

Pinner High School: A-Level Chemistry

Welcome to A-Level Chemistry! We will be going further into how atoms are arranged and their structure and relationships in reactions. It is a tough course but very rewarding! This transition work is designed to help bridge the gap between GCSE and A-Level.

Compulsory Summer tasks:

- The tasks to complete are compulsory are in the booklet provided. The tasks cover the core Chemistry principles. They are not test but make sure you are able to confidently complete each section.
- Please bring them into me, Dr. Munir, in the first lesson in September.

Advised work

You will benefit from keeping up to date with current conversations in Chemistry. Here are some links to consider:

- Royal Society of Chemistry: <https://www.rsc.org/> and <https://www.chemistryworld.com/>
- Science Daily: https://www.sciencedaily.com/news/matter_energy/chemistry/
- American Chemical Society: <https://cen.acs.org/>
- List of Chemistry related podcasts: <https://geniuslabgear.com/blogs/for-scientists/best-chemistry-podcasts>

Optional Work:

- Research an area an area of Chemistry that interests you and write one side of A4 on the topic. I look forward to reading those who complete this!

GCSE to A-Level Transition Booklet

A complete guide for students moving from GCSE Science to A-Level Chemistry

This booklet combines resources from AQA and Oxford University Press to support your transition. It covers:

- Understanding the A-Level specification and assessment structure
- Key scientific vocabulary and practical science terminology
- SI units, prefixes, and data conversion
- Core maths skills: standard form, significant figures, unit conversion
- Balancing equations, rearranging formulae, calculating concentrations
- Molar calculations, percentage yield, and percentage error
- Atomic structure, formulae, ions, empirical formulae
- Graphs, tangents, and reaction rates
- Extended writing: types of bonding

Sources: AQA Student Transition Activities (2020/2023) and Oxford University Press A Level Sciences GCSE → A Level Transition Student Sheet (2019).

Complete this after you have finished the booklet:

Self-Assessment Checklist

Tick each skill as Strength (✓✓) or To Develop (✓) after completing the questions above.

Skill	✓✓	✓	Skill	✓✓	✓
Done with care and thoroughness			Can work out % yield		
Shows suitable working			Understands why yield < 100%		
Can write ionic formulae			Can work out % atom economy		
Can work out Mr			Understands limiting reagents		
Work out moles from mass			Can work out gas volumes		
Use equation to find reacting moles			Can determine reacting ratios		
Can work out mass from moles			Solution (titration) calculations		
Convert units (kg ↔ g)			Convert mol/dm ³ to g/dm ³		
Understands reacting gas volumes			Does not round numbers too early		
Determines formula from ratios			Can use significant figures correctly		
Knows titration apparatus			Always gives units in answers		

Section 1: Understanding the Specification and Assessment

Specification at a Glance

The AQA A-Level Chemistry specification is divided into three broad areas:

- 3.1 Physical chemistry
- 3.2 Inorganic chemistry
- 3.3 Organic chemistry

Content Common to AS and A-Level

3.1 Physical Chemistry	3.2 Inorganic Chemistry	3.3 Organic Chemistry
3.1.1 Atomic structure	3.2.1 Periodicity	3.3.1 Introduction to organic chemistry
3.1.2 Amount of substance	3.2.2 Group 2, the alkaline earth metals	3.3.2 Alkanes
3.1.3 Bonding	3.2.3 Group 7(17), the halogens	3.3.3 Halogenoalkanes
3.1.4 Energetics		3.3.4 Alkenes
3.1.5 Kinetics		3.3.5 Alcohols
3.1.6 Chemical equilibrium, Le Chatelier's principle and K_c		3.3.6 Organic analysis
3.1.7 Oxidation, reduction and redox equations		

A-Level Only Content

3.1 Physical Chemistry	3.2 Inorganic Chemistry	3.3 Organic Chemistry
3.1.8 Thermodynamics	3.2.4 Properties of Period 3 elements and their oxides	3.3.7 Optical isomerism
3.1.9 Rates of reaction	3.2.5 Transition metals	3.3.8 Aldehydes and ketones
3.1.10 Equilibrium constant K_p	3.2.6 Reactions of ions in aqueous solution	3.3.9 Carboxylic acids and derivatives
3.1.11 Electrode potentials and electrochemical cells		3.3.10 Aromatic chemistry
3.1.12 Acids and bases		3.3.11 Amines
		3.3.12 Polymers
		3.3.13 Amino acids, proteins and DNA
		3.3.14 Organic synthesis
		3.3.15 Nuclear magnetic resonance spectroscopy
		3.3.16 Chromatography

