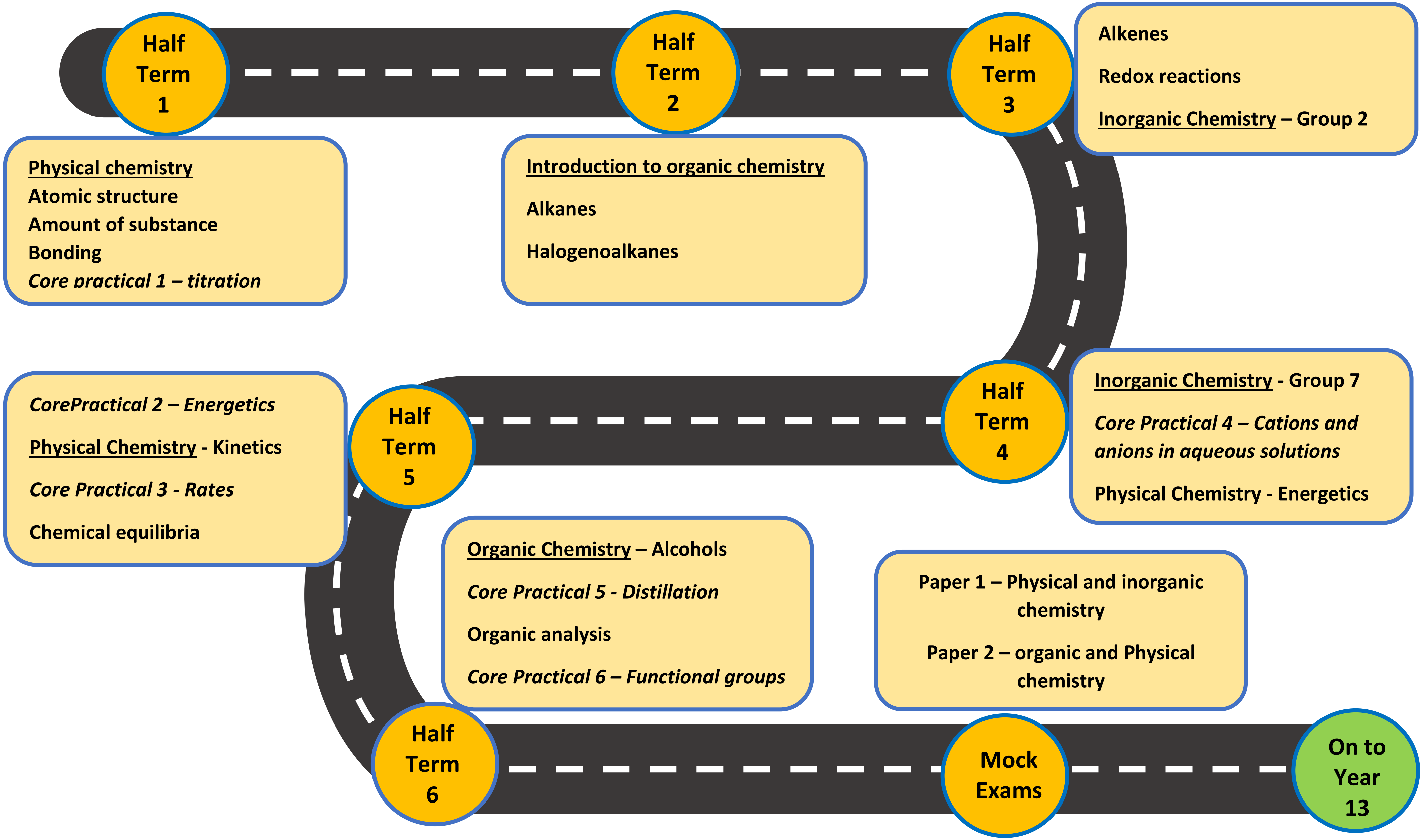
Eastbrook Sixth Form

Independent Study Guide

Chemistry

Year 12 Chemistry ROADMAP



Half Term 1

Physical chemistry
Atomic structure
Amount of substance
Bonding
Core practical 1 – titration

Half Term 2

Introduction to organic chemistry

Alkanes

Halogenoalkanes

Half Term 3

Alkenes

Redox reactions

Inorganic Chemistry – Group 2

Half Term 4

Inorganic Chemistry - Group 7

Core Practical 4 – Cations and anions in aqueous solutions

Physical Chemistry - Energetics

Half Term 5

CorePractical 2 – Energetics

Physical Chemistry - Kinetics

Core Practical 3 - Rates

Chemical equilibria

Half Term 6

Organic Chemistry – Alcohols

Core Practical 5 - Distillation

Organic analysis

Core Practical 6 – Functional groups

Mock Exams

Paper 1 – Physical and inorganic chemistry

Paper 2 – organic and Physical chemistry

On to Year 13

Year 12 Term One

Summary

Term 1 topics are for paper 1 and paper 2

In *atomic structure*, you will learn about the subatomic particles, isotopes, mass spectroscopy, electronic structure and ionisation energy. Know how to interpret and use data from mass spectrometry. You need to practice explaining trends using principles (like shielding and nuclear attraction).

