A level Chemistry

Edexcel

Summer Transition Booklet

Dr Patel

spa@slougheton.com

Summer Bridging Work: Chemistry Y11 into Y12

Welcome to A-Level Chemistry at Slough and Eton

This is a guide to help you get ready for A-Level Chemistry. It is aimed to be used after you complete your GCSE throughout the remainder of the Summer term and over the Summer Holidays to ensure you are ready to start your course in September.

Assessment

Please bring this completed booklet, textbook and equipment to your FIRST Chemistry lesson (this could be the first day of school). There will also be a transition test in the second week on all GCSE Chemistry content, Transition Booklet content and test will determine your suitability for the course.

Introduction

A-level Chemistry is a big step up from GCSE. In order to prepare for Chemistry A-level, it is vital that you have an excellent understanding of key concepts, all of which you covered at GCSE and will study in greater depth over the first year of A-level Chemistry:

1. Atomic structure
2. Amount of substance
3. Bonding
4. Energetics
5. Kinetics
6. Chemical Equilibria, Le Chatelier's Principle and Kc
7. Oxidation, Reduction and Redox equations
8. Organic Chemistry

To ensure you have an excellent grounding in each of these topics, please continue to review all GCSE Chemistry content so that you have a solid foundation to starting A-level Chemistry.

Task -ALL students must complete this

1. So, to start you off correctly you MUST **complete** all GCSE questions. This is to help you recap and retrieve vital knowledge you have learned during your GCSE course that provides the foundation for A-Level Chemistry to build upon. This will allow us to get a good idea of what you need to work on in the early months to make sure you are able to keep up with the demands of one of the most difficult subjects.

Use your normal GCSE revision resources to help you complete them, but here are some suggestions:

- www.senecalearning.com
- www.gcsepod.com
- www.bitesize.com
- Youtube - Free Science Lessons
- Youtube - Primrose Kitten

If there is anything you struggle with, write Cornell notes on it using this video for guidance How to make Cornell Notes (ignore AO1/2/3) and put them in your folder.

2. You MUST also **attempt** the A-Level Questions. They are accessible to you with the GCSE content you have – you might just need to think outside the box a bit and stretch yourself! This gives insight into the style of questions at A-Level and shows the jump is not that large if you are fully prepped with all of your GCSE knowledge. Again here are some useful websites:

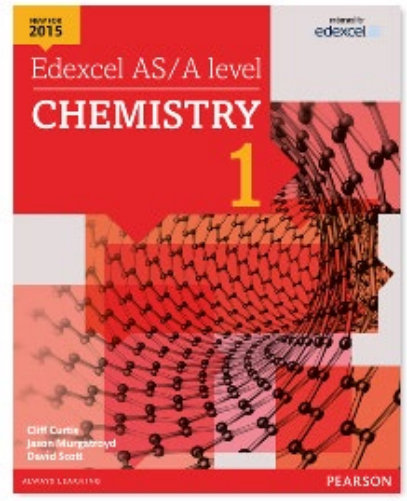
- CGP – 'Head start to Chemistry' and 'Essential Maths Skills' books
- MaChemGuy – Prepare for A-Level Chemistry
- ASFC Chemistry – Starting A-Level Chemistry

3. Revise the content, **answer ALL the questions**. You must **print the booklet** and bring it to your first Chemistry lesson.

Preparing for A-level Chemistry Lessons

1. Purchase **A4 lined paper** and a **A4 folder with dividers** and plastic wallets for use in Chemistry Only. You also should have pens, pencil, highlighters, green pen, calculator, ruler etc. Prepare to be fully equipped every lesson.

2. Purchase the following **textbook**:



Pre-read and make notes on the first few pages from your Edexcel Chemistry Book 1 Topic 1 and 5.

1. Atomic Structure

GCSE questions

Q1. This question is about the structure of the atom.

(a) Complete the sentences. Choose answers from the box. Each word may be used once, more than once, or not at all.

electron	**ion**	**neutron**
nucleus	**proton**	

The centre of the atom is the _____ .

The two types of particle in the centre of the atom are the proton and the _____ .

James Chadwick proved the existence of the _____ .

Niels Bohr suggested particles orbit the centre of the atom. This type of particle is the _____ .

The two types of particle with the same mass are the neutron and the _____ . **(5)**

The table below shows information about two isotopes of element **X**.

