OCR A Comb Sci Chemistry

Topic C1: Particles

C1.1a — describe the main features of the particle model in terms of states of matter and change of state

1. Solid, liquid and gas.
2. Particles are closely packed in a regular arrangement.
3. Particles are close together but arranged randomly.
4. Particles are far apart and arranged randomly.
5. Particles vibrate around fixed positions.
6. Particles move around each other.

C1.1b — explain in terms of the particle model the distinction between physical changes and chemical changes

1. A physical change does not produce a new substance.
2. A chemical change produces one or more new substances.
3. The particles remain the same but their arrangement or movement changes.
4. Atoms are rearranged to form different substances.
5. A physical change.
6. A chemical change.

C1.1c — explain the limitations of the particle model in relation to changes of state when particles are represented by inelastic spheres (e.g. like bowling balls)

1. Forces of attraction between particles.
2. The particles are shown as much larger than they really are.

3. The spaces between particles are not shown accurately.
4. The particles are assumed to be hard, inelastic spheres that do not change shape.
5. It does not accurately represent the forces and spacing between particles.
6. Particle size, particle spacing and forces between particles.

Topic C2: Elements, compounds and mixtures

C2.1a — explain what is meant by the purity of a substance, distinguishing between the scientific and everyday use of the term 'pure'

1. A pure substance contains only one substance with no other substances mixed with it.
2. One element or one compound.
3. Free from contamination or unwanted substances.
4. In chemistry, pure has a precise meaning: only one substance is present.
5. A substance present in a material that is not wanted.
6. They can change properties such as melting point and boiling point.

C2.1b — use melting point data to distinguish pure from impure substances

1. It melts at one fixed temperature.
2. Its melting point is usually lower and occurs over a range of temperatures.
3. Compare the measured melting point with the known melting point of the pure substance.
4. The substance is likely to be pure.
5. The substance is likely to be impure.
6. It suggests that the substance is impure.

C2.1c — calculate relative formula masses of species separately and in a balanced chemical equation

1. The relative atomic mass is the average mass of an atom compared with a standard carbon atom.

2. Relative molecular mass is the total of the relative atomic masses of all atoms in a molecule.
3. The total of the relative atomic masses of all atoms shown in a formula.
4. Add the relative atomic masses of all the atoms in the formula.
5. $Mr(H_2O) = (2 \times 1) + 16 = 18$.
6. $Mr(CaCO_3) = 40 + 12 + (3 \times 16) = 100$.

C2.1d — deduce the empirical formula of a compound from the relative numbers of atoms present or from a model or diagram and vice versa

1. The simplest whole-number ratio of atoms in a compound.
2. The simplest ratio of each type of atom.
3. Divide the numbers of each atom by their highest common factor.
4. $C_2H_4 \rightarrow CH_2$.
5. $CO_2 \rightarrow CO_2$.
6. Use the subscripts in the empirical formula to find the simplest ratio of the atoms.

C2.1e — explain that many useful materials are formulations of mixtures

1. A mixture designed to have particular properties.
2. Two or more substances that are not chemically bonded together.
3. They can be designed to have useful properties for a particular purpose.
4. A mixture containing a metal and one or more other elements.
5. Their components are not chemically bonded in fixed ratios.
6. Brass.

C2.1f — describe, explain and exemplify the processes of filtration, crystallisation, simple distillation, and fractional distillation

1. An insoluble solid and a liquid.
2. The mixture passes through filter paper; the liquid passes through while the insoluble solid remains as residue.
3. A dissolved solid from a solution.
4. The solvent is evaporated and the dissolved substance forms crystals.
5. A solvent from a solution, or liquids with very different boiling points.

6. Fractional distillation uses a fractionating column and separates liquids with similar boiling points more effectively.

C2.1g — describe the techniques of paper and thin layer chromatography using aqueous and non-aqueous solvents and locating agents

1. Mixtures of dissolved substances.
2. Paper.
3. A thin layer of a solid such as silica.
4. It carries the substances through the stationary phase.
5. It makes substances that are otherwise invisible visible.
6. Either type of solvent can be selected depending on which substances need to be separated.

C2.1h — recall that chromatography involves a stationary and a mobile phase and that separation depends on the distribution between the phases

1. The phase that stays fixed, such as paper or silica.
2. The solvent that moves through the stationary phase.
3. It moves more slowly and travels a shorter distance.
4. It moves further with the mobile phase.
5. Different attractions between substances and the two phases.
6. How strongly it interacts with the stationary and mobile phases.