Assessment Structure

AS Level — Two Written Papers

AS Paper 1	
What's assessed	Relevant Physical chemistry (3.1.1–3.1.4, 3.1.6, 3.1.7); Inorganic chemistry (3.2.1–3.2.3); Practical skills
How it's assessed	Written exam: 1 hour 30 mins 80 marks 50% of AS
Questions	65 marks short and long answer; 15 marks multiple choice

AS Paper 2	
What's assessed	Relevant Physical chemistry (3.1.2–3.1.6); Organic chemistry (3.3.1–3.3.6); Practical skills
How it's assessed	Written exam: 1 hour 30 mins 80 marks 50% of AS
Questions	65 marks short and long answer; 15 marks multiple choice

A-Level — Three Written Papers

A-Level Paper 1	
What's assessed	Relevant Physical chemistry (3.1.1–3.1.4, 3.1.6–3.1.8, 3.1.10–3.1.12); Inorganic chemistry (Section 3.2); Practical skills
How it's assessed	Written exam: 2 hours 105 marks 35% of A-level
Questions	105 marks of short and long answer questions

A-Level Paper 2	
What's assessed	Relevant Physical chemistry (3.1.2–3.1.6, 3.1.9); Organic chemistry (Section 3.3); Practical skills
How it's assessed	Written exam: 2 hours 105 marks 35% of A-level
Questions	105 marks of short and long answer questions

A-Level Paper 3	
What's assessed	Any content; Any practical skills
How it's assessed	Written exam: 2 hours 90 marks 30% of A-level
Questions	40 marks practical techniques and data analysis; 20 marks cross-specification; 30 marks multiple choice

Assessment Objectives (AOs)

AO1 (~30%)	Demonstrate knowledge and understanding of scientific ideas, processes, techniques, and procedures.
AO2 (~45%)	Apply knowledge and understanding in theoretical and practical contexts, when handling qualitative and quantitative data.
AO3 (~25%)	Analyse, interpret, and evaluate scientific information, ideas, and evidence; make judgements and reach conclusions; develop and refine practical design and procedures.

At least 20% of marks assess mathematical skills (equivalent to Level 2 / Higher Tier GCSE Maths or above).

At least 15% of marks assess knowledge, skills, and understanding in relation to practical work.

Section 2: Scientific Vocabulary

Understanding and applying the correct terms are essential for practical science and written examinations. Learn each definition thoroughly, then cover the right-hand column and test yourself.

Designing an Investigation

Hypothesis	A proposal intended to explain certain facts or observations.
Independent variable	A variable selected by the investigator whose values are changed during the investigation.
Dependent variable	A variable that is measured as the outcome of an experiment (measured every time the independent variable is changed).
Control variable	A variable that is kept constant to avoid it affecting the dependent variable.
Range	The maximum and minimum values of the independent or dependent variable.
Interval	The quantity between readings — e.g. 11 readings equally spaced over 1 metre gives an interval of 10 cm.
Fair test	A test in which only the independent variable is allowed to affect the dependent variable.

Making Measurements

Valid measurement	A measurement that measures what it is supposed to be measuring.
True value	The value that would be obtained in an ideal measurement where there were no errors of any kind.
Accurate	A result that is close to the true value.
Precise	Repeated measurements that are very similar to (consistent with) each other and the calculated mean value.
Repeatability	How precise repeated measurements are when taken by the same person, using the same equipment, under the same conditions.
Reproducibility	How precise repeated measurements are when taken by different people, using different equipment.
Resolution	The smallest change that can be measured using the measuring instrument that gives a readable change in the reading.
Uncertainty	The interval within which the true value is expected to lie.
Measurement error	The difference between a measured value and the true value.

Errors

Random error	Causes readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next. Reduced by repeating measurements and calculating a mean.
Systematic error	A consistent difference between measured values and true values; causes readings to differ from the true value by a consistent amount each time a measurement is made.

Zero error

A type of systematic error; the measuring instrument gives a false reading when the true value of the measured quantity is zero.