In *bonding and structure*, you will study types of bonding, electronegativity, intermolecular forces, shapes of molecules and properties related structure. VSEPR and intermolecular forces regularly appear in structure and property questions.

In amount of substance, you will study the mole concept, RAM, empirical formula, ideal gas equation, atom economy. Titration calculations, limiting reagents and ionic equations. Be confident with mole calculations — they often underpin longer questions.

In alkanes, alkenes and halogenoalkanes, you will study the structure and properties, reactions, mechanisms and naming of all the basic organic molecules.

Assessment Objectives

AO1 – Knowledge and Understanding

- Description: Demonstrate knowledge and understanding of scientific ideas, techniques, and procedures

AO2 – Application

- Description: Apply knowledge and understanding of scientific ideas, techniques, and procedures.

AO3 – Analysis, Interpretation and Evaluation

- Description: Analyse, interpret, and evaluate scientific information, ideas, and evidence.

Required Reading List

AQA Chemistry by Ted Lister and Janet Renshaw 2nd edition
***Chemistry for AQA* by Clive Tiley (Hodder Education)**
aqa.org.uk – aqa official specification and past papers
chemguide.co.uk
https://chemrevise.org/revision-guides
Physics and maths tutor – A Level Chemistry

Additional Reading List

Periodic Table and Atomic Structure" sections in *Nelson Chemistry 1* (Nelson Thornes)
***AQA Chemistry A Level Year 1 & AS* by Graham Curtis (CGP) — Moles and gas calculations**

Self-Study Questions	**What the mark scheme says?**
1 Explain how a mass spectrometer works, including the stages of ionisation, acceleration, ion drift, and detection. **2** How can mass spectrometry be used to find relative atomic mass? **3** Explain the trends in first ionisation energy across a period and down a group. **4** Describe the arrangement of electrons in shells and sub-shells (s, p, d).	**1** Look for clear mention of all four stages, with key terms like ionisation, acceleration, drift, detection, and how ions separate. **2** Precision in describing the weighted average calculation is key. **3** Explain using shielding, nuclear attraction, and atomic radius to score higher marks **4** Clear and correct description of electron configuration principles is needed.
5 Compare and contrast ionic and covalent bonding in terms of electron transfer or sharing, melting points, electrical conductivity, and solubility. **6** Explain the types of intermolecular forces with examples and how they affect the properties of substances.	**5** Mark schemes reward answers that explicitly compare and use correct terminology like "electrostatic forces", "ions", "electron pairs", and mention physical states where conductivity occurs. **6** You must include Van der Waals (London dispersion) forces, Permanent dipole-dipole interactions and hydrogen bonding and how these affect mpts, bpts and solubility
7 Use VSEPR theory to predict the shapes of molecules and ions: Linear, Trigonal planar, tetrahedral, trigonal bipyramidal and octahedral	**7** The mark scheme rewards clear explanation of electron pair repulsion and specific shapes linked to number of electron pairs. Including bond angles strengthens the answer. Mentioning effect of lone pairs (if applicable) is often required for full marks.
8 Define relative atomic mass (Ar) and relative molecular (formula) mass (Mr). How are they calculated?	**8** Mark schemes often award marks for including both clear definitions and showing understanding of weighted averages for Ar. Correct terminology like "weighted average" and "relative abundance" is important.

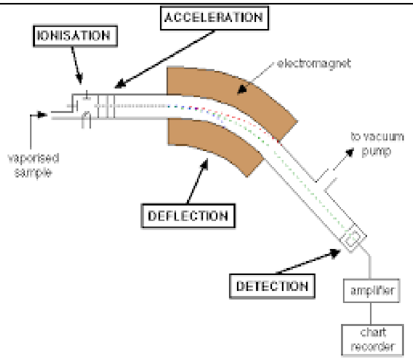
9 How do you use the ideal gas equation to calculate volume, pressure, temperature, or amount of gas? **10** Explain how to perform titration calculations to find the concentration of an unknown solution.	For Mr, stating it's the sum of Ar values in the molecule or formula is expected. Mark schemes reward clarity, correct formula, and correct rearrangements or substitutions. Using proper units and correct stoichiometric approach is also key for full marks
11 Describe the steps in the free radical substitution of methane with chlorine. **12** How do catalytic converters reduce harmful emissions?	Remember to include initiation, propagation and termination steps. Marks for balanced equations and stating the dangers of SO2 and CO.
13 Describe and explain the **electrophilic addition** mechanism with HBr. **14** Describe the **nucleophilic substitution** mechanisms with CN- and NH3 **15** Describe the **elimination reaction** of a halogenoalkane using ethanolic NaOH. **16** What is meant by **E/Z isomerism** and how is it determined?	Marks awarded for curly arrows, correct structure, charges and lone pairs. Use of **Cahn-Ingold-Prelog (CIP)** priority rules to assign E/Z is needed to get full marks

