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Topic 1: Quantitative chemistry

1.1 The mole concept and Avogadro's constant

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
1.1.1	Apply the mole concept to substances.	Moles and Formulae	
1.1.2	Determine the number of particles and the amount of substance (in moles).	Moles and Formulae	

1.2 Formulas

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
1.2.1	Define the terms *relative atomic mass* (A_r) and *relative molecular mass* (M_r).	Moles and Formulae	
1.2.2	Calculate the mass of one mole of a species from its formula.	Moles and Formulae	
1.2.3	Solve problems involving the relationship between the amount of substance in moles, mass and molar mass.	Moles and Formulae	
1.2.4	Distinguish between the terms *empirical formula* and *molecular formula*.	Moles and Formulae	
1.2.5	Determine the empirical formula from the percentage composition or from other experimental data.	Moles and Formulae	
1.2.6	Determine the molecular formula when given both the empirical formula and experimental data.	Moles and Formulae	

1.3 Chemical equations

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
1.3.1	Deduce chemical equations when all reactants and products are given.	Chemical Calculations	
1.3.2	Identify the mole ratio of any two species in a chemical equation.	Chemical Calculations	
1.3.3	Apply the state symbols (s), (l), (g) and (aq).	Chemical Calculations	

1.4 Mass and gaseous volume relationships in chemical reactions

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
1.4.1	Calculate theoretical yields from chemical equations.	Chemical Calculations	
1.4.2	Determine the limiting reactant and the reactant in excess when quantities of reacting substances are given.		

1.4.3	Solve problems involving theoretical, experimental and percentage yield.	Chemical Calculations	
1.4.4	Apply Avogadro's law to calculate reacting volumes of gases.	Moles and Formulae	
1.4.5	Apply the concept of molar volume at standard temperature and pressure in calculations.	Moles and Formulae	
1.4.6	Solve problems involving the relationship between temperature, pressure and volume for a fixed mass of an ideal gas.	Moles and Formulae	
1.4.7	Solve problems using the ideal gas equation, $PV = nRT$	Moles and Formulae	
1.4.8	Analyse graphs relating to the ideal gas equation.		

1.5 Solutions

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
1.5.1	Distinguish between the terms *solute*, *solvent*, *solution* and *concentration* (g dm^{-3} and mol dm^{-3}).		
1.5.2	Solve problems involving concentration, amount of solute and volume of solution.	Chemical Calculations	

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Topic 2: Atomic structure

2.1 The atom

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
2.1.1	State the position of protons, neutrons and electrons in the atom.	Atomic Structure	
2.1.2	State the relative masses and relative charges of protons, neutrons and electrons.	Atomic Structure	
2.1.3	Define the terms *mass number* (*A*), *atomic number* (*Z*) and *isotopes of an element*.	Atomic Structure	
2.1.4	Deduce the symbol for an isotope given its mass number and atomic number.	Atomic Structure	
2.1.5	Calculate the number of protons, neutrons and electrons in atoms and ions from the mass number, atomic number and charge.	Atomic Structure	
2.1.6	Compare the properties of the isotopes of an element.	Atomic Structure	
2.1.7	Discuss the uses of radioisotopes.		

2.2 The mass spectrometer

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
2.2.1	Describe and explain the operation of a mass spectrometer.	Atomic Structure	
2.2.2	Describe how the mass spectrometer may be used to determine relative atomic mass using the ^{12}C scale.	Atomic Structure	
2.2.3	Calculate non-integer relative atomic masses and abundance of isotopes from given data.	Atomic Structure	

2.3 Electron arrangement

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
2.3.1	Describe the electromagnetic spectrum.		
2.3.2	Distinguish between a *continuous spectrum* and a *line spectrum*.		
2.3.3	Explain how the lines in the emission spectrum of hydrogen are related to electron energy levels.		
2.3.4	Deduce the electron arrangement for atoms and ions up to $Z = 20$.	Electron Arrangement	