Section 3: SI Units, Prefixes, and Data Conversion

Every measurement has a size and a unit. The SI (Système International) unit system provides a standard so that, for example, a kilogram in the UK is the same as a kilogram in China. There are seven SI base units:

Physical Quantity	SI Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Common Prefixes

Very large and very small numbers are expressed using prefixes. The most important are:

Prefix (symbol)	Power of 10	Multiplication factor
Tera (T)	10^{12}	1 000 000 000 000
Giga (G)	10^9	1 000 000 000
Mega (M)	10^6	1 000 000
kilo (k)	10^3	1 000
deci (d)	10^{-1}	0.1
centi (c)	10^{-2}	0.01
milli (m)	10^{-3}	0.001
micro (μ)	10^{-6}	0.000 001
nano (n)	10^{-9}	0.000 000 001
pico (p)	10^{-12}	0.000 000 000 001
femto (f)	10^{-15}	0.000 000 000 000 001

Note: Speed is written as $m s^{-1}$ at A-level, not m/s as at GCSE.

Activity 1 — SI Units and Prefixes

1. What is the most appropriate unit for each of the following measurements?

- The mass of water in a test tube.
- The volume of water in a burette.
- The time taken for a solution to change colour.
- The radius of a gold atom.
- The number of particles (e.g. atoms) in a chemical.
- The temperature of a liquid.

2. Rewrite the following quantities using correct SI units.

- g. a. 0.5 litres
- h. b. 5 minutes
- i. c. 20 °C
- j. d. 70 °F
- k. e. 10 mL (millilitres)
- l. f. 5.5 tonnes
- m. g. 96.4 microlitres (µL)

3. A flow rate of 240 grams per minute was recorded at 20 °C. Rewrite this flow rate using correct SI units. Show your working.

Activity 2 — Converting Data

Rewrite each of the following:

- 1. 1. 0.1 metres in millimetres
- 2. 2. 1 centimetre in millimetres
- 3. 3. 104 micrograms in grams
- 4. 4. 1.1202 kilometres in metres
- 5. 5. 70 decilitres in millilitres
- 6. 6. 70 decilitres in litres
- 7. 7. 10 cm³ in litres
- 8. 8. 2140 pascals in kilopascals
- 9. 9. 300 µm to m
- 10. 10. 5 MJ to mJ
- 11. 11. 10 GW to kW

Section 4: Core Maths Skills

Throughout A-Level Chemistry you must be proficient in standard form, significant figures, decimal places, SI units, and unit conversion. At least 20% of A-level marks assess maths skills.

4.1 Standard Form

Very large and very small numbers are written in standard form: $A \times 10^x$, where A is a number from 1 to 10 and x is the number of places you move the decimal point.

Example: $50\,000\text{ mol dm}^{-3} = 5 \times 10^4\text{ mol dm}^{-3}$; $0.000\,02\text{ Nm}^2 = 2 \times 10^{-5}\text{ Nm}^2$

Activity 3 — Standard Form

1. Write the following numbers in standard form:

- n. a. 4 000
- o. b. 1 000 000
- p. c. Boiling point of sodium chloride: $1413\text{ }^\circ\text{C}$
- q. d. Largest nanoparticles: $0.0001 \times 10^{-3}\text{ m}$
- r. e. Number of atoms in 1 mol of water: 1806×10^{21}

2. Change the following values to ordinary numbers:

- s. a. 5.5×10^{-6}
- t. b. 2.9×10^2
- u. c. 1.115×10^4
- v. d. 1.412×10^{-3}
- w. e. 7.2×10^1

3. A zinc oxide nanoparticle is a cube of side 82 nm. Calculate its surface area and give your answer in standard form.

4. A 1.00 g sample of toothpaste contains $2.88 \times 10^{-5}\text{ mol}$ of sodium fluoride (NaF; $M_r = 42$). Calculate the concentration in ppm (1 ppm = 1 mg per kg) to 3 significant figures.

4.2 Significant Figures and Decimal Places

Only record digits that are meaningful. Zeros before a figure are not significant (e.g. 0.000 435 has 3 s.f.). Zeros between significant figures are significant (e.g. 0.003 018 = 0.003 02 to 3 s.f.).

Activity 4 — Significant Figures

1. Express the following to 3 significant figures:

- x. a. 57 658
- y. b. 0.045 346
- z. c. 36.937
- aa. d. 0.043 19

2. Express the following to the stated number of significant figures:

bb. a. 258 (2 s.f.)

cc. b. 7 999 032 (1 s.f.)