	Mass number	**Percentage (%) abundance**
Isotope 1	63	70
Isotope 2	65	30

(b) Calculate the relative atomic mass (A_r) of element **X** using the equation:

$$A_r = \frac{\text{(mass number} \times \text{percentage) of isotope 1} + \text{(mass number} \times \text{percentage) of isotope 2}}{100}$$

Use the table above. Give your answer to 1 decimal place.

_____

_____ A_r = _____ **(2)**

(c) Suggest the identity of element **X**. Use the periodic table.

Element **X** is _____ **(1)**

(d) The radius of an atom of element **X** is 1.2×10^{-10} m

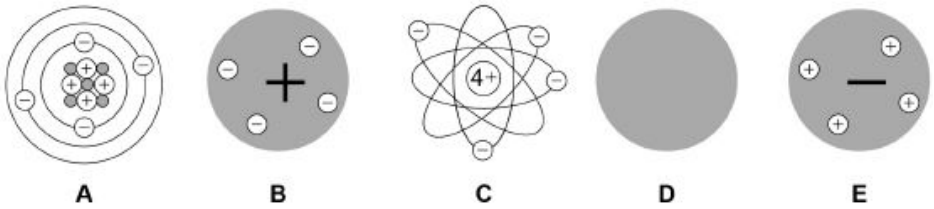
The radius of the centre of the atom is $\frac{1}{10000}$ the radius of the atom.

Calculate the radius of the centre of an atom of element **X**. Give your answer in standard form.

_____

Radius = _____ m **(2)**

Q2. The diagram below represents different models of the atom.



(a) Which diagram shows the plum pudding model of the atom? Tick **one** box.

A		B		C		D		E	

(1)

(b) Which diagram shows the model of the atom developed from the alpha particle scattering experiment? Tick **one** box.

A		B		C		D		E	

(1)

(c) Which diagram shows the model of the atom resulting from Bohr's work? Tick **one** box.

A		B		C		D		E	

(1)

(d) Define the mass number of an atom.

_____

_____ **(1)**

(e) Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of ^{69}**X**
- 40% of ^{71}**X**

Estimate the relative atomic mass of element **X**. Tick **one** box.

< 69.5	
Between 69.5 and 70.0	
Between 69.5 and 70.0	
Between 70.0 and 70.5	
> 70.5	

(1)

A-Level question to give a go!

Q1. Which of these correctly shows the numbers of sub-atomic particles in a $^{41}K^{+}$ ion?

	Number of electrons	Number of protons	Number of neutrons	
A	19	19	20	⬭
B	18	20	21	⬭
C	18	19	22	⬭
D	19	18	23	⬭

(Total 1 mark)

Q2. Magnesium exists as three isotopes: ^{24}Mg, ^{25}Mg and ^{26}Mg

(a) In terms of sub-atomic particles, state the difference between the three isotopes of magnesium.

_____

_____ **(1)**

(b) State how, if at all, the chemical properties of these isotopes differ.

Give a reason for your answer.

Chemical properties _____

Reason

_____

_____ **(2)**

2. Amount of Substance

GCSE questions

Q3. A student investigated the reactions of copper carbonate and copper oxide with dilute hydrochloric acid. In both reactions one of the products is copper chloride.

(a) A student wanted to make 11.0 g of copper chloride.

The equation for the reaction is:

$$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$$

Relative atomic masses, A_r: H = 1; C = 12; O = 16; Cl = 35.5; Cu = 63.5

Calculate the mass of copper carbonate the student should react with dilute hydrochloric acid to make 11.0 g of copper chloride.

_____

_____

_____Mass of copper carbonate = _____ g **(4)**

(b) The percentage yield of copper chloride was 79.1 %. Calculate the mass of copper chloride the student actually produced.

_____

_____Actual mass of copper chloride produced = _____ g **(2)**

(c) Look at the equations for the two reactions:

Reaction 1 $CuCO_3(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l) + CO_2(g)$

Reaction 2 $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$

Reactive formula masses: CuO = 79.5; HCl = 36.5; $CuCl_2$ = 134.5; H_2O = 18

The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$$

Calculate the percentage atom economy for Reaction 2.

_____

_____

_____Percentage atom economy = _____ % **(3)**

(d) The atom economy for Reaction 1 is 68.45 %. Compare the atom economies of the two reactions for making copper chloride. Give a reason for the difference.