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Topic 3: Periodicity

3.1 The periodic table

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
3.1.1	Describe the arrangement of elements in the periodic table in order of increasing atomic number.		
3.1.2	Distinguish between the terms *group* and *period*.		
3.1.3	Apply the relationship between the electron arrangement of elements and their position in the periodic table up to $Z = 20$.	Electron Arrangement	
3.1.4	Apply the relationship between the number of electrons in the highest occupied energy level for an element and its position in the periodic table.	Electron Arrangement	

3.2 Physical properties

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
3.2.1	Define the terms *first ionization energy* and *electronegativity*.	Electron Arrangement	
3.2.2	Describe and explain the trends in atomic radii, ionic radii, first ionization energies, electronegativities and melting points for the alkali metals (Li → Cs) and the halogens (F →I).	Electron Arrangement Trends in Group 2 Halogens	
3.2.3	Describe and explain the trends in atomic radii, ionic radii, first ionization energies and electronegativities for elements across period 3.	Electron Arrangement Trends in Period 3	
3.2.4	Compare the relative electronegativity values of two or more elements based on their positions in the periodic table.	Electron Arrangement	

3.3 Chemical properties

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
3.3.1	Discuss the similarities and differences in the chemical properties of elements in the same group.	Trends in Group 2 Halogens	
3.3.2	Discuss the changes in nature, from ionic to covalent and from basic to acidic, of the oxides across period 3.		Periodicity in Period 3

Topic 4: Bonding

4.1 Ionic bonding

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
4.1.1	Describe the ionic bond as the electrostatic attraction between oppositely charged ions.	Bonding and Intermolecular Forces	
4.1.2	Describe how ions can be formed as a result of electron transfer.	Bonding and Intermolecular Forces	
4.1.3	Deduce which ions will be formed when elements in groups 1, 2 and 3 lose electrons.		
4.1.4	Deduce which ions will be formed when elements in groups 5, 6 and 7 gain electrons.		
4.1.5	State that transition elements can form more than one ion.	Electron Arrangement	Introducing Transition Metals
4.1.6	Predict whether a compound of two elements would be ionic from the position of the elements in the periodic table or from their electronegativity values.		
4.1.7	State the formula of common polyatomic ions formed by nonmetals in periods 2 and 3.		
4.1.8	Describe the lattice structure of ionic compounds.	Bonding and Intermolecular Forces	

4.2 Covalent bonding

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
4.2.1	Describe the covalent bond as the electrostatic attraction between a pair of electrons and positively charged nuclei.	Bonding and Intermolecular Forces	
4.2.2	Describe how the covalent bond is formed as a result of electron sharing.	Bonding and Intermolecular Forces	
4.2.3	Deduce the Lewis (electron dot) structures of molecules and ions for up to four electron pairs on each atom.		
4.2.4	State and explain the relationship between the number of bonds, bond length and bond strength.		
4.2.5	Predict whether a compound of two elements would be covalent from the position of the elements in the periodic table or from their electronegativity values.		
4.2.6	Predict the relative polarity of bonds from electronegativity values.	Bonding and Intermolecular Forces	
4.2.7	Predict the shape and bond angles for species with four, three and two negative charge centres on the central atom using the valence shell electron pair repulsion theory (VSEPR).	Structure and Shape	

4.2.8	Predict whether or not a molecule is polar from its molecular shape and bond polarities.	Bonding and Intermolecular Forces	
4.2.9	Describe and compare the structure and bonding in the three allotropes of carbon (diamond, graphite and C_{60} fullerene).	Structure and Shape	
4.2.10	Describe the structure of and bonding in silicon and silicon dioxide.	Structure and Shape	

4.3 Intermolecular forces

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
4.3.1	Describe the types of intermolecular forces (attractions between molecules that have temporary dipoles, permanent dipoles or hydrogen bonding) and explain how they arise from the structural features of molecules.	Bonding and Intermolecular Forces	
4.3.2	Describe and explain how intermolecular forces affect the boiling points of substances.	Bonding and Intermolecular Forces Trends in Period 3	Periodicity in Period 3