3. Give the following to the stated number of decimal places:

dd. a. 4.763 (1 d.p.)

ee. b. 0.543 (2 d.p.)

ff. c. 1.005 (2 d.p.)

gg. d. 1.9996 (3 d.p.)

4. Using: number of molecules = moles \times 6.02×10^{23} , calculate the number of molecules in 0.5 mol of oxygen. Give your answer in standard form to 3 s.f.

4.3 The Delta Symbol (Δ)

The symbol Δ means 'change in'. You will encounter it frequently in energetics (ΔH = enthalpy change), kinetics, and equilibrium.

Activity 5 — Using the Delta Symbol (Energetics)

The diagram below represents the reaction profile for the reaction between zinc and copper sulfate solution (sketch your own or refer to your textbook).

12. 1. Which point on the profile represents the products of the reaction?

13. 2. Which arrow or region represents the activation energy?

14. 3. Complete the sentence: 'The reaction is _____ and therefore ΔH is _____.' (Use: endothermic / exothermic / negative / positive)

Section 5: Atomic Structure

Learn these definitions and facts thoroughly — they underpin much of A-Level Physical Chemistry.

Atom	A nucleus containing protons and neutrons, surrounded by electrons.
Proton	Relative mass = 1; relative charge = +1.
Neutron	Relative mass = 1; relative charge = 0.
Electron	Relative mass = 1/1840; relative charge = -1.
Atomic number (Z)	The number of protons in the nucleus of a single atom of an element. In a neutral atom, this also equals the number of electrons.
Mass number (A)	Number of protons + number of neutrons.
Isotope	An atom with the same number of protons but a different number of neutrons.
Ion	An atom, or group of atoms, with a charge.
Strong nuclear force	The force that holds an atomic nucleus together.
Mass spectrometer	An instrument that accurately determines the mass and abundance of separate atoms or molecules.
Electron shells	Main energy levels. Shell n holds a maximum of $2n^2$ electrons. Shell 1 = $2e^-$; Shell 2 = $8e^-$; Shell 3 = $18e^-$.
Sub-shells (orbitals)	s, p, d, f (in order of energy). Each orbital holds a maximum of 2 electrons.
Ionisation energy	The energy required to remove one mole of electrons from one mole of gaseous atoms. Unit: kJ mol^{-1} .
Relative atomic mass (Ar)	Average mass of 1 atom \div ($1/12 \times$ mass of 1 atom of ^{12}C)
Relative molecular mass (Mr)	Average mass of 1 molecule \div ($1/12 \times$ mass of 1 atom of ^{12}C)

Activity 6 — Atoms and the Periodic Table

1. Use the periodic table to give the atomic number of:

- hh. a. Osmium
- ii. b. Lead
- jj. c. Sodium
- kk. d. Chlorine

2. Give the relative atomic mass (Ar) of:

- ll. a. Helium
- mm. b. Francium
- nn. c. Barium
- oo. d. Oxygen

3. Give the number of neutrons in each element:

- pp. a. Fluorine
- qq. b. Beryllium
- rr. c. Gold

Activity 7 — Isotopes and Relative Atomic Mass

1. What is the relative atomic mass of bromine if ^{79}Br and ^{81}Br exist in equal amounts?
2. A sample of neon is made up of: $^{20}\text{Ne} = 90.9\%$; $^{21}\text{Ne} = 0.3\%$; $^{22}\text{Ne} = 8.8\%$. Calculate the relative atomic mass of neon to 4 significant figures.
3. Copper's isotopes are ^{63}Cu and ^{65}Cu . If $A_r(\text{Cu}) = 63.5$, what are the relative abundances of these isotopes?

Section 6: Formulae, Ions, and Equations

Common Formulae

Activity 8 — Formulae of Common Compounds

State the formulae of the following compounds:

1. Methane
2. Sulfuric acid
3. Potassium manganate(VII)
4. Water

Ions and Ionic Compounds

The table below lists formulae of common ions. Use it to work out the formulae of ionic compounds.