C2.1i — interpret chromatograms, including measuring Rf values

1. The pattern of separated substances produced by chromatography.
2. It usually indicates one substance is present.
3. It indicates that more than one substance is present.
4. The distance travelled by a substance compared with the distance travelled by the solvent front.
5. Rf = distance travelled by substance ÷ distance travelled by solvent front.
6. Rf = 4 ÷ 8 = 0.50.

C2.1j — suggest suitable purification techniques given information about the substances involved

1. Filtration.
2. Crystallisation.
3. Simple distillation.
4. Fractional distillation.
5. Properties such as solubility, boiling point and whether a substance is soluble or insoluble.
6. Liquids with different boiling points vaporise and condense at different temperatures.

C2.1k — suggest chromatographic methods for distinguishing pure from impure substances

1. A pure substance usually gives one spot; an impure substance usually gives more than one spot.
2. The same principle applies using a thin layer of stationary material.
3. A pure substance.
4. An impure substance or mixture.
5. Gas chromatography can be used to separate and identify components in a gas mixture.
6. Multiple spots show that more than one substance is present.

C2.2a — describe metals and non-metals and explain the differences between them on the basis of their characteristic physical and chemical properties

1. Good electrical conductivity and high melting points.
2. Poor electrical conductivity and generally low melting points.
3. Positive ions.
4. Negative ions.
5. A metal oxide.
6. Metal + oxygen → metal oxide.

C2.2b — explain how the atomic structure of metals and non-metals relates to their position in the Periodic Table

1. Mainly on the left and centre.
2. Mainly on the right.
3. It generally increases by one across a period.
4. They usually have relatively few outer-shell electrons and can lose them to form positive ions.
5. They tend to gain or share electrons to obtain a stable outer shell.
6. The number of outer-shell electrons influences how atoms react.

C2.2c — explain how the position of an element in the Periodic Table is related to the arrangement of electrons in its atoms and hence to its atomic number, group number and period number

1. The number of protons in the nucleus.
2. The number of electrons in the outer shell for main-group elements.
3. The number of occupied electron shells.
4. They have the same number of electrons.
5. Count the electrons in the outer shell.
6. Count the occupied electron shells.

C2.2d — describe and compare the nature and arrangement of chemical bonds in: i. ionic compounds ii. simple molecules iii. giant covalent structures iv. polymers v. metals

1. Ionic bonding.
2. A giant lattice of oppositely charged ions.
3. Covalent bonding.
4. A giant network of atoms joined by covalent bonds.
5. By strong covalent bonds in long chains.
6. Electrostatic attraction between positive metal ions and delocalised electrons.

C2.2e — explain chemical bonding in terms of electrostatic forces and the transfer or sharing of electrons

1. Electrons move from one atom to another.
2. It loses electrons.
3. It gains electrons.
4. Atoms share electrons.
5. Strong electrostatic attraction between oppositely charged ions.
6. Attraction between positive metal ions and delocalised electrons.

C2.2f — construct dot and cross diagrams for simple covalent and binary ionic substances

1. Electrons from different atoms.
2. Which electrons are shared or transferred during bonding.
3. Two electrons.
4. Sodium loses one electron to form Na^+ and chlorine gains one electron to form Cl^-.
5. Show one shared pair of electrons between the two chlorine atoms, with each chlorine having a full outer shell.
6. Show two electrons transferred from Mg to O, forming Mg^{2+} and O^{2-} with full outer shells.

C2.2g — describe the limitations of particular representations and models

1. It does not show the actual three-dimensional shape or electron density.
2. It does not accurately represent the sizes or distances of atoms.
3. Atoms are shown as large spheres for simplicity.
4. It cannot accurately show the three-dimensional structure.
5. It may hide some details or be difficult to interpret.
6. Each model simplifies some features and cannot show everything at once.

C2.2h — explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number

1. Outer-shell electrons.

2. They are involved in forming chemical bonds.
3. Electrons are transferred from the metal to the non-metal.
4. A neutral atom has the same number of electrons as protons.
5. It determines whether atoms are likely to lose, gain or share electrons.
6. They have the same number of outer-shell electrons.