4.4 Metallic bonding

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
4.4.1	Describe the metallic bond as the electrostatic attraction between a lattice of positive ions and delocalized electrons.	Bonding and Intermolecular Forces	
4.4.2	Explain the electrical conductivity and malleability of metals.	Bonding and Intermolecular Forces	

4.5 Physical properties

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
4.5.1	Compare and explain the properties of substances resulting from different types of bonding.	Bonding and Intermolecular Forces	

Topic 5: Energetics

5.1 Exothermic and endothermic reactions

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
5.1.1	Define the terms *exothermic reaction*, *endothermic reaction* and *standard enthalpy change of reaction* (ΔH^{Θ}) .	Energetics	Thermodynamics
5.1.2	State that combustion and neutralization are exothermic processes.	Energetics	
5.1.3	Apply the relationship between temperature change, enthalpy change and the classification of a reaction as endothermic or exothermic.	Energetics	
5.1.4	Deduce, from an enthalpy level diagram, the relative stabilities of reactants and products, and the sign of the enthalpy change for the reaction.	Energetics	

5.2 Calculations of enthalpy changes

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
5.2.1	Calculate the heat energy change when the temperature of a pure substance is changed.	Energetics	
5.2.2	Design suitable experimental procedures for measuring the heat energy changes of reactions.	Energetics	
5.3.3	Calculate the enthalpy change for a reaction using experimental data on temperature changes, quantities of reactants and mass of water.	Energetics	
5.2.4	Evaluate the results of experiments to determine enthalpy changes.	Energetics	

5.3 Hess's law

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
5.3.1	Determine the enthalpy change of a reaction that is the sum of two or three reactions with known enthalpy changes.	Energetics	

5.4 Bond enthalpies

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
5.4.1	Define the term *average bond enthalpy*.	Energetics	Thermodynamics
5.4.2	Explain, in terms of average bond enthalpies, why some reactions are exothermic and others are endothermic.	Energetics	Thermodynamics

Topic 6: Kinetics

6.1 Rates of reaction

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
6.1.1	Define the term *rate of reaction*.	Kinetics	
6.1.2	Describe suitable experimental procedures for measuring rates of reactions.	Kinetics	
6.1.3	Analyse data from rate experiments.	Kinetics	

6.2 Collision theory

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
6.2.1	Describe the kinetic theory in terms of the movement of particles whose average energy is proportional to temperature in kelvins.	Kinetics	Kinetics
6.2.2	Define the term *activation energy*, E_a.	Kinetics	Kinetics
6.2.3	Describe the collision theory.	Kinetics	Kinetics
6.2.4	Predict and explain, using the collision theory, the qualitative effects of particle size, temperature, concentration and pressure on the rate of a reaction.	Kinetics	Kinetics
6.2.5	Sketch and explain qualitatively the Maxwell–Boltzmann energy distribution curve for a fixed amount of gas at different temperatures and its consequences for changes in reaction rate.	Kinetics	
6.2.6	Describe the effect of a catalyst on a chemical reaction.	Kinetics	
6.2.7	Sketch and explain Maxwell– Boltzmann curves for reactions with and without catalysts.	Kinetics	

Topic 7: Equilibrium

7.1 Dynamic equilibrium

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
7.1.1	Outline the characteristics of chemical and physical systems in a state of equilibrium.	Equilibria	

7.2 The position of equilibrium

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
7.2.1	Deduce the equilibrium constant expression (K_c) from the equation for a homogeneous reaction.		Equilibria
7.2.2	Deduce the extent of a reaction from the magnitude of the equilibrium constant.		Equilibria
7.2.3	Apply Le Chatelier's principle to predict the qualitative effects of changes of temperature, pressure and concentration on the position of equilibrium and on the value of the equilibrium constant.	Equilibria	Equilibria
7.2.4	State and explain the effect of a catalyst on an equilibrium reaction.	Equilibria	Equilibria
7.2.5	Apply the concepts of kinetics and equilibrium to industrial processes.	Equilibria	Equilibria

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Topic 8: Acids and bases

8.1 Theories of acids and bases

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
8.1.1	Define *acids* and *bases* according to the Brønsted–Lowry and Lewis theories.		Acids and Bases
8.1.2	Deduce whether or not a species could act as a Brønsted–Lowry and/or a Lewis acid or base.		Acids and Bases
8.1.3	Deduce the formula of the conjugate acid (or base) of any Brønsted–Lowry base (or acid).		Acids and Bases

8.2 Properties of acids and bases

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
8.2.1	Outline the characteristic properties of acids and bases in aqueous solution.		