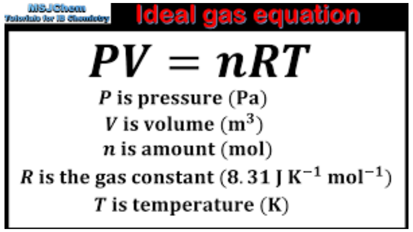
Where this term links with Career Prospects

Analytical Chemist: Uses knowledge of isotopes and mass spectrometry to identify substances in fields like environmental science, pharmaceuticals, or forensics.
Nuclear Scientist: Works with atomic particles and nuclear reactions, needing a deep grasp of atomic structure.
Chemical Engineer: Applies bonding principles to develop processes for manufacturing chemicals and materials.
Formulation Chemist: Calculates precise amounts of ingredients in products like cosmetics, paints, or food additives.
Environmental Scientist: Uses mole concept and gas laws to measure pollution levels and chemical changes in the atmosphere

Top Tip from the Department

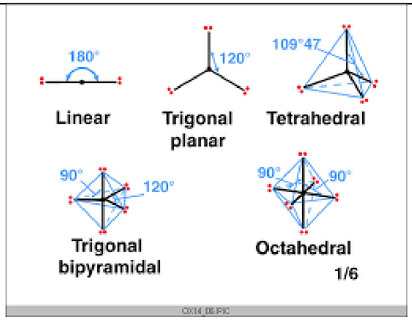
Understand the concepts, not just definitions.
Work through isotope abundance and relative atomic mass calculations repeatedly until confident.
Practice drawing shapes using VSEPR theory, showing lone pairs and bond angles.
Practice converting between moles, mass, volume, and number of particles until it becomes second nature.
Do lots of past paper questions to get comfortable with rearranging formulas and using the ideal gas equation.
Chemistry is logical; if you understand the principles, you'll find it easier to tackle tricky questions.

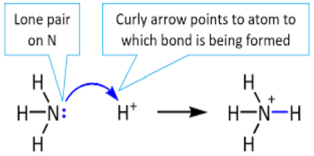



MSJChem Tutorials for IB Chemistry Ideal gas equation

$$PV = nRT$$

P is pressure (Pa)
V is volume (m^3)
n is amount (mol)
R is the gas constant ($8.31\ J\ K^{-1}\ mol^{-1}$)
T is temperature (K)





Year 12 Term Two

Summary	**Assessment Objectives**
For Papers 1 and 2 Redox reactions - You will learn how to Identify oxidising and reducing agents and being able to write half-equations and combine them into full redox equations Group 2 – You will study the trends in terms of atomic radius, ionisation energy, and charge density. Group 7 – you will learn to write and explain redox equations, recognise oxidising ability decreases and reducing ability increases down the group. Energetics – You will perform calorimetry calculations. Draw and interpret enthalpy level diagrams and apply Hess's law using data tables or cycles Core practicals - Record data accurately, calculate values, and evaluate errors. You need to describe apparatus and method clearly and safely. Identify and reduce uncertainties.	**AO1** – Knowledge and Understanding • Description: Demonstrate knowledge and understanding of scientific ideas, techniques, and procedures **AO2** – Application • Description: Apply knowledge and understanding of scientific ideas, techniques, and procedures. **AO3** – Analysis, Interpretation and Evaluation • Description: Analyse, interpret, and evaluate scientific information, ideas, and evidence.

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Self-Study Questions	**What the mark scheme says?**
1 Write ionic half-equations for the reaction between magnesium and hydrochloric acid. **2** Assign oxidation numbers to all atoms in: a) H_2SO_4 b) $KMnO_4$ c) Fe^{2+} and Fe^{3+}	*Half-equations* must show electrons correctly; combining them must result in a balanced full equation. Remember sum of oxidation numbers = 0 for a neutral compound. For ions, their oxidation number = their charge
3 Describe the trend in solubility of Group 2 hydroxides down the group **4** Why does reactivity increase down Group 2?	Trends explained using *charge density*, *shielding*, and *ionic radius*.
5 Describe and explain the trend in reactivity of halogens.	Boiling points increase down the group needs to be explained in terms of intermolecular forces.
6 Write ionic equations for halogen displacement reactions. **7** What happens when NaBr and NaI react with concentrated sulfuric acid?	Remember a **more reactive halogen displaces a less reactive halide ion**. Across halide ions, reducing ability increases down the group. You must be able to write half equations and full ionic equations.
8 Draw and label enthalpy profile diagrams for exothermic and endothermic reactions.	You should be able to define standard enthalpy changes: *formation, combustion, neutralisation* under standard conditions. Always draw a Hess's cycle to calculate enthalpy change. Diagrams must show correct **ΔH values** and direction

9 How do you determine ΔH using Hess's Law?	
10 What are the key steps in a titration? **11** Describe how you measure enthalpy change using a polystyrene cup. **12** What is observed when Group 2 metals react with water?	**Titration steps**: pipette known volume, add indicator, titrate with burette, swirl, note end-point, calculate titre; repeat for concordant results. **Polystyrene cup calorimetry**: measure mass, mix reactants, record temperature change, calculate ΔH; discuss energy losses and measurement accuracy. **Group 2 reactivity practical**: observe gas evolution, use acid titration to determine concentration of $M(OH)_2$ formed.