C2.2i — explain in terms of atomic number how Mendeleev's arrangement was refined into the modern Periodic Table

1. Increasing atomic mass, while considering similarities in properties.
2. Atomic masses and chemical properties.
3. Increasing atomic number.
4. The number of protons in the nucleus.
5. Some elements did not fit perfectly when arranged by atomic mass.
6. Elements with similar electron arrangements and properties appear at regular intervals.

C2.3a — recall that carbon can form four covalent bonds

1. Four.
2. Four.
3. It has four outer-shell electrons and needs four more to achieve a full outer shell.
4. Four.
5. Four.
6. It can bond with itself and many other elements in different arrangements.

C2.3b — explain that the vast array of natural and synthetic organic compounds occur due to the ability of carbon to form families of similar compounds, chains and rings

1. A compound containing carbon, usually with hydrogen.
2. Carbon atoms can form covalent bonds with other carbon atoms.
3. Carbon atoms can join together in closed chains.
4. A group of compounds with similar structures and chemical properties.
5. Carbon can form many different structures and combinations.

6. Natural compounds occur naturally; synthetic compounds are made by humans.

C2.3c — explain the properties of diamond, graphite, fullerenes and graphene in terms of their structures and bonding

1. Strong covalent bonding.
2. Each carbon atom is strongly bonded to four other carbon atoms.
3. Layers of carbon atoms arranged in hexagonal structures.
4. It has delocalised electrons that can move through the layers.
5. Carbon structures made from carbon atoms arranged in hollow shapes.
6. It is a single layer of carbon atoms in a hexagonal arrangement; the strong covalent bonds make it strong.

C2.3d — use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur

1. The arrangement and movement of particles change.
2. Energy is absorbed.
3. Energy is absorbed.
4. An attractive force between molecules.
5. Stronger intermolecular forces require more energy to overcome.
6. More energy is needed to separate the molecules.

C2.3e — use data to predict states of substances under given conditions

1. Melting point, boiling point and temperature.
2. It changes from solid to liquid.
3. It changes from liquid to gas.
4. Solid.
5. Gas.
6. Liquid.

C2.3f — explain how the bulk properties of materials (ionic compounds; simple molecules; giant covalent structures; polymers and metals) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged

1. Properties of a material that can be observed or measured on a large scale.
2. Strong electrostatic attractions between ions require lots of energy to overcome.
3. Only weak intermolecular forces need to be overcome.
4. Many strong covalent bonds need to be broken.
5. They contain delocalised electrons that can carry charge.
6. Bonding and structure determine how particles interact on a large scale.

Topic C3: Chemical reactions

C3.1a — use chemical symbols to write the formulae of elements and simple covalent and ionic compounds

1. Na.
2. O_2.
3. H_2O.
4. CO_2.
5. NaCl.
6. MgO.

C3.1b — use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations and half equations

1. Ca.

2. $CaCl_2$.
3. $2Mg + O_2 \rightarrow 2MgO$.
4. $2H_2 + O_2 \rightarrow 2H_2O$.
5. The number of atoms of each element.
6. The electrons transferred during a redox reaction.

C3.1c — use the names and symbols of common elements from a supplied Periodic Table to write formulae and balanced chemical equations where appropriate

1. K.
2. Cl.
3. Fe.
4. Cu.
5. Al_2O_3.
6. $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$.

C3.1d — use the formula of common ions to deduce the formula of a compound

1. +1.
2. −1.
3. NaCl.
4. $MgCl_2$.
5. CaO.
6. Al_2O_3.

C3.1e — construct balanced ionic equations

1. An equation showing only the ions and substances directly involved in a reaction.
2. Spectator ions.
3. $H^+ + OH^- \rightarrow H_2O$.
4. $Ag^+ + Cl^- \rightarrow AgCl$.
5. The total charge must be equal on both sides.
6. The number of each type of atom must be equal on both sides.

C3.1f — describe the physical states of products and reactants using state symbols (s, l, g and aq)

1. Solid.
2. Liquid.
3. Gas.
4. Aqueous; dissolved in water.
5. NaCl(s).
6. NaCl(aq).

C3.1g — describe tests to identify selected gases

1. A glowing splint.
2. It relights.
3. A lit splint.
4. It produces a squeaky pop.
5. Bubble the gas through limewater.
6. Damp blue litmus paper is bleached white.