8.3 Strong and weak acids and bases

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
8.3.1	Distinguish between *strong* and *weak* acids and bases in terms of the extent of dissociation, reaction with water and electrical conductivity.		
8.3.2	State whether a given acid or base is strong or weak.		
8.3.3	Distinguish between *strong* and *weak* acids and bases, and determine the relative strengths of acids and bases, using experimental data.		

8.4 The pH scale

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
8.4.1	Distinguish between aqueous solutions that are *acidic*, *neutral* or *alkaline* using the pH scale.		
8.4.2	Identify which of two or more aqueous solutions is more acidic or alkaline using pH values.		
8.4.3	State that each change of one pH unit represents a 10-fold change in the hydrogen ion concentration [H^+(aq)].		Acids and Bases
8.4.4	Deduce changes in [H^+(aq)] when the pH of a solution changes by more than one pH unit.		

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Topic 9: Oxidation and reduction

9.1 Introduction to oxidation and reduction

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
9.1.1	Define *oxidation* and *reduction* in terms of electron loss and gain.	Redox Reactions	Redox Chemistry and Electrode Potentials
9.1.2	Deduce the oxidation number of an element in a compound.	Redox Reactions	Redox Chemistry and Electrode Potentials
9.1.3	State the names of compounds using oxidation numbers.	Redox Reactions	Redox Chemistry and Electrode Potentials
9.1.4	Deduce whether an element undergoes oxidation or reduction in reactions using oxidation numbers.	Redox Reactions	Redox Chemistry and Electrode Potentials

9.2 Redox equations

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
9.2.1	Deduce simple oxidation and reduction half-equations given the species involved in a redox reaction.	Redox Reactions	Redox Chemistry and Electrode Potentials
9.2.2	Deduce redox equations using half-equations.	Redox Reactions	Redox Chemistry and Electrode Potentials
9.2.3	Define the terms *oxidizing agent* and *reducing agent*.	Redox Reactions	
9.2.4	Identify the oxidizing and reducing agents in redox equations.	Redox Reactions	

9.3 Reactivity

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
9.3.1	Deduce a reactivity series based on the chemical behaviour of a group of oxidizing and reducing agents.	Redox Reactions	
9.3.2	Deduce the feasibility of a redox reaction from a given reactivity series.	Redox Reactions	

9.4 Voltaic cells

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
9.4.1	Explain how a redox reaction is used to produce electricity in a voltaic cell.		Redox Chemistry and Electrode Potentials
9.4.2	State that oxidation occurs at the negative electrode (anode) and reduction occurs at the positive electrode (cathode).		Redox Chemistry and Electrode Potentials

9.5 Electrolytic cells

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
9.5.1	Describe, using a diagram, the essential components of an electrolytic cell.		Redox Chemistry and Electrode Potentials
9.5.2	State that oxidation occurs at the positive electrode (anode) and reduction occurs at the negative electrode (cathode).		Redox Chemistry and Electrode Potentials
9.5.3	Describe how current is conducted in an electrolytic cell.		Redox Chemistry and Electrode Potentials
9.5.4	Deduce the products of the electrolysis of a molten salt.		