_____**(1)**

A-Level question to give a go!

Q3. Ethanol can be made from glucose by fermentation.

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

In an experiment, 268 g of ethanol (M_r = 46.0) were made from 1.44 kg of glucose (M_r = 180.0).
What is the percentage yield?

A 18.6% ⬭

B 36.4% ⬭

C 51.1% ⬭

D 72.8% ⬭

(Total 1 mark)

Q4. A gas cylinder contains 5.0 kg of propane.
How many propane molecules are in the cylinder?
The Avogadro constant, $L = 6.022 \times 10^{23}$ mol^{-1}

A 6.8×10^{22} ⬭

B 7.2×10^{22} ⬭

C 6.8×10^{25} ⬭

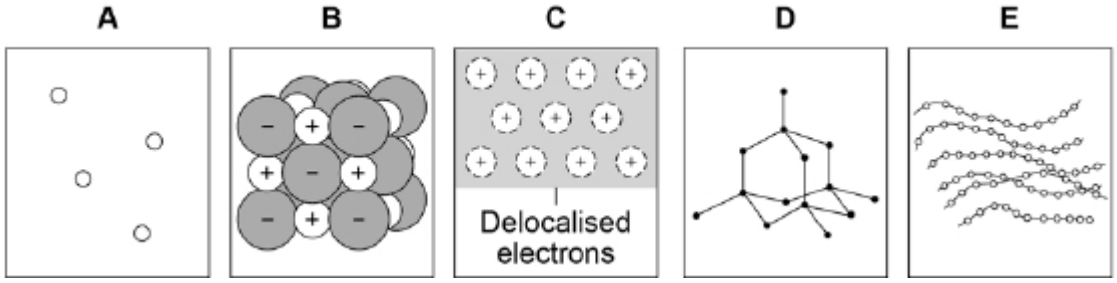
D 7.2×10^{25} ⬭

(Total 1 mark)

3. Bonding

GCSE questions

Q4. **Figure 1** shows the structure of five substances.



(a) Which diagram shows a gas? Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(b) Which diagram shows the structure of diamond? Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(c) Which diagram shows a metallic structure? Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(d) Which diagram shows a polymer? Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

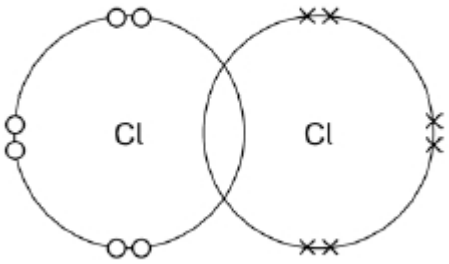
(e) A chlorine atom has 7 electrons in the outer shell.

Two chlorine atoms covalently bond to form a chlorine molecule, Cl_2

Figure 2 is a dot and cross diagram showing the outer shells and some electrons in a chlorine molecule.

Complete the dot and cross diagram. Show only the electrons in the outer shell.

Figure 2



(1)

(f) What is the reason for chlorine's low boiling point? Tick (✓) **one** box.

Strong covalent bonds ☐

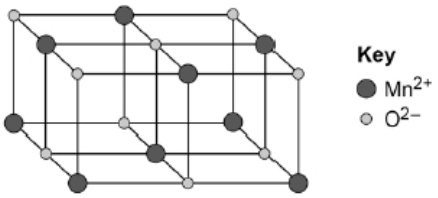
Strong forces between molecules ☐

Weak covalent bonds ☐

Weak forces between molecules ☐

(1)

Figure 3 represents the structure of manganese oxide. Manganese oxide is an ionic compound.



(g) Determine the empirical formula of manganese oxide. Use **Figure 3**.

_____

_____Empirical formula = _____ **(1)**

(h) Why does manganese oxide conduct electricity as a liquid? Tick (✓) **one** box.

Atoms move around in the liquid ☐

Electrons move around in the liquid ☐

Ions move around in the liquid ☐

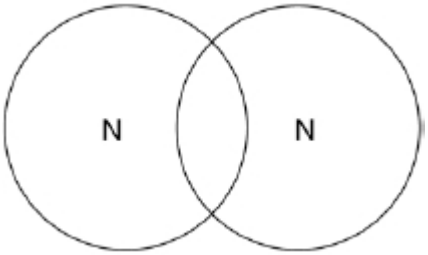
Molecules move around in the liquid ☐

(1)

Q5. This question is about structure and bonding.