Where this term links with Career Prospects

Electrochemist - design of batteries, fuel cells, corrosion prevention

Medicine

Environmental science: water softening, pollution control using Group 2 compounds

Research scientist: experimental design and data analysis skills

Education: teaching practical chemistry in schools or colleges

Top Tip from the Department

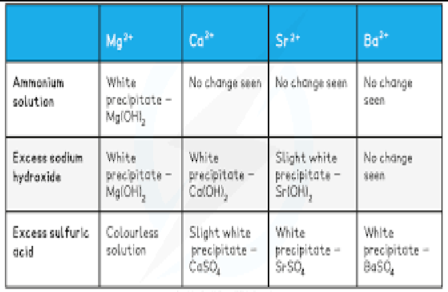
Focus on **why** trends happen, not just what happens. For example, why reactivity increases or decreases down a group.

Write and balance **half-equations** and full redox equations regularly.

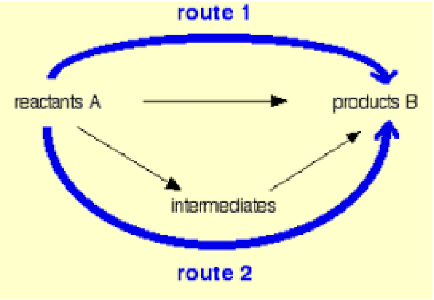
Know the **steps** for titrations and calorimetry by heart — and understand why each step matters.

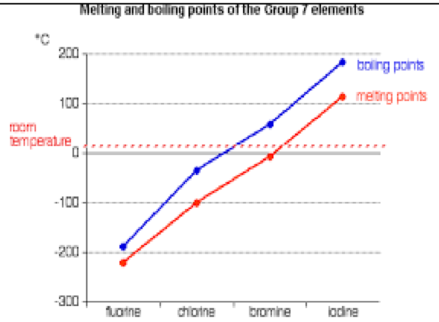
Practical calculating yields, concentrations, and enthalpy changes from your practical data.

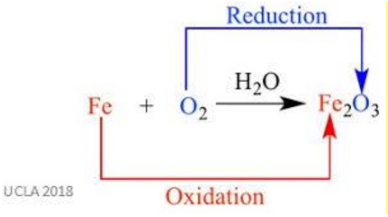
Don't hesitate to clarify doubts with teachers or peers. Teaching concepts to someone else is a great way to learn.

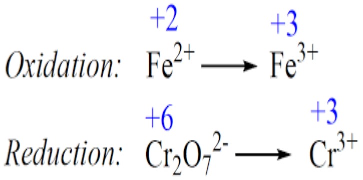


	Mg^{2+}	Ca^{2+}	Sr^{2+}	Ba^{2+}
Ammonium solution	White precipitate – $Mg(OH)_2$	No change seen	No change seen	No change seen
Excess sodium hydroxide	White precipitate – $Mg(OH)_2$	White precipitate – $Ca(OH)_2$	Slight white precipitate – $Sr(OH)_2$	No change seen
Excess sulfuric acid	Colourless solution	Slight white precipitate – $CaSO_4$	White precipitate – $SrSO_4$	White precipitate – $BaSO_4$









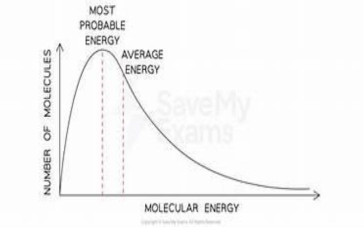
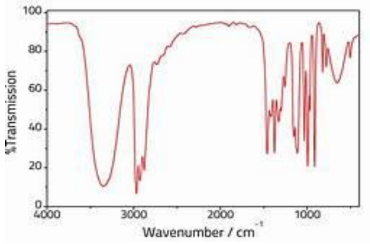
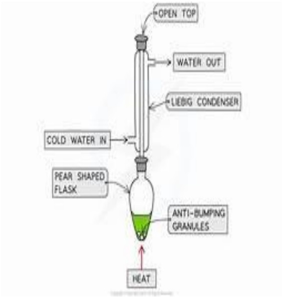
Year 12 Term Three

Summary	**Assessment Objectives**
For papers 1 and 2 Kinetics - you will learn about collision theory, Maxwell-Boltzman distribution which shows the distribution of molecular energies at given temperature and catalysts. Chemical equilibria – You will explore reversible reactions, Le Chatelier's Principle and perform calculations using equilibrium constant, Kc. Alcohols – You will learn how to classify alcohols as primary, secondary and tertiary, their reactions and mechanisms. Organic analysis – You will learn the tests for the presence of key functional groups; how Infrared Spectroscopy is used to identify bonds via absorption IR radiation and mass Spectrometry.	**AO1** – Knowledge and Understanding • Description: Demonstrate knowledge and understanding of scientific ideas, techniques, and procedures **AO2** – Application • Description: Apply knowledge and understanding of scientific ideas, techniques, and procedures. **AO3** – Analysis, Interpretation and Evaluation • Description: Analyse, interpret, and evaluate scientific information, ideas, and evidence.