Positive ions	Formula	Negative ions
Aluminium	Al^{3+}	Bromide — Br^-
Ammonium	NH_4^+	Carbonate — CO_3^{2-}
Barium	Ba^{2+}	Chloride — Cl^-
Calcium	Ca^{2+}	Fluoride — F^-
Copper(II)	Cu^{2+}	Iodide — I^-
Hydrogen	H^+	Hydroxide — OH^-
Iron(II)	Fe^{2+}	Nitrate — NO_3^-
Iron(III)	Fe^{3+}	Oxide — O^{2-}
Lead	Pb^{2+}	Sulfate — SO_4^{2-}
Lithium	Li^+	Sulfide — S^{2-}
Magnesium	Mg^{2+}	
Potassium	K^+	
Silver	Ag^+	
Sodium	Na^+	
Zinc	Zn^{2+}	

Activity 9 — Ionic Compounds

Use the table above to state the formulae of the following ionic compounds:

1. Magnesium bromide
2. Barium oxide
3. Zinc chloride
4. Ammonium chloride
5. Ammonium carbonate
6. Aluminium bromide
7. Calcium nitrate

29. 8. Iron(II) sulfate
30. 9. Iron(III) sulfate

Empirical Formula

Activity 10 — Empirical Formula

Use the periodic table to answer the following. For each question, divide the mass of each element by its A_r to get moles, then find the simplest whole-number ratio.

31. 1. A sample contains: 0.360 g carbon, 0.060 g hydrogen, 0.160 g oxygen. Find the empirical formula.
32. 2. A compound contains: 0.479 g titanium, 0.180 g carbon, 0.730 g oxygen. Find the empirical formula.
33. 3. A 300 g sample contains 145.9 g carbon and 24.32 g hydrogen (remainder is oxygen). Find the empirical formula.
34. 4. A 300 g sample contains only C, H, and O. The percentage of C equals the percentage of O; hydrogen is 5.99%. Find the empirical formula.

Section 7: Balancing Chemical Equations

Conservation of mass: atoms are not created or destroyed in chemical reactions — they are rearranged. The total number of each type of atom must be the same on both sides of the equation.

Method

- Balance one element at a time.
- Use numbers in front of formulae (coefficients) — never change the formula itself.
- Fractions are sometimes needed (e.g. $\frac{1}{2}$ O₂); multiply through by 2 to give whole numbers.
- Brackets: e.g. Ca(OH)₂ contains 1 Ca, 2 O, and 2 H.

Example: $2H_2 + O_2 \rightarrow 2H_2O$ | $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

Activity 11 — Balancing Equations

1. Write balanced symbol equations for the following reactions:

- ss. a. Aluminium + oxygen → aluminium oxide
tt. b. Methane + oxygen → carbon dioxide + water
uu. c. Calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

2. Balance the following:

- vv. a. $C + O_2 \rightarrow CO$
ww.b. $N_2 + H_2 \rightarrow NH_3$
xx. c. $C_2H_4 + O_2 \rightarrow H_2O + CO_2$
yy. d. $C_6H_{14} + O_2 \rightarrow CO_2 + H_2O$
zz. e. $NH_2CH_2COOH + O_2 \rightarrow CO_2 + H_2O + N_2$

3. Balance equations with brackets:

- aaa. a. $Mg(OH)_2 + HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$
bbb. b. $Fe(NO_3)_2 + Na_3PO_4 \rightarrow Fe_3(PO_4)_2 + NaNO_3$

4. Chalcopyrite (CuFeS₂) — balance the two stages of copper extraction (fractions allowed):

- ccc. Stage 1: $CuFeS_2 + O_2 + SiO_2 \rightarrow Cu_2S + Cu_2O + SO_2 + FeSiO_3$
ddd. Stage 2: $Cu_2S + CuO \rightarrow Cu + SO_2$

Section 8: Moles, Concentration, and Molar Calculations

Key Formulae

$n = m / M$	Amount (mol) = mass (g) \div molar mass (g mol^{-1})
$c = n / V$	Concentration (mol dm^{-3}) = moles \div volume (dm^3). Note: $1 \text{ dm}^3 = 1 \text{ L} = 1000 \text{ cm}^3$
Avogadro constant	6.02×10^{23} particles per mole
Gas molar volume (RTP)	24.0 dm^3 per mole at room temperature and pressure

Molar mass: add the A_r values from the periodic table. E.g. CaCO_3 : $40.1 + 12 + (3 \times 16) = 100.1 \text{ g mol}^{-1}$

Activity 12 — Moles and Particles

Complete the table using the periodic table:

Substance	Mass (g)	Amount (mol)	Number of particles
Helium		18.12×10^{23}	
Chlorine (Cl)		14.2	
Methane			4
Sulfuric acid		4.905	

Activity 13 — Molar Calculations (Masses and Gas Volumes)

1. 0.486 g of magnesium reacted with oxygen: $2\text{Mg(s)} + \text{O}_2(\text{g}) \rightarrow 2\text{MgO(s)}$

- eee. a. Calculate the amount, in moles, of magnesium that reacted.
fff. b. Calculate the amount, in moles, of magnesium oxide made.
ggg. c. Calculate the mass, in grams, of magnesium oxide made.