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Topic 10: Organic chemistry

10.1 Introduction

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
10.1.1	Describe the features of a homologous series.	Introducing Organic Chemistry	
10.1.2	Predict and explain the trends in boiling points of members of a homologous series.		
10.1.3	Distinguish between *empirical*, *molecular* and *structural* formulas.	Introducing Organic Chemistry	
10.1.4	Describe structural isomers as compounds with the same molecular formula but with different arrangements of atoms.	Introducing Organic Chemistry	
10.1.5	Deduce structural formulas for the isomers of the non-cyclic alkanes up to C_6.	Alkanes	
10.1.6	Apply IUPAC rules for naming the isomers of the non-cyclic alkanes up to C_6.	Alkanes	
10.1.7	Deduce structural formulas for the isomers of the straight-chain alkenes up to C_6.	Alkenes	
10.1.8	Apply IUPAC rules for naming the isomers of the straight-chain alkenes up to C_6.	Alkenes	
10.1.9	Deduce structural formulas for compounds containing up to six carbon atoms with one of the following functional groups: alcohol, aldehyde, ketone, carboxylic acid and halide.	Halogenoalkanes Alcohols	
10.1.10	Apply IUPAC rules for naming compounds containing up to six carbon atoms with one of the following functional groups: alcohol, aldehyde, ketone, carboxylic acid and halide.	Halogenoalkanes Alcohols	Carbonyl Compounds
10.1.11	Identify the following functional groups when present in structural formulas: amino (NH_2), benzene ring and esters (RCOOR).		Acyl Compounds Aromatic Compounds Amines Organic Synthesis
10.1.12	Identify primary, secondary and tertiary carbon atoms in alcohols and halogenoalkanes.	Halogenoalkanes Alcohols	
10.1.13	Discuss the volatility and solubility in water of compounds containing the functional groups listed in 10.1.9.	Alcohols	Carbonyl Compounds

10.2 Alkanes

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
10.2.1	Explain the low reactivity of alkanes in terms of bond enthalpies and bond polarity.		

10.2.2	Describe, using equations, the complete and incomplete combustion of alkanes.	Alkanes	
10.2.3	Describe, using equations, the reactions of methane and ethane with chlorine and bromine.	Halogenoalkanes	
10.2.4	Explain the reactions of methane and ethane with chlorine and bromine in terms of a free-radical mechanism.	Halogenoalkanes	

10.3 Alkenes

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
10.3.1	Describe, using equations, the reactions of alkenes with hydrogen and halogens.	Halogenoalkanes	
10.3.2	Describe, using equations, the reactions of symmetrical alkenes with hydrogen halides and water.	Alkenes Halogenoalkanes	
10.3.3	Distinguish between *alkanes* and *alkenes* using bromine water.	Alkenes	
10.3.4	Outline the polymerization of alkenes.	Alkenes	Polymers and Amino Acids
10.3.5	Outline the economic importance of the reactions of alkenes.		

10.4 Alcohols

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
10.4.1	Describe, using equations, the complete combustion of alcohols.		
10.4.2	Describe, using equations, the oxidation reactions of alcohols.	Alcohols	
10.4.3	Determine the products formed by the oxidation of primary and secondary alcohols.	Alcohols	

10.5 Halogenoalkanes

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
10.5.1	Describe, using equations, the substitution reactions of halogenoalkanes with sodium hydroxide.	Halogenoalkanes	
10.5.2	Explain the substitution reactions of halogenoalkanes with sodium hydroxide in terms of S_N1 and S_N2 mechanisms.		

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10.6 Reaction pathways

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
10.6.1	Deduce reaction pathways given the starting materials and the product.		Organic Synthesis

Topic 11: Measurement and data processing

11.1 Introduction

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
11.1.1	Describe and give examples of random uncertainties and systematic errors.		
11.1.2	Distinguish between *precision* and *accuracy*.		
11.1.3	Describe how the effects of random uncertainties may be reduced.		
11.1.4	State random uncertainty as an uncertainty range (±).		
11.1.5	State the results of calculations to the appropriate number of significant figures.		

11.2 Uncertainties in calculated results

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
11.2.1	State uncertainties as absolute and percentage uncertainties.		
11.2.2	Determine the uncertainties in results.		

11.3 Graphical techniques

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
11.3.1	Sketch graphs to represent dependences and interpret graph behaviour.		
11.3.2	Construct graphs from experimental data.		
11.3.3	Draw best-fit lines through data points on a graph.		
11.3.4	Determine the values of physical quantities from graphs.		