Required Reading List	**Additional Reading List**
AQA Chemistry: A Level by Ted Lister & Janet Renshaw (Oxford University Press) ***AQA A2 Chemistry: Unit 4 – Kinetics, Equilibria and Organic Chemistry*** (Philip Allan Student Unit Guide by Margaret Cross) **chemguide.co.uk** **https://chemrevise.org/revision-guides** **Physics and maths tutor – A Level Chemistry**	***Modern Liquid Phase Kinetics*** (B. G. Cox) — an Oxford Chemistry Primer offering deeper insights into rate theory **Harris – *Quantitative Chemical Analysis*** and **Skoog et al. – *Fundamentals of Analytical Chemistry*** — frequently recommended for organic and instrumental method Oxford Chemistry Primers https://mrcolechemistry.co.uk/

Self-Study Questions	**What the mark scheme says?**
1 Describe how increasing the temperature affects the rate of a chemical reaction at the molecular level. **2** Sketch and compare two Maxwell–Boltzmann distributions: one at 300 K and one at 500 K. **3** How could you experimentally determine the rate of a reaction involving a gas?	**1** Link effect of temperature to kinetic energy of particles and activation energy. **2** Remember, curve at 500 K shifts right and flattens, peak is lower and further right and more particles with energy greater than activation energy. **3** Experimental determination of rate – you must; • Measure volume of gas evolved over time (e.g. using gas syringe) • Plot volume vs time and find gradient • Repeat at different concentrations
4 State Le Chatelier's Principle and explain it in terms of shifting equilibrium positions. **5** Consider the following equilibrium reaction: $N2(g)+3H2(g)\rightleftharpoons 2NH3(g)$ $\Delta H=-92$ kJ mol−1 • What happens to the position of equilibrium if the pressure is increased? • What is the effect of increasing temperature?	**4** Explain how the system in equilibrium reestablishes when change is made. **5** Apply the following key points • ↑ Pressure → shift right (fewer gas moles) • ↑ Temp → shift left (endothermic direction) • Yield of NH_3 decreases with increased temperature
6 Describe how a primary alcohol can be oxidised to an aldehyde and then to a carboxylic acid. **7** Outline a mechanism for the dehydration of ethanol using H_2SO_4.	**6** Alcohol + [O] → aldehyde (distil) Aldehyde + [O] → carboxylic acid (reflux) Use acidified potassium dichromate **7** Mechanism for dehydration • Step 1: Protonation of –OH group • Step 2: Loss of H_2O forming carbocation

	- Step 3: Elimination of H^+ to form alkene - Show curly arrows from bonds
8 How does infrared spectroscopy help identify organic compounds?	**8** In IR spectroscopy, bonds absorb specific IR frequencies and compare the wavenumbers with database for identification.
9 What causes fragmentation in mass spectrometry? **10** A mass spectrum has an M^+ peak at m/z = 60. Suggest a possible molecular formula	**9** Fragmentation is caused by molecule breaking into fragments when bombarded by high-energy electrons M^+ peak = molecular ion = molecular mass **10** Could be methyl ethanoate
Challenge/stretch Yourself **11** Explain how the concepts of **collision theory** and **equilibrium** could both be used to interpret the Haber Process. **12** Predict the IR spectrum features for ethanol, ethanal, and ethanoic acid and explain how they differ. **13** A compound contains C, H and O. Its mass spectrum shows M^+ = 88. IR spectrum shows a broad absorption at 3300 cm^{-1} and a sharp one at 1700 cm^{-1}. Deduce its structure.	**11** Remember, collision theory explains high pressure/temperature effects on rate, equilibrium shifts (Le Chatelier) favour product at high pressure and trade-off between rate and yield. **12** Use the data sheet to find the wave numbers for O-H, C=O bonds **13** B road OH + sharp C=O → carboxylic acid Possible structure: CH_3CH_2COOH (propanoic acid)

Where this term links with Career Prospects Process Chemist Pharmaceutical Scientist Chemical Engineer Research & Development Scientist Environmental Chemist Forensic scientist Toxicologist Medicine/Dentistry	**Top Tip from the Department** Always link changes (e.g. temperature, catalysts) to the number of particles with energy ≥ activation energy. Examiners love this phrase. It's not enough to say "rate increases" — explain *why* using collision theory and Maxwell–Boltzmann ideas. When applying Le Chatelier's Principle, always say what the system is opposing. Don't just say "it shifts left/right" — say *why* it does. Always state the oxidising agent and conditions when describing alcohol oxidation. **Write like a chemist, practice diagrams, learn the exact expectations from the AQA mark schemes.**	 		