2. Oscar heated 4.25 g of sodium nitrate: $2\text{NaNO}_3(\text{s}) \rightarrow 2\text{NaNO}_2(\text{s}) + \text{O}_2(\text{g})$

- hhh. a. Calculate the amount, in moles, of sodium nitrate that reacted.
iii. b. Calculate the amount, in moles, of oxygen made.

3. 0.500 kg of magnesium carbonate decomposes: $\text{MgCO}_3(\text{s}) \rightarrow \text{MgO(s)} + \text{CO}_2(\text{g})$. Give answers to 3 s.f.

- jjj. a. Calculate the amount, in moles, of magnesium carbonate used.
kkk.b. Calculate the amount, in moles, of carbon dioxide produced.

Rearranging Equations and Concentrations

You must be able to rearrange the key formulae above. For example, rearranging $c = n/V$: multiply both sides by V to get $n = c \times V$; divide both sides by c to get $V = n/c$.

Activity 14 — Rearranging Equations and Calculating Concentrations

1. Rearrange $c = n/V$ to make: (a) n the subject, (b) V the subject.
2. Rearrange $PV = nRT$ to make: (a) n the subject, (b) T the subject.
3. Calculate the concentration (mol dm^{-3}) when 0.2 mol of solute is dissolved in 50 cm^3 of solution.
4. Calculate the concentration (mol dm^{-3}) when 0.05 mol of solute is dissolved in 2.0 dm^3 of solution.
5. Calculate the number of moles of NaOH in 36 cm^3 of 0.1 mol dm^{-3} aqueous solution.

Section 9: Percentage Yield and Percentage Error

Key Formulae

Percentage yield	$\% \text{ yield} = (\text{actual amount of product} / \text{theoretical amount of product}) \times 100$
Percentage error	$\% \text{ error} = (\text{maximum error} / \text{measured value}) \times 100$

Note: When calculating temperature change (which requires two readings), the maximum error is doubled.

Activity 15 — Percentage Yield and Percentage Error

Percentage yield:

35. 1. Calculate the percentage yield of a reaction with a theoretical yield of 4.75 mol of product and an actual yield of 3.19 mol. Give your answer to 3 s.f.
36. 2. Calculate the percentage yield of a reaction with a theoretical yield of 12.00 mol of product and an actual yield of 6.25 mol. Give your answer to 3 s.f.

Percentage error:

37. 3. A gas syringe has a maximum error of $\pm 0.5 \text{ cm}^3$. Calculate the maximum % error when recording:
(a) 21.0 cm^3 ; (b) 43.0 cm^3 . Give answers to 3 s.f.
38. 4. A thermometer has a maximum error of $\pm 0.5 \text{ }^\circ\text{C}$. Calculate the maximum % error when recording temperature rises of: (a) $12.0 \text{ }^\circ\text{C}$; (b) $37.6 \text{ }^\circ\text{C}$. Give answers to 3 s.f.

Section 10: Practical Skills

The practical skills from GCSE are developed further at A-Level. At least 15% of A-Level marks are related to practical work. The following activity consolidates key skills including hypothesis writing, identifying variables, error analysis, and data processing.

Activity 16 — Practical Investigation: Electrolysis of Copper Sulfate Solution

Students investigated whether the time a current flows through an electrolyte affects the mass of copper deposited on the negative electrode. Equipment: measuring cylinder, balance, two carbon rod electrodes, 6V power supply and bulb, 0.5 mol dm^{-3} copper sulfate solution, stopwatch, wires, 100 cm^3 beaker.

Method: Measure 50 cm^3 copper sulfate solution into the beaker. Record the mass of the negative electrode. Set up the circuit at 6V dc. Turn on the power supply for the allotted time. Remove and carefully dry the negative electrode. Record its mass again.