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Topic 12: Atomic structure

12.1 Electron configuration

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
12.1.1	Explain how evidence from first ionization energies across periods accounts for the existence of main energy levels and sub-levels in atoms.	Electron Arrangement	
12.1.2	Explain how successive ionization energy data is related to the electron configuration of an atom.	Electron Arrangement	
12.1.3	State the relative energies of s, p, d and f orbitals in a single energy level.	Electron Arrangement	
12.1.4	State the maximum number of orbitals in a given energy level.	Electron Arrangement	
12.1.5	Draw the shape of an s orbital and the shapes of the p_x, p_y and p_z orbitals.	Electron Arrangement	
12.1.6	Apply the Aufbau principle, Hund's rule and the Pauli exclusion principle to write electron configurations for atoms and ions up to $Z = 54$.	Electron Arrangement	

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Topic 13: Periodicity

13.1 Trends across period 3

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
13.1.1	Explain the physical states (under standard conditions) and electrical conductivity (in the molten state) of the chlorides and oxides of the elements in period 3 in terms of their bonding and structure.		Periodicity in Period 3
13.1.2	Describe the reactions of chlorine and the chlorides referred to in 13.1.1 with water.		Periodicity in Period 3

13.2 First-row d-block elements

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
13.2.1	List the characteristic properties of transition elements.		Introducing Transition Metals
13.2.2	Explain why Sc and Zn are not considered to be transition elements.		Introducing Transition Metals
13.2.3	Explain the existence of variable oxidation number in ions of transition elements.		Introducing Transition Metals
13.2.4	Define the term *ligand*.		Introducing Transition Metals
13.2.5	Describe and explain the formation of complexes of d-block elements.		Introducing Transition Metals Transition Metals: Colours and Reactions
13.2.6	Explain why some complexes of d-block elements are coloured.		Transition Metals: Colours and Reactions
13.2.7	State examples of the catalytic action of transition elements and their compounds.		Uses of Transition Metals
13.2.8	Outline the economic significance of catalysts in the Contact and Haber processes.		

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Topic 14: Bonding

14.1 Shapes of molecules and ions

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
14.1.2	Predict the shape and bond angles for species with five and six negative charge centres using the VSEPR theory.		

14.2 Hybridization

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
14.2.1	Describe σ and π bonds.	Alkenes	
14.2.2	Explain hybridization in terms of the mixing of atomic orbitals to form new orbitals for bonding.		Aromatic Compounds
14.2.3	Identify and explain the relationships between Lewis structures, molecular shapes and types of hybridization (sp, sp^2 and sp^3).		

14.3 Delocalization of electrons

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
14.3.1	Describe the delocalization of π electrons and explain how this can account for the structures of some species.	Alkenes	Aromatic Compounds

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Topic 15: Energetics

15.1 Standard enthalpy changes of reaction

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
15.1.1	Define and apply the terms standard state, *standard enthalpy change of formation* (ΔH_f^Θ) and *standard enthalpy change of combustion* (ΔH_c^Θ).	Energetics	Thermodynamics
15.1.2	Determine the enthalpy change of a reaction using standard enthalpy changes of formation and combustion.	Energetics	Thermodynamics

15.2 Born–Haber cycle

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
15.2.1	Define and apply the terms lattice enthalpy and electron affinity.		Thermodynamics
15.2.2	Explain how the relative sizes and the charges of ions affect the lattice enthalpies of different ionic compounds.		Thermodynamics
15.2.3	Construct a Born–Haber cycle for group 1 and 2 oxides and chlorides, and use it to calculate an enthalpy change.		Thermodynamics
15.2.4	Discuss the difference between theoretical and experimental lattice enthalpy values of ionic compounds in terms of their covalent character.		Thermodynamics

15.3 Entropy

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
15.3.1	State and explain the factors that increase the entropy in a system.		
15.3.2	Predict whether the entropy change (ΔS) for a given reaction or process is positive or negative.		
15.3.3	Calculate the standard entropy change for a reaction (ΔS^Θ) using standard entropy values (S^Θ).		