Year 13 Chemistry ROADMAP

Half Term 1

<u>Physical Chemistry</u>
Thermodynamics
Rate equations
Core Practical 7 – Initial rate method

Half Term 2

<u>Organic Chemistry</u> – Optical isomers, Carbonyls and Carboxylic acids

<u>Physical</u> – Kp, acids and bases

Core Practical 9 – acids and bases

Aromatic Chemistry, Amines, Polymers and DNA

Mock Exams

Paper 1 – Physical and Inorganic Chemistry

Paper 2 – Organic and Physical Chemistry

Electrochemical cells

Core Practical 8 – Electrochemical cell

Transition metals

Reactions of ions in aqueous solutions

Half Term 3

Period 3 elements and oxides

NMR, Chromatography and organic analysis

Core Practical 12 - TLC

Half Term 4

Revision

Half Term 5

Paper 1 – Physical and Inorganic Chemistry

Paper 2 – Organic and Physical Chemistry

Paper 3 – All the topics and Core Practicals

Final Exams

Further Education

Year 13 Term One

Summary	Assessment Objectives
Needed for papers 1 + 2 Thermodynamics – you will learn how to construct and use Born Haber cycles to calculate lattice enthalpy of formation or dissociation. To be able to use $\Delta G=\Delta H-T\Delta S$ for calculations. Rate equations – You will learn how to use Rate=k[A]m[B]n to calculate overall order, initial rates method and rate determining steps. Carbonyls – You will explore the structures, reactions and mechanisms for aldehydes, ketones and carboxylic acid derivatives. Acids and bases – You will be taught how to use the following equations; • $pH = -\log[H^+]$ • Ka = [H+][A−]/[HA] • pKa = –log(Ka) • Kw = [H+][OH−] Aromatic chemistry – You will learn the structure, bonding, reactions and mechanisms. Amines - You will learn the structure, basicity, reactions and mechanisms.	**Assessment Objectives** **AO1** – Knowledge and Understanding • Description: Demonstrate knowledge and understanding of scientific ideas, techniques, and procedures **AO2** – Application • Description: Apply knowledge and understanding of scientific ideas, techniques, and procedures. **AO3** – Analysis, Interpretation and Evaluation • Description: Analyse, interpret, and evaluate scientific information, ideas, and evidence.

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Self-Study Questions	What the mark scheme says?
1 Define the following: • Enthalpy of atomisation • First ionisation energy • Lattice enthalpy of formation **2** Construct a Born–Haber cycle for the formation of $MgCl_2$ and calculate the lattice enthalpy given enthalpies of formation, atomisation, ionisation, and electron affinity.	**Use correct sign conventions** Lattice enthalpy of **formation** = exothermic (–); enthalpy of **dissociation** = endothermic (+) **Set up your Born–Haber cycle vertically**, not just with Hess's Law boxes Makes it easier to assign signs and apply Hess's Law
3 Describe how you could use initial rates to determine the order with respect to a reactant	**Orders of reaction must come from data**, not chemical equations Even if the equation suggests a 1:1 mole ratio, that doesn't determine rate law. Remember doubling [X] **doubles** rate for 1st order and doubling [X] **quadruples** rate for 2nd order
4 What is a buffer solution and how does it work? **5** A weak acid has Ka = 1.8×10^{-5} mol dm^{-3}. Calculate the pH of a 0.1 mol dm^{-3} solution **6** A buffer contains 0.2 mol dm^{-3} ethanoic acid and 0.1 mol dm^{-3} sodium ethanoate (Ka = 1.74×10^{-5}). Calculate the pH.	Buffer resists pH changes by neutralising added acid/base [H+] =Ka×[HA] You could use pH=pKa+log10([HA][A−])

7 Explain why benzene is more stable than expected from its structure. **8** Write a balanced equation and mechanism for the nitration of benzene.	**benzene stability** • Enthalpy of hydrogenation is less exothermic than expected • Indicates delocalisation/stabilisation of π-electrons • Benzene has equal C–C bond lengths Mechanism = Curly arrow from benzene ring to NO_2^+; Formation of arenium ion, then H^+ lost
9 Compare the base strength of ammonia, methylamine, and phenylamine. **10** How would you synthesise ethylamine from chloroethane?	Discuss why amines act as bases, compare basicity using inductive effect. Remember to use excess ammonia to prevent secondar/tertiary amines being formed
11 A reaction has ΔH = –50 kJ mol^{-1} and ΔS = –120 J $mol^{-1}K^{-1}$. a) Calculate ΔG at 298 K. b) Is the reaction feasible? **12** Compare and contrast the mechanisms of nucleophilic addition (carbonyls) and electrophilic substitution (benzene). **13** Explain how a buffer system works in blood using the H_2CO_3/HCO_3^- system.	**Convert entropy units to kJ $mol^{-1}K^{-1}$ before using ΔG = ΔH – TΔS** Divide J by 1000 — don't forget this or your feasibility answer will be wrong! Nucleophilic addition: involves attack on δ^+ carbon of polar C=O Electrophilic substitution: attack of electrophile on electron-rich benzene ring Different mechanisms, both involve intermediates and reformation of π-bond Remember this buffer system works in **dynamic balance with CO_2 levels**