39. 1. Write a hypothesis for this investigation.
40. 2. Predict the result.
41. 3. Identify: (a) the independent variable; (b) the dependent variable; (c) one control variable.
42. 4. What is the difference between repeatable and reproducible results?
43. 5. What is the most likely resolution of the balance used in a school laboratory?
44. 6. How could you make the reading more precise?
45. 7. Random errors cause readings to be spread about the true value. How could you reduce the effect of random errors and improve accuracy?

8. Calculate the mean increase in mass for each time measurement:

Time / min	Reading 1 / g	Reading 2 / g	Reading 3 / g	Mean / g
2	0.62	0.64	0.45	
4	0.87	0.83	0.86	
6	0.99	1.02	0.97	
8	1.06	1.05	1.08	
10	1.10	1.12	1.10	

9. Plot a graph of mean mass increase (y-axis) against time (x-axis). Include axis labels and units.

Section 11: Graphs and Tangents — Deducing Reaction Rates

To investigate reaction rate, plot a concentration–time graph. The rate at any point equals the gradient of the tangent to the curve at that point.

Drawing a Tangent

- Draw a straight line that just touches (is tangent to) the curve at the point of interest.
- Read off where the tangent crosses the axes.
- Gradient = $\Delta y / \Delta x$ = change in concentration / change in time.
- Rate is always positive, so take the magnitude of the gradient.
- The steeper the gradient, the faster the rate.
- When the gradient is flat (zero), the reaction has stopped.

Note: When a chemical is listed in square brackets [X], this means 'the concentration of X'.

Activity 17 — Graphs, Tangents, and Half-Life

1. Rate from a concentration–time graph

A concentration–time graph shows [A] starting at 2.0 mol dm^{-3} and falling to zero. When $[A] = 1.0 \text{ mol dm}^{-3}$, a tangent intercepts the y-axis at 1.75 and the x-axis at 48 s. The gradient = $-1.75/48 = -0.0365 \text{ mol dm}^{-3} \text{ s}^{-1}$.

- iii. a. Using this graph, calculate the rate of reaction when $[A]$ falls to 0.5 mol dm^{-3} by drawing a tangent at that point.

2. Half-life and reaction order

The table below shows the change in concentration of bromine during a reaction:

Time / s	$[\text{Br}_2] / \text{mol dm}^{-3}$
0	0.0100
60	0.0090
120	0.0066
180	0.0053
240	0.0044
360	0.0028

- mmm. a. Plot a concentration–time graph for the data above.
nnn. b. Calculate the rate of decrease of $[\text{Br}_2]$ by drawing tangents at two points.
ooo. c. Find the half-life at two points and deduce the order of reaction with respect to Br_2 .

Section 12: Extended Writing

The ability to write coherently in a logical, well-structured way is essential at A-Level. Command words tell you what your answer must include:

Describe	State what happens — facts and observations without reasons.
Explain	Give reasons why something happens (not just a description).
Compare	Give similarities AND differences; advantages AND disadvantages.
Evaluate	Weigh up evidence, consider limitations, reach a judgement.
Suggest	Apply your knowledge to an unfamiliar situation.

Activity 18 — Extended Writing: Types of Bonding

Compare the similarities and differences between ionic, covalent, and metallic bonding.

Your answer should address: the particles involved, the nature of the electrostatic attraction, typical physical properties of substances with each type of bonding (melting point, electrical conductivity, solubility), and give examples.

Space for your answer:

Section 13: GCSE Quantitative Chemistry — Practice Questions

The following questions are additional GCSE-level practice on quantitative chemistry. They cover the key calculation types you must be confident with before starting A-Level. Work through them carefully, showing all working. Questions sourced from Chemsheets GCSE 1355 and 1357.

Part A — Chemsheets GCSE 1355: Calculations

Question 1 — Ionic Formulae

Give the formula of the following ionic substances:

a) aluminium chloride		d) iron(III) hydroxide	
b) silver(I) sulfate		e) ammonium carbonate	
c) magnesium nitrate		f) magnesium sulfide	

Question 2 — Relative Formula Mass (Mr)

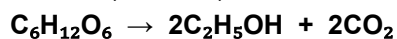
Calculate the relative formula mass of the following substances:

a) oxygen, O_2

b) aluminium nitrate, $Al(NO_3)_3$

Question 3 — Percentage Yield (Fermentation of Glucose)

Ethanol (C_2H_5OH) can be made by fermentation using glucose:



a) Calculate the maximum mass of ethanol that could be formed from 9 g of glucose.

