- ☐ **State when equilibrium is reached** When the forward and reverse reactions happen at exactly the same rate. (Equilibrium)
- ☐ **Know that amounts stay constant at equilibrium** The concentrations of reactants and products stop changing, but they are not necessarily equal. (Equilibrium)

Organic chemistry

- ☐ **Use the general formula of the alkanes** Recognise an alkane from its formula, and write the formula for any number of carbon atoms: 10 carbon atoms gives $C_{10}H_{22}$. (Crude oil, hydrocarbons and alkanes)
- ☐ **Draw the displayed formula of an alkane** Show every atom and every bond: each carbon atom forms four single bonds and each hydrogen atom forms one. (Crude oil, hydrocarbons and alkanes)
- ☐ **Describe the temperature gradient in the column** The fractionating column is hottest at the bottom and coolest at the top. (Fractional distillation and petrochemicals)
- ☐ **Explain what feedstock means** A raw material used to make other chemicals; fractions are feedstock for the petrochemical industry. (Fractional distillation and petrochemicals)
- ☐ **Choose a suitable fuel using property data** For example, a fuel for a gas stove must have a boiling point below room temperature and be very flammable. (Properties of hydrocarbons)
- ☐ **State what happens to the fuel in combustion** The carbon and hydrogen in the fuel are oxidised, and energy is released. (Properties of hydrocarbons)
- ☐ **Describe the conditions for catalytic and steam cracking** Catalytic: vapour passed over a hot catalyst. Steam: vapour mixed with steam and heated to a very high temperature. (Cracking and alkenes)
- ☐ **Give uses of the products of cracking** Smaller alkanes are used as fuels such as petrol; alkenes are used to make polymers and many other chemicals. (Cracking and alkenes)
- ☐ **Use the general formula of the alkenes** C_nH_{2n} : the number of hydrogen atoms is double the number of carbon atoms. (Structure and formulae of alkenes)
- ☐ **Explain what unsaturated means** Alkenes have two fewer hydrogen atoms than the alkane with the same number of carbon atoms, because they contain a $C=C$. (Structure and formulae of alkenes)
- ☐ **Name the products of addition reactions** Hydrogen gives an alkane, steam gives an alcohol, and a halogen gives a compound with two halogen atoms. (Reactions of alkenes)
- ☐ **Give the conditions for adding hydrogen and steam** Hydrogen: a nickel catalyst. Steam: high temperature, high pressure and a catalyst (phosphoric acid). (Reactions of alkenes)
- ☐ **Describe the reactions of alcohols** Sodium: fizzing (hydrogen). Water: dissolves, neutral solution. Oxidising agent: a carboxylic acid forms. (Alcohols)
- ☐ **Describe the reaction with carbonates** Fizzing as carbon dioxide is given off; a salt and water also form, e.g. sodium ethanoate. (Carboxylic acids)
- ☐ **Describe how an ester is made** Carboxylic acid + alcohol, with an acid catalyst, gives an ester and water: ethanoic acid + ethanol $\rightarrow$ ethyl ethanoate + water. (Carboxylic acids)

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- ☐ **Recognise monomers that form addition polymers** The monomer must contain a C=C double bond.
(Addition polymerisation)
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- ☐ **Describe the structure of DNA** Two polymer chains, made from four different nucleotides, in the form of a double helix. (DNA and other naturally occurring polymers)
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Chemical analysis

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- ☐ **Describe how impurities change melting and boiling** Impurities lower the melting point and widen the melting range; dissolved impurities raise the boiling point. (Pure substances)
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- ☐ **Interpret heating curves to judge purity** A flat section at a fixed temperature shows a pure substance changing state; a sloping section shows a mixture. (Pure substances)
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- ☐ **Explain why quantities are carefully measured** The right amount of each component gives the product the properties it needs. (Formulations)
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- ☐ **Suggest the purpose of a component** Use the information given, e.g. a pigment gives colour and a sweetener improves taste. (Formulations)
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- ☐ **Calculate an R_f value** $R_f = \text{distance moved by substance} \div \text{distance moved by solvent}$, both measured from the start line. (Chromatography)
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- ☐ **Name reactions that produce hydrogen** Metals with acids, very reactive metals with water, and electrolysis of many solutions (at the negative electrode). (Test for hydrogen)
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- ☐ **Name reactions that produce oxygen** Decomposition of hydrogen peroxide, electrolysis (at the positive electrode) and photosynthesis. (Test for oxygen)
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- ☐ **Describe how to test gas from a reaction** Use a delivery tube to bubble the gas from the reaction through limewater. (Test for carbon dioxide)
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- ☐ **Name reactions that produce carbon dioxide** Acids with metal carbonates, and complete combustion of fuels that contain carbon. (Test for carbon dioxide)
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- ☐ **Name a reaction that produces chlorine** Electrolysis of a chloride solution, such as sodium chloride solution: chlorine forms at the positive electrode. (Test for chlorine)
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- ☐ **Explain why the wire loop must be clean** Traces of other metal ions would add their own colour and give a false result. (Flame tests)
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- ☐ **Use excess sodium hydroxide to identify aluminium** Only aluminium hydroxide dissolves in excess sodium hydroxide solution. (Metal hydroxides)
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- ☐ **Distinguish calcium ions from magnesium ions** Both precipitates stay in excess, so do a flame test: calcium gives orange-red. (Metal hydroxides)
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- ☐ **Name the products of acid and carbonate** A salt, water and carbon dioxide. (Carbonates)
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- ☐ **Identify a compound from two ion tests** Combine the metal ion test result with the halide test result, e.g. lilac flame + yellow precipitate → potassium iodide. (Halides)
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- ☐ **Identify a compound using two ion tests** e.g. a blue precipitate with sodium hydroxide and a white precipitate with barium chloride → copper(II) sulfate. (Sulfates)
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- ☐ **Explain accurate, sensitive and rapid** Accurate: close to the true value. Sensitive: detects very small amounts. Rapid: gives results quickly. (Instrumental methods)
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- ☐ **Identify a metal ion from reference spectra** Each metal ion gives its own pattern of lines; the ion is present if all its lines appear. (Flame emission spectroscopy)
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Chemistry of the atmosphere