Where this term links with Career Prospects

Pharmacologist
Analytical Chemist
Chemical Process Engineer
Forensic Scientist
Materials Chemist
Cosmetic Formulator
Environmental Scientist

University Degrees
These Topics Support
Chemistry, Physics, Engineering
Pharmacy, Biomedical Science
Neuroscience, Pharmaceutical Sciences
Medicinal Chemistry, Forensics

Top Tip from the Department

Use correct chemical terminology — AQA rewards clarity and penalizes vague phrases like "more reactive" or "faster"

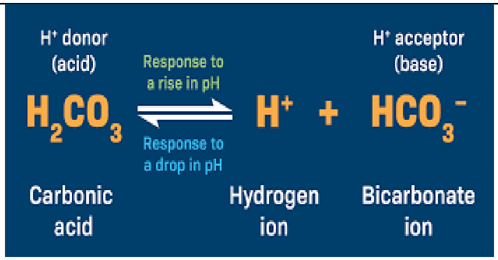
Curly arrows = precision

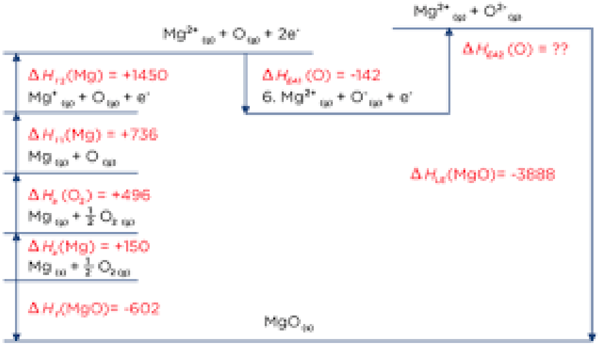
- Curly arrow starts **at lone pair or bond**, ends at **atom or bond**
- No floating arrows!

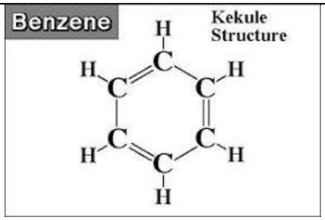
For all mechanisms:

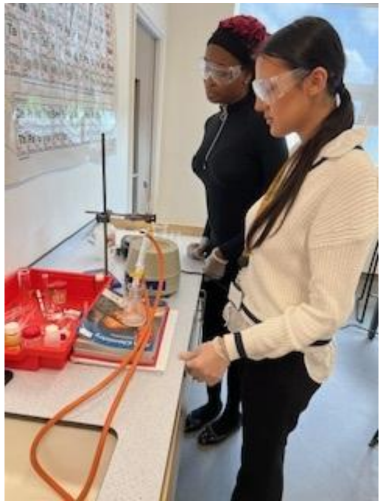
- **State type** (e.g., nucleophilic addition, electrophilic substitution)
- **Show lone pairs if relevant**
- Use correct **intermediate names or structures**

Mark schemes often want:
Reagent, Conditions, Observation (if applicable) and Full equations (not just word equations)









Year 13 Term Two

Summary	**Assessment Objectives**
Needed for paper 1 and paper 2 Electrochemical cells – You will learn how to construct electrochemical cells using two half cells, calculate standard electrode potentials from data tables, be able to write cell notation and how batteries and fuel cells work. Transition metals – You will learn their characteristic properties, how ligand bind to metal ions, how to draw complex ions, ligand substitution reactions and catalysis. Period 3 – You will explore their reactions with water and oxygen, properties of their oxides, trends in physical properties and chemical equations. NMR – Principles of NMR, interpretation of ^{1}H NMR & ^{13}C NMR spectra and how to deduce the structure of organic molecules will be taught. TLC -The basic principles, how to calculate and interpret Rf values will be explored.	**Assessment Objectives** **AO1** – Knowledge and Understanding • Description: Demonstrate knowledge and understanding of scientific ideas, techniques, and procedures **AO2** – Application • Description: Apply knowledge and understanding of scientific ideas, techniques, and procedures. **AO3** – Analysis, Interpretation and Evaluation • Description: Analyse, interpret, and evaluate scientific information, ideas, and evidence.