15.4 Spontaneity

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
15.4.1	Predict whether a reaction or process will be spontaneous by using the sign of ΔG^Θ.		Thermodynamics
15.4.2	Calculate ΔG^Θ for a reaction using the equation $\Delta G^\Theta = \Delta H^\Theta - T\Delta S^\Theta$ and by using values of the standard free energy change of formation, ΔG_f^Θ.		Thermodynamics

15.4.3	Predict the effect of a change in temperature on the spontaneity of a reaction using standard entropy and enthalpy changes and the equation $\Delta G^{\Theta} = \Delta H^{\Theta} - T\Delta S^{\Theta}$.		Thermodynamics

Topic 16: Kinetics

16.1 Rate expression

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
16.1.1	Distinguish between the terms *rate constant*, *overall order of reaction* and *order of reaction* with respect to a particular reactant.		Kinetics
16.1.2	Deduce the rate expression for a reaction from experimental data.		Kinetics
16.1.3	Solve problems involving the rate expression.		Kinetics
16.1.4	Sketch, identify and analyse graphical representations for zero-, first- and second-order reactions.		Kinetics

16.2 Reaction mechanism

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
16.2.1	Explain that reactions can occur by more than one step and that the slowest step determines the rate of reaction (rate-determining step).		Kinetics
16.2.2	Describe the relationship between reaction mechanism, order of reaction and rate-determining step.		Kinetics

16.3 Activation energy

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
16.3.1	Describe qualitatively the relationship between the rate constant (k) and temperature (T).		Kinetics
16.3.2	Determine activation energy (E_a) values from the Arrhenius equation by a graphical method.		

Topic 17: Equilibrium

17.1 Liquid–vapour equilibrium

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
17.1.1	Describe the equilibrium established between a liquid and its own vapour and how it is affected by temperature changes.		
17.1.2	Sketch graphs showing the relationship between vapour pressure and temperature and explain them in terms of the kinetic theory.		
17.1.3	State and explain the relationship between enthalpy of vaporization, boiling point and intermolecular forces.		

17.2 The equilibrium law

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
17.2.1	Solve homogeneous equilibrium problems using the expression for K_c.		Equilibria

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Topic 18: Acids and bases

18.1 Calculations involving acids and bases

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
18.1.1	State the expression for the ionic product constant of water (K_w).		Acids and Bases
18.1.2	Deduce $[H^+(aq)]$ and $[OH^-(aq)]$ for water at different temperatures given K_w values.		Acids and Bases
18.1.3	Solve problems involving $[H^+(aq)]$, $[OH^-(aq)]$, pH and pOH.		Acids and Bases
18.1.4	State the equation for the reaction of any weak acid or weak base with water, and hence deduce the expressions for K_a and K_b.		Acids and Bases
18.1.5	Solve problems involving solutions of weak acids and bases using the expressions: $K_a \times K_b = K_w$ $pK_a + pK_b = pK_w$ $pH + pOH = pK_w$.		Acids and Bases
18.1.6	Identify the relative strengths of acids and bases using values of K_a, K_b, pK_a and pK_b.		Acids and Bases

18.2 Buffer solutions

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
18.2.1	Describe the composition of a buffer solution and explain its action.		Acids and Bases
18.2.2	Solve problems involving the composition and pH of a specified buffer system.		Acids and Bases

18.3 Salt hydrolysis

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
18.3.1	Deduce whether salts form acidic, alkaline or neutral aqueous solutions.		