C3.1h — recall and use the definitions of the Avogadro constant (in standard form) and of the mole

1. The number of particles in one mole.
2. 6.02×10^{23} mol^{-1}.
3. mol^{-1}.
4. The amount of substance containing the Avogadro number of particles.
5. 6.02×10^{23}.
6. Number of particles = moles × Avogadro constant.

C3.1i — explain how the mass of a given substance is related to the amount of that substance in moles and vice versa

1. moles = mass ÷ molar mass.
2. mol.
3. g.
4. g mol^{-1}.
5. 18 ÷ 18 = 1 mol.

6. $0.5 \times 44 = 22$ g.

C3.1j — explain how the mass of a solute and the volume of the solution is related to the concentration of the solution

1. A substance dissolved in a solvent.
2. A mixture formed when a solute dissolves in a solvent.
3. The amount of solute in a given volume of solution.
4. Concentration = mass ÷ volume.
5. $20 \div 2 = 10$ g/dm^3.
6. $40 \times 0.5 = 20$ g.

C3.1k — recall and use the law of conservation of mass

1. Mass cannot be created or destroyed.
2. It stays the same.
3. Atoms are rearranged but not created or destroyed.
4. The same atoms are present before and after the reaction.
5. 15 g.
6. $24 - 9 = 15$ g.

C3.1l — explain any observed changes in mass in non-enclosed systems during a chemical reaction and explain them using the particle model

1. Particles can enter or leave the system.
2. The measured mass decreases.
3. The measured mass increases.
4. Particles have moved into or out of the system rather than being created or destroyed.
5. Oxygen from the air combines with the substance.
6. Gas particles can escape or enter, changing the measured mass.

C3.1m — deduce the stoichiometry of an equation from the masses of reactants and products and explain the effect of a limiting quantity of a reactant

1. The ratio in which substances react according to a balanced equation.
2. The coefficients give the mole ratio of the substances.
3. The reactant that is completely used up first.
4. It is completely used up.
5. It remains after the reaction stops.
6. The balanced equation is: $4Al + 3O_2 \rightarrow 2Al_2O_3$ Using Ar: Al = 27, O = 16:

- M_r of Al_2O_3 = (2 × 27) + (3 × 16) = 102
- Moles of Al = 135 ÷ 27 = 5 mol
- From the equation, 4 mol Al → 2 mol Al_2O_3
- Therefore, 5 mol Al → 2.5 mol Al_2O_3
- Mass = 2.5 × 102 = 255 g

C3.1n — use a balanced equation to calculate masses of reactants or product

1. The mole ratio from the balanced equation and the molar masses.
2. moles = mass ÷ Mr.
3. mass = moles × Mr.
4. 0.5 × 40 = 20 g.
5. 88 ÷ 44 = 2 mol.
6. It gives the correct mole ratio between reactants and products.

C3.2a — distinguish between endothermic and exothermic reactions on the basis of the temperature change of the surroundings

1. A reaction that transfers energy to the surroundings.
2. It increases.
3. A reaction that takes in energy from the surroundings.
4. It decreases.
5. Exothermic.
6. Endothermic.

C3.2b — draw and label a reaction profile for an exothermic and an endothermic reaction

1. The energy changes during a chemical reaction.
2. Energy.
3. Progress of reaction.
4. The energy needed to start the reaction.

5. Products have less energy than the reactants.
6. Products have more energy than the reactants.

C3.2c — explain activation energy as the energy needed for a reaction to occur

1. The minimum energy needed for a reaction to occur.
2. Particles need enough energy for bonds to break and the reaction to begin.
3. From the reactants' energy level to the highest point of the profile.
4. The reaction does not occur successfully.
5. Yes.
6. Yes.

C3.2d — calculate energy changes in a chemical reaction by considering bond making and bond breaking energies

1. Energy is absorbed.
2. Energy is released.
3. Energy change = energy needed to break bonds − energy released when bonds form.
4. 500 − 700 = −200 kJ/mol, so the reaction is exothermic.
5. Exothermic.
6. Endothermic.