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AQA Chemistry: A Level by Ted Lister & Janet Renshaw (Oxford University Press) ***AQA A2 Chemistry:*** (Philip Allan Student Unit Guide by Margaret Cross) **chemguide.co.uk** **https://chemrevise.org/revision-guides** **Physics and maths tutor – A Level Chemistry**	**Calculations in AS/A Level Chemistry** – Jim Clark **Inorganic Chemistry** – Housecroft & Sharpe **Organic Chemistry** – Clayden, Greeves & Warren
Self-Study Questions	**What the mark scheme says?**
1 A student wants to design a cell with the highest possible voltage using metals from the reactivity series. a) Suggest two metals and explain your choice using E° values. b) Explain what limits the practical use of this theoretical voltage 2 Explain how a lithium-ion rechargeable battery works, and compare its redox reactions during charging and discharging	Choose a very reactive metal and an unreactive metal, use data books and calculate the maximum cell voltage. Common mistakes are students write a half-cell reaction but forget to balance electrons or explain which electrode is oxidised. Thick about side **reactions**, **corrosion**, or **instability** of electrodes can reduce real voltage output. Some materials are **too expensive** or impractical to use. Standard conditions are difficult to achieve, and some metals are far too reactive. The battery operates via **redox reactions** that occur during **charging** and **discharging.**
3 Explain why $[Fe(H_2O)_6]^{3+}$ is more acidic in solution than $[Fe(H_2O)_6]^{2+}$. When excess $EDTA^{4-}$ is added to $[Cu(H_2O)_6]^{2+}$, a ligand substitution reaction occurs: [Cu(H2O)6]2+ + EDTA4- → [CuEDTA]2− + 6H2O a) Explain why this reaction is entropically favourable. b) Why is the resulting complex more stable?	Higher oxidation state → higher charge density → stronger polarization → easier proton loss → more acidic. **Compare charges:** Fe^{3+} vs Fe^{2+} — Fe^{3+} has higher positive charge attracting electron density away from water molecules More particles → greater disorder → positive ΔS → entropically favourable
4 Explain the structure and bonding of SiO_2 and P_4O_{10}, and how this relates to their boiling points. 5 Compare and contrast the acid-base character and bonding of Na_2O, Al_2O_3, and SO_3.	**Use the correct terminology**: e.g., "giant covalent", "simple molecular", "ionic with covalent character". **Link bonding type to property**: Always explain *why* the structure/bonding leads to high/low boiling points or acidic/basic behaviour. Include equations!
6 Explain what each part of an NMR spectrum tells you: • Number of peaks	Use precise terminology like **"chemical environment," "spin-spin coupling," "integration area,"** and **"adjacent protons."**

- Chemical shift - Integration - Splitting 7 How would you distinguish between **butanoic acid** and **methyl propanoate** using: - ^{1}H NMR - ^{13}C NMR - Infrared spectroscopy 8 A ^{13}C NMR spectrum shows four peaks for a compound with molecular formula $C_5H_{10}O$. Suggest a structure and justify it using symmetry and carbon environments	Mention the **n+1 rule** explicitly for splitting if relevant. You might also get marks for examples, e.g., “A singlet means no neighbouring protons,” or “A triplet indicates two adjacent protons.” Identify the acid proton in butanoic acid (broad peak, high ppm). Identify methyl ester proton singlet in methyl propanoate. Note differences in splitting/chemical shifts of alkyl protons. Differentiate by chemical shift of carbonyl carbon (acid vs ester). Presence of methyl ester carbon peak in methyl propanoate. Number of peaks and chemical shifts consistent with each structure. Suggest a structure consistent with molecular formula and number of carbons. Explain fewer peaks due to equivalent carbon environments (symmetry). Mention carbon types (e.g., carbonyl carbon, methyl, etc.).
9 Describe the basic setup and purpose of TLC 10 Why do some spots move further up the TLC plate than others? 11 How can you use TLC to determine the purity of a compound?	Main points to include are: Sample spotted near the base of TLC plate. Developing solvent moves up by capillary action. Separation occurs because components move different distances. Used to separate, identify, or check purity of compounds. Distance travelled depends on interaction with stationary phase. More polar compounds interact strongly with stationary phase and move less. One spot indicates purity. Multiple spots indicate impurities. Compare Rf values with reference compounds.

Where this term links with Career Prospects	**Top Tip from the Department**			
Pharmacologist Analytical Chemist Chemical Process Engineer Forensic Scientist Materials Chemist Cosmetic Formulator Environmental Scientist Radiologist **University Degrees** These Topics Support Chemistry, Physics, Engineering Pharmacy, Biomedical Science Neuroscience, Pharmaceutical Sciences Medicinal Chemistry, Forensics	Focus on *why* things happen (e.g., why SiO_2 has a high melting point) instead of just memorizing facts. Regularly sketch molecules, NMR peaks, and TLC plates. Visual practice cements your understanding. Use correct terms like “chemical environment,” “spin-spin coupling,” “Rf value,” and “giant covalent” confidently in your answers. Allocate time per question and leave time to check answers. Master foundational knowledge (atomic structure, bonding) to support learning complex topics.