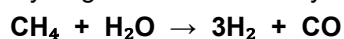
b) In this reaction, only 4.0 g of ethanol was formed. Calculate the percentage yield.

c) Suggest two reasons why the yield was less than 100%.

- 1 _____
2 _____

Question 4 — Reacting Masses and Atom Economy (Steam Reforming)

Hydrogen can be made by reacting methane with steam:

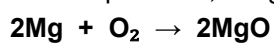


a) Calculate the mass of hydrogen that can be made by reacting 64 g of methane with excess steam.

b) Calculate the percentage atom economy to make hydrogen in this reaction.

Question 5 — Limiting Reagent (Magnesium Combustion)

In an experiment, 3.2 g of magnesium was reacted with 3.2 g of oxygen. One of the chemicals was in excess.



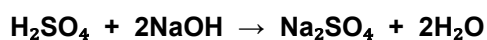
Determine which is the limiting reagent and then calculate the mass of magnesium oxide formed.

Question 6 — Gas Volumes at RTP (Argon)

Calculate the volume of 10 g of argon (Ar) gas at room temperature and pressure.

Question 7 — Titration Calculation (Sulfuric Acid / Sodium Hydroxide)

25.0 cm³ of a solution of sodium hydroxide was titrated against 0.200 mol/dm³ sulfuric acid. 23.7 cm³ of the sulfuric acid was needed to neutralise the sodium hydroxide.



a) Complete the table by giving the name of the apparatus used for each purpose:

To measure the volume of sulfuric acid	To measure the volume of sodium hydroxide	To carry out the titration

b) Calculate the concentration of the sodium hydroxide in mol/dm³ to 3 significant figures.

c) Calculate the concentration of the sodium hydroxide in g/dm³ to 3 significant figures.

Part B — Chemsheets GCSE 1357: More Calculations

Question 8 — Relative Formula Mass (Mr)

Calculate the relative formula mass of the following substances:

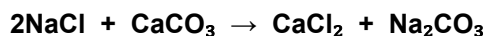
a) bromine, Br_2

b) iron(III) sulfate, $\text{Fe}_2(\text{SO}_4)_3$

c) sodium nitrate

Question 9 — Reacting Masses and Atom Economy (Sodium Carbonate)

Sodium carbonate can be made from sodium chloride:

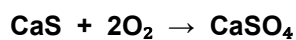


a) Calculate the mass of sodium carbonate that can be made by reacting 585 g of sodium chloride with excess calcium carbonate.

b) Calculate the percentage atom economy to make sodium carbonate in this reaction.

Question 10 — Reacting Masses with Unit Conversion (Calcium Sulfate)

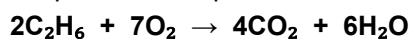
Calcium sulfate can be made from calcium sulfide:



Calculate the mass of oxygen needed to react with 3.6 kg of calcium sulfide.

Question 11 — Reacting Gas Volumes (Combustion of Ethane)

What volume of oxygen gas reacts with 100 cm³ of ethane (C₂H₆)? All gas volumes are measured at the same temperature and pressure.



Question 12 — Gas Volume at RTP (Carbon Dioxide)

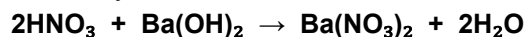
Calculate the volume of 88 g of carbon dioxide (CO₂) gas at room temperature and pressure.

Question 13 — Deducing a Formula from Reacting Masses (Iron Oxide)

In a reaction, 11.2 g of iron reacts with 4.8 g of oxygen. Find the molar ratio in which the iron and oxygen react and use this to deduce the formula of the iron oxide formed.

Question 14 — Titration Calculation (Nitric Acid / Barium Hydroxide)

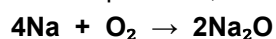
25.0 cm³ of a solution of nitric acid was titrated against 0.0200 mol/dm³ barium hydroxide. 28.2 cm³ of the barium hydroxide was needed to neutralise the acid.



Calculate the concentration of the nitric acid in mol/dm³. Give your answer to 3 significant figures.

Question 15 — Limiting Reagent (Sodium Combustion)

In an experiment, 11.5 g of sodium was reacted with 3.2 g of oxygen. One of the chemicals was in excess.



Determine which is the limiting reagent and then calculate the mass of sodium oxide formed.