C3.3a — explain reduction and oxidation in terms of loss or gain of oxygen, identifying which species are oxidised and which are reduced

1. Gain of oxygen.
2. Loss of oxygen.
3. It gains oxygen.
4. It loses oxygen.
5. Copper oxide.
6. Carbon.

C3.3b — explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced

1. Loss of electrons.
2. Gain of electrons.
3. It loses electrons.
4. It gains electrons.
5. Magnesium.
6. Cu^{2+}.

C3.3c — recall that acids form hydrogen ions when they dissolve in water and solutions of alkalis contain hydroxide ions

1. Hydrogen ions, H^+.
2. Hydroxide ions, OH^-.
3. H^+.
4. OH^-.
5. H^+.
6. OH^-.

C3.3d — describe neutralisation as acid reacting with alkali or a base to form a salt plus water

1. An acid reacting with an alkali or base to form a salt and water.
2. Salt and water.
3. Salt and water.
4. Acid + alkali → salt + water.
5. Sodium chloride.
6. Potassium sulfate.

C3.3e — recognise that aqueous neutralisation reactions can be generalised to hydrogen ions reacting with hydroxide ions to form water

1. Hydrogen ions and hydroxide ions.
2. H^+.

3. OH^-.
4. H_2O.
5. $H^+ + OH^- \rightarrow H_2O$.
6. They react together to form water.

C3.3f — recall that carbonates and some metals react with acids and write balanced equations predicting products from given reactants

1. Carbon dioxide.
2. Salt, water and carbon dioxide.
3. Hydrogen.
4. Salt and hydrogen.
5. Calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide.
6. $Mg + 2HCl \rightarrow MgCl_2 + H_2$.

C3.3g — use and explain the terms dilute and concentrated (amount of substance) and weak and strong (degree of ionisation) in relation to acids

1. A small amount of acid per unit volume of solution.
2. A large amount of acid per unit volume of solution.
3. An acid that ionises almost completely in water.
4. An acid that only partially ionises in water.
5. Concentration describes the amount of acid; strength describes how much the acid ionises.
6. Concentration.

C3.3h — recall that relative acidity and alkalinity are measured by pH

1. How acidic or alkaline a solution is.
   7.
2. Less than 7.
3. Greater than 7.
4. pH 2.
5. pH 12.

C3.3i — describe neutrality and relative acidity and alkalinity in terms of the effect of the concentration of hydrogen ions on the numerical value of pH

1. pH decreases.
2. pH increases.
3. The solution is neutral.
4. pH 2.
5. pH 12.
6. It indicates a higher hydrogen ion concentration.

C3.3j — use the idea that as hydrogen ion concentration increases by a factor of ten, the pH value of a solution decreases by one

1. pH decreases by 1.
2. pH increases by 1.
3. It increased by a factor of 10.
4. It decreased by a factor of 100.
5. pH 2.
6. pH 4.

C3.3k — describe techniques and apparatus used to measure pH

1. Universal indicator.
2. A pH meter.
3. Red at low pH, green around pH 7 and purple at high pH.
4. Add universal indicator and compare the colour with a pH colour chart.
5. Place the electrode in the solution and read the pH.
6. A pH meter.

C3.4a — recall that metals (or hydrogen) are formed at the cathode and non-metals are formed at the anode in electrolysis using inert electrodes

1. The decomposition of an ionic compound using electricity.
2. Positive ions.

3. Negative ions.
4. A metal, or hydrogen if hydrogen is preferentially discharged.
5. A non-metal.
6. Cations are positive ions; anions are negative ions.

C3.4b — predict the products of electrolysis of binary ionic compounds in the molten state

1. Its ions become free to move.
2. The positive ion.
3. The negative ion.
4. Sodium and chlorine.
5. $Na^+ + e^- \rightarrow Na$.
6. $2Cl^- \rightarrow Cl_2 + 2e^-$.

C3.4c — describe competing reactions in the electrolysis of aqueous solutions of ionic compounds in terms of the different species present

1. Hydrogen ions and hydroxide ions from water.
2. Hydrogen or the metal.
3. A halogen or oxygen.
4. Hydrogen at the cathode and chlorine at the anode, with sodium hydroxide remaining in solution.
5. Copper at the cathode and oxygen at the anode.
6. Water contains ions that can also be discharged at the electrodes.

C3.4d — describe electrolysis in terms of the ions present and reactions at the electrodes

1. They gain electrons.
2. They lose electrons.
3. Reduction.
4. Oxidation.
5. $2H^+ + 2e^- \rightarrow H_2$.
6. $2Cl^- \rightarrow Cl_2 + 2e^-$.