- ☐ **Calculate the volume of a gas in air** Multiply the total volume by the percentage divided by 100, e.g. $20 \div 100 \times 500 \text{ cm}^3 = 100 \text{ cm}^3$ of oxygen. (Proportions of gases in the atmosphere)
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- ☐ **Name other gases in the early atmosphere** Nitrogen from volcanoes gradually built up, and there may have been small proportions of methane and ammonia. (The Earth's early atmosphere)
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- ☐ **State when algae first produced oxygen** Algae first produced oxygen about 2.7 billion years ago, and oxygen appeared in the atmosphere soon after. (How oxygen increased)
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- ☐ **Describe how limestone formed** Shells and skeletons of sea creatures, made of calcium carbonate, settled, were buried and were compressed into rock. (How carbon dioxide decreased)
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- ☐ **Describe how coal formed** Remains of plants, mainly trees, were buried and compressed over millions of years. (How carbon dioxide decreased)
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- ☐ **Describe what happens to the Sun's radiation** Short wavelength radiation from the Sun passes through the atmosphere and is absorbed by the Earth's surface, warming it. (Greenhouse gases)
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- ☐ **Explain how deforestation increases carbon dioxide** Burning the trees releases carbon dioxide, and fewer trees are left to remove it by photosynthesis. (Human activities that increase greenhouse gases)
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- ☐ **Describe four different potential effects** Give four clearly different effects, each with a short consequence, e.g. sea levels rise, causing flooding. (Global climate change)
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- ☐ **Describe actions to reduce emissions** Alternative energy, energy conservation, carbon capture and storage, carbon taxes and licences, carbon off-setting and carbon neutrality. (The carbon footprint and its reduction)
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- ☐ **Describe how carbon monoxide and soot form** Incomplete combustion in a limited supply of oxygen produces carbon monoxide and carbon particles (soot). (Atmospheric pollutants from fuels)
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- ☐ **Describe how sulfur dioxide forms** Sulfur in the fuel reacts with oxygen when the fuel burns. (Atmospheric pollutants from fuels)
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- ☐ **Explain why carbon monoxide is hard to detect** It is colourless and odourless, so you cannot see or smell it. (Properties and effects of atmospheric pollutants)
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Using resources

- ☐ **Define sustainable development** Development that meets the needs of current generations without compromising the ability of future generations to meet their own needs. (Using resources and sustainable development)
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- ☐ **Give reasons for each treatment step** Filter beds remove solid particles; sterilising with chlorine, ozone or ultraviolet light kills microbes. (Potable water)
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- ☐ **Name two methods of desalination** Distillation, and processes that use membranes such as reverse osmosis. (Potable water)
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- ☐ **List the stages of sewage treatment in order** Screening and grit removal, sedimentation, anaerobic digestion of the sludge, and aerobic biological treatment of the effluent. (Waste water treatment)
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- ☐ **Compare plastic and paper bags using an LCA** Plastic bags come from crude oil (finite) but can be reused many times; paper bags come from trees but are reused less. (Life cycle assessment)
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- ☐ **Describe how glass and metals are recycled** Glass is crushed and melted to make different glass products; metals are melted and recast or reformed. (Ways of reducing the use of resources)
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- ☐ **Explain why recycling saves resources and energy** Less of a limited raw material is used, and usually less energy than extracting and processing new material. (Ways of reducing the use of resources)
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- ☐ **Describe the rusting experiment with three tubes** Nails in water open to air, in boiled water under oil, and in dry air; only the first rusts. (Corrosion and its prevention)
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- ☐ **Compare high carbon, low carbon and stainless steel** High carbon steel is strong but brittle; low carbon steel is softer and easily shaped; stainless steel is hard and resists corrosion. (Alloys as useful materials)
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- ☐ **Give examples of composites and their parts** Reinforced concrete is steel rods in concrete; fibreglass is glass fibres in a polymer resin. (Ceramics, polymers and composites)
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- ☐ **Describe how ammonia is separated and gases recycled** On cooling, ammonia liquefies and is removed; unreacted nitrogen and hydrogen are recycled. (The Haber process)
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- ☐ **Name ammonium salts made from ammonia** With nitric acid, ammonium nitrate; with sulfuric acid, ammonium sulfate; with phosphoric acid, ammonium phosphate. (Production and uses of NPK fertilisers)
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