18.4 Acid–base titrations

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
18.4.1	Sketch the general shapes of graphs of pH against volume for titrations involving strong and weak acids and bases, and explain their important features.		Acids and Bases

18.5 Indicators

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
18.5.1	Describe qualitatively the action of an acid–base indicator.		Acids and Bases
18.5.2	State and explain how the pH range of an acid–base indicator relates to its pK_a value.		Acids and Bases
18.5.3	Identify an appropriate indicator for a titration, given the equivalence point of the titration and the pH range of the indicator.		Acids and Bases

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Topic 19: Oxidation and reduction

19.1 Standard electrode potentials

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
19.1.1	Describe the standard hydrogen electrode.		Redox Chemistry and Electrode Potentials
19.1.2	Define the term *standard electrode potential* ($E^{\ominus}$) .		Redox Chemistry and Electrode Potentials
19.1.3	Calculate cell potentials using standard electrode potentials.		Redox Chemistry and Electrode Potentials
19.1.4	Predict whether a reaction will be spontaneous using standard electrode potential values.		Redox Chemistry and Electrode Potentials

19.2 Electrolysis

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
19.2.1	Predict and explain the products of electrolysis of aqueous solutions.		
19.2.2	Determine the relative amounts of the products formed during electrolysis.		
19.2.3	Describe the use of electrolysis in electroplating.		

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Topic 20: Organic chemistry

20.1 Introduction

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
20.1.1	Deduce structural formulas for compounds containing up to six carbon atoms with one of the following functional groups: amine, amide, ester and nitrile.		Acyl Compounds Amines
20.1.2	Apply IUPAC rules for naming compounds containing up to six carbon atoms with one of the following functional groups: amine, amide, ester and nitrile.		Acyl Compounds Amines

20.2 Nucleophilic substitution reactions

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
20.2.1	Explain why the hydroxide ion is a better nucleophile than water.		
20.2.2	Describe and explain how the rate of nucleophilic substitution in halogenoalkanes by the hydroxide ion depends on the identity of the halogen.	Halogenoalkanes	
20.2.3	Describe and explain how the rate of nucleophilic substitution in halogenoalkanes by the hydroxide ion depends on whether the halogenoalkane is primary, secondary or tertiary.		
20.2.4	Describe, using equations, the substitution reactions of halogenoalkanes with ammonia and potassium cyanide.	Halogenoalkanes	
20.2.5	Explain the reactions of primary halogenoalkanes with ammonia and potassium cyanide in terms of the S_N2 mechanism.		
20.2.6	Describe, using equations, the reduction of nitriles using hydrogen and a nickel catalyst.		Amines

20.3 Elimination reactions

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
20.3.1	Describe, using equations, the elimination of HBr from bromoalkanes.	Halogenoalkanes	
20.3.2	Describe and explain the mechanism for the elimination of HBr from bromoalkanes.	Halogenoalkanes	

20.4 Condensation reactions

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
20.4.1	Describe, using equations, the reactions of alcohols with carboxylic acids to form esters, and state the uses of esters.		Acyl Compounds
20.4.2	Describe, using equations, the reactions of amines with carboxylic acids.		Polymers and Amino Acids
20.4.3	Deduce the structures of the polymers formed in the reactions of alcohols with carboxylic acids.		Polymers and Amino Acids
20.4.4	Deduce the structures of the polymers formed in the reactions of amines with carboxylic acids.		Polymers and Amino Acids
20.4.5	Outline the economic importance of condensation reactions.		

20.5 Reaction pathways

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
20.5.1	Deduce reaction pathways given the starting materials and the product.		Organic Synthesis

20.6 Stereoisomerism

	Assessment statements	Boardworks AS Chemistry	Boardworks A2 Chemistry
20.6.1	Describe stereoisomers as compounds with the same structural formula but with different arrangements of atoms in space.	Introducing Organic Chemistry	
20.6.2	Describe and explain geometrical isomerism in non-cyclic alkenes.	Introducing Organic Chemistry	
20.6.3	Describe and explain geometrical isomerism in C_3 and C_4 cycloalkanes.		
20.6.4	Explain the difference in the physical and chemical properties of geometrical isomers.		
20.6.5	Describe and explain optical isomerism in simple organic molecules.	Introducing Organic Chemistry	Organic Synthesis
20.6.6	Outline the use of a polarimeter in distinguishing between optical isomers.	Introducing Organic Chemistry	Organic Synthesis
20.6.7	Compare the physical and chemical properties of enantiomers.	Introducing Organic Chemistry	Organic Synthesis