C3.4e — describe the technique of electrolysis using inert and non-inert electrodes

1. An electrode that does not react during electrolysis.
2. Platinum.
3. They are chemically unreactive under the conditions.
4. An electrode that can react during electrolysis.
5. It can be oxidised or reduced and become part of the reaction.
6. A direct current power supply.

Topic C4: Predicting and identifying chemical products

C4.1a — recall the simple properties of Groups 1, 7 and 0

1. Alkali metals.
2. Halogens.
3. Noble gases.
4. They are relatively soft and have low densities.
5. They are non-metals.
6. They are very unreactive.

C4.1b — explain how observed simple properties of Groups 1, 7 and 0 depend on the outer shell of electrons of the atoms and predict properties from given trends down the groups

1. One.
2. Seven.
3. Losing one electron gives them a full outer shell.
4. Gaining one electron gives them a full outer shell.
5. It increases down the group.
6. It decreases down the group.

C4.1c — predict possible reactions and probable reactivity of elements from their positions in the Periodic Table

1. Its group and position within the group.
2. Potassium.
3. Fluorine.
4. Displacement.
5. Yes.
6. No.

C4.1d — explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion

1. It loses electrons.
2. Losing electrons allows the metal to form a positive ion.
3. Hydrogen.
4. Hydrogen.
5. A metal salt and hydrogen.
6. It loses electrons more readily and forms positive ions more easily.

C4.1e — deduce an order of reactivity of metals based on experimental results

1. More reactive metals react more readily or vigorously with water.
2. More reactive metals generally react more quickly or vigorously.
3. The metal is more reactive.
4. Metal A.
5. Magnesium.
6. Compare the reactions and arrange metals from most to least reactive.

Topic C5: Monitoring and controlling chemical reactions

C5.1a — suggest practical methods for determining the rate of a given reaction

1. How quickly reactants are changed into products.
2. Measure the volume of gas produced over time.
3. Measure how quickly the mass decreases.

4. A shorter time means a faster reaction.
5. The time taken for the cross to disappear.
6. Rate $\propto$ 1/time.

C5.1b — interpret rate of reaction graphs

1. The rate of reaction.
2. A faster reaction.
3. The reaction has stopped producing gas.
4. The total amount of gas produced.
5. The reaction that reaches the final volume sooner.
6. 1/20 = 0.05 s^{-1}.

C5.1c — describe the effect of changes in temperature, concentration, pressure, and surface area on rate of reaction

1. It increases.
2. It increases.
3. It increases.
4. It increases.
5. Powdered marble.
6. The reaction at high pressure.

C5.1d — explain the effects on rates of reaction of changes in temperature, concentration and pressure in terms of frequency and energy of collision between particles

1. They must collide with enough energy and in the correct orientation.
2. It increases the number of successful collisions.
3. They have more kinetic energy.
4. Collisions happen more frequently.
5. Particles collide more frequently.
6. Particles have more energy and collide more frequently, increasing successful collisions.

C5.1e — explain the effects on rates of reaction of changes in the size of the pieces of a reacting solid in terms of surface area to volume

1. It increases.
2. It increases.
3. More particles are exposed and available to collide.
4. The small pieces.
5. More surface is exposed for collisions.
6. More particles are exposed at the surface.

C5.1f — describe the characteristics of catalysts and their effect on rates of reaction

1. A substance that increases the rate of a reaction without being used up.
2. It increases the rate.
3. No.
4. It lowers the activation energy.
5. No.
6. It increases.

C5.1g — identify catalysts in reactions

1. Manganese dioxide.
2. It catalyses the decomposition of hydrogen peroxide.
3. It increases.
4. Compare the reaction rate with and without the substance while checking that the substance is not used up.
5. It remains chemically unchanged.
6. It is not consumed by the reaction.

C5.1h — explain catalytic action in terms of activation energy reaction profiles

1. It decreases.
2. With a lower peak.
3. More particles have enough energy to react.
4. It increases.
5. The catalysed profile has a lower activation-energy peak.
6. No; it changes the activation energy, not the overall energy change.

C5.1i — recall that enzymes act as catalysts in biological systems

1. Biological catalysts, usually proteins.
2. They speed up biological reactions.
3. Yes.
4. They lower the activation energy.
5. They allow important reactions to occur quickly at suitable temperatures.
6. Digestion.

C5.2a — recall that some reactions may be reversed by altering the reaction conditions

1. A reaction that can proceed in both directions.
2. $\rightleftharpoons$.
3. Reactants form products.
4. Products form reactants.
5. They can change the position of equilibrium.
6. The products can react to reform the original reactants.

C5.2b — recall that dynamic equilibrium occurs in a closed system when the rates of forward and reverse reactions are equal

1. A state in which the forward and reverse reactions occur at equal rates.
2. A closed system.
3. It equals the rate of the reverse reaction.
4. It equals the rate of the forward reaction.
5. Yes.
6. No; both reactions continue.

C5.2c — predict the effect of changing reaction conditions on equilibrium position and suggest appropriate conditions to produce as much of a particular product as possible

1. It shifts towards products.
2. It shifts towards ammonia.

3. It shifts towards the reactants.
4. It shifts towards the reactants.
5. It shifts towards SO_3.
6. A lower temperature.

Topic C6: Global challenges

C6.1a — explain, using the position of carbon in the reactivity series, the principles of industrial processes used to extract metals, including extraction of a non-ferrous metal

1. Carbon is less reactive than iron but more reactive than copper.
2. Carbon is more reactive than iron and can remove oxygen from iron oxide.
3. The metal is released from its compound.
4. Metal oxide + carbon → metal + carbon dioxide.
5. Carbon cannot remove oxygen from compounds of metals more reactive than carbon.
6. Copper oxide + carbon → copper + carbon dioxide.

C6.1b — explain why and how electrolysis is used to extract some metals from their ores

1. They are more reactive than carbon and cannot be extracted by carbon reduction.
2. They gain electrons and form metal atoms.
3. They lose electrons.
4. The ions must be free to move.
5. It requires a large amount of electrical energy.
6. Aluminium is more reactive than carbon.

C6.1c — evaluate alternative biological methods of metal extraction

1. Using bacteria to help extract metals from ores.
2. They can react with minerals and release metal ions into solution.
3. Using plants to absorb metals from soil.
4. Plants absorb metal ions and concentrate them in their tissues.

5. They can use less energy and produce less environmental damage.
6. They can be slow and may only work for certain metals or concentrations.

C6.1d — describe the basic principles in carrying out a life-cycle assessment of a material or product

1. An assessment of the environmental impacts of a product throughout its life.
2. Raw materials, manufacture, transport, use and disposal.
3. Transport uses energy and can produce emissions.
4. Its energy use and environmental effects are considered.
5. Disposal can produce waste or pollution.
6. Energy use, resource use, emissions, waste and pollution.

C6.1e — interpret data from a life-cycle assessment of a material or product

1. The environmental impacts of different products or materials.
2. Greater environmental impact.
3. Compare the impacts of each stage.
4. Impacts can occur at any stage.
5. Compare the total impacts across their life cycles.
6. Its use, transport or disposal may have a large environmental impact.

C6.1f — describe a process where a material or product is recycled for a different use, and explain why this is viable

1. Processing used materials so they can be used again.
2. Turning a used material into a different useful product.
3. Used plastic bottles being made into polyester clothing.
4. Less new material needs to be extracted.
5. Less waste is sent to landfill.
6. Cost, energy use, available technology, environmental benefits and demand for the recycled material.

C6.1g — evaluate factors that affect decisions on recycling

1. Recycling is difficult without somewhere to collect and process materials.
2. High costs can make recycling less viable.
3. Recycling can require significant energy.
4. The environmental benefits must be weighed against environmental costs.
5. Recycling is more useful when there is demand for the recycled material.
6. It may be too expensive, energy-intensive or have little demand.

C6.1h — describe the separation of crude oil by fractional distillation

1. A mixture of hydrocarbons.
2. Fractional distillation.
3. It is heated so that most of it vaporises.
4. Mixtures of hydrocarbons with similar boiling points.
5. Near the top of the column.
6. Refinery gases, petrol, kerosene and diesel.

C6.1i — explain the separation of crude oil by fractional distillation

1. They have different boiling points.
2. Larger molecules generally have higher boiling points.
3. They become stronger.
4. More energy is needed to separate larger molecules.
5. They condense at similar temperatures.
6. The temperature changes with height, so different hydrocarbons condense at different levels.

C6.1j — describe the fractions as largely a mixture of compounds of formula C_nH_{2n+2} which are members of the alkane homologous series

1. C_nH_{2n+2}.
2. A family of compounds with similar chemical properties and the same general formula.
3. CH_4.
4. C_3H_8.
5. Each successive alkane has one more carbon and two more hydrogen atoms.
6. Each fraction contains several hydrocarbons with similar boiling points.

C6.1k — recall that crude oil is a main source of hydrocarbons and is a feedstock for the petrochemical industry

1. Hydrocarbons.
2. Compounds containing only carbon and hydrogen.
3. A raw material used to make other products.
4. It provides hydrocarbons used to make many chemicals and materials.
5. Fuels, plastics, solvents and other chemicals.
6. They provide the raw materials needed to manufacture many useful products.

C6.1l — explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is a finite resource

1. They provide fuels and raw materials for many products.
2. Petrol and diesel.
3. Plastics and solvents.
4. It is available in a limited amount and cannot be replaced quickly.
5. It takes millions of years to form and is being used much faster than it forms.
6. Supplies will eventually become limited or exhausted.

C6.1m — describe the production of materials that are more useful by cracking

1. Breaking long-chain hydrocarbons into shorter molecules.
2. To produce more useful shorter-chain hydrocarbons.
3. High temperature and a catalyst, or high temperature and steam depending on the process.
4. Shorter-chain alkanes and alkenes.
5. They are used to make polymers and other useful chemicals.
6. It produces more of the shorter-chain hydrocarbons that are in greater demand.

C6.2a — interpret evidence for how it is thought the atmosphere was originally formed

1. Carbon dioxide, water vapour, nitrogen and small amounts of other gases.
2. Volcanic gases were released into the atmosphere.
3. Oxygen.
4. Carbon dioxide decreased and oxygen increased over time.
5. Evidence from rocks, fossils and scientific measurements.
6. There is limited direct evidence from billions of years ago.

C6.2b — describe how it is thought an oxygen-rich atmosphere developed over time

1. Photosynthetic microorganisms such as cyanobacteria.
2. Photosynthesis.
3. Oxygen levels increased.
4. More photosynthesis released more oxygen.
5. Carbon dioxide levels decreased.
6. Plants carried out photosynthesis, releasing oxygen and removing carbon dioxide.

C6.2c — describe the greenhouse effect in terms of the interaction of radiation with matter within the atmosphere

1. The warming of Earth's surface and lower atmosphere because greenhouse gases absorb and re-emit infrared radiation.
2. Mainly visible and ultraviolet radiation.
3. It warms the Earth's surface.
4. Infrared radiation.
5. They absorb and re-emit infrared radiation.
6. This reduces the rate at which thermal energy escapes into space.

C6.2d — evaluate the evidence for additional anthropogenic (human activity) causes of climate change and describe the uncertainties in the evidence base

1. Caused by human activity.
2. It increases atmospheric carbon dioxide.
3. Both have increased over time.

4. Rising greenhouse gas concentrations, temperature records and evidence from climate observations and models.
5. Other factors may cause one or both changes.
6. Future climate depends on uncertain future emissions and complex interactions in the climate system.

C6.2e — describe the potential effects of increased levels of carbon dioxide and methane on the Earth's climate and how these effects may be mitigated

1. They absorb infrared radiation.
2. The greenhouse effect becomes stronger.
3. It increases.
4. Rising sea levels and changes in weather patterns.
5. It reduces carbon dioxide emissions.
6. Renewable energy produces little or no greenhouse gas emissions during electricity generation.

C6.2f — describe the major sources of carbon monoxide, sulfur dioxide, oxides of nitrogen and particulates in the atmosphere and explain the problems caused by increased amounts of these substances

1. Incomplete combustion of fossil fuels.
2. It reduces the blood's ability to carry oxygen.
3. Burning sulfur-containing fossil fuels.
4. Acid rain.
5. High-temperature combustion in engines and power stations.
6. They can damage the lungs and contribute to respiratory and cardiovascular problems.

C6.2g — describe the principal methods for increasing the availability of potable water in terms of the separation techniques used

1. Water that is safe to drink.
2. It removes insoluble solid particles.

3. To remove dissolved salts and produce pure water.
4. Water is evaporated and then condensed, leaving dissolved salts behind.
5. It generally requires less energy than desalinating seawater.
6. Availability of water, cost, energy requirements, local conditions and the level of contamination.