(a) Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule, N_2

Show only the electrons in the outer shell.



(2)

(b) Explain why nitrogen is a gas at room temperature. Answer in terms of nitrogen's structure.

_____

_____

_____

_____ **(3)**

(c) Graphite and fullerenes are forms of carbon. Graphite is soft and is a good conductor of electricity. Explain why graphite has these properties. Answer in terms of structure and bonding.

_____

_____

_____

_____

_____ **(4)**

A-Level question to give a go!

Q5. Which is the correct crystal structure for the substance named?

	Substance	Structure	
A	Iodine	Simple molecular	⬭
B	Diamond	Ionic	⬭
C	Sodium chloride	Giant covalent	⬭
D	Graphite	Metallic	⬭

(Total 1 mark)

Q6. What is the formula of calcium nitrate(V)?

A $CaNO_3$ ⬭

B $Ca(NO_3)_2$ ⬭

C Ca_2NO_2 ⬭

D $Ca(NO_2)_2$ ⬭

(Total 1 mark)

Q7. The table shows some data about the elements bromine and magnesium.

Element	Melting point / K	Boiling point / K
Bromine	266	332
Magnesium	923	1383

In terms of structure and bonding explain why the boiling point of bromine is different from that of magnesium. Suggest why magnesium is a liquid over a much greater temperature range compared to bromine.

(Total 5 marks)

4. Energetics

GCSE questions

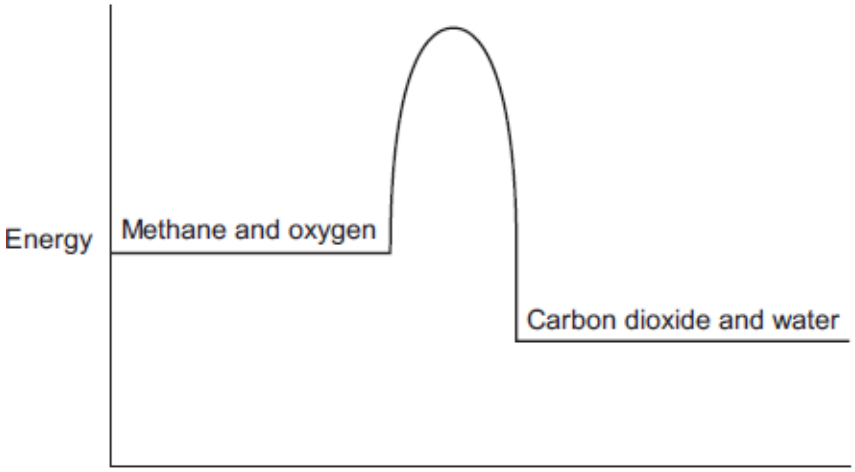
Q6. Methane (CH_4) is used as a fuel.

(a) Methane burns in oxygen.

(i) The diagram below shows the energy level diagram for the complete combustion of methane.

Draw and label arrows on the diagram to show:

- the activation energy
- the enthalpy change, ΔH.



(2)

(ii) Complete and balance the symbol equation for the complete combustion of methane.

$$CH_4 + _____ \longrightarrow CO_2 + _____$$ **(2)**

(ii) Explain why, in terms of the energy involved in bond breaking and bond making, the combustion of methane is exothermic.

(3)

(b) Methane reacts with chlorine in the presence of sunlight. The equation for this reaction is:

Some bond dissociation energies are given in the table.

Bond	Bond dissociation energy in kJ per mole
C−H	413
C−Cl	327
Cl−Cl	243
H−Cl	432

(i) Show that the enthalpy change, ΔH, for this reaction is −103 kJ per mole.

(3)

(ii) Methane also reacts with bromine in the presence of sunlight.

This reaction is less exothermic than the reaction between methane and chlorine.

The enthalpy change, ΔH, is −45 kJ per mole.

What is a possible reason for this? Tick (✓) **one** box.

CH_3Br has a lower boiling point than CH_3Cl ☐

The C−Br bond is weaker than the C−Cl bond. ☐

The H−Cl bond is weaker than the H−Br bond. ☐

Chlorine is more reactive than bromine. ☐

(1)

A-Level question to give a go!

Q8. Calculate the enthalpy change, in kJ, for this dissociation of mole of propan-1-ol.

$$C_3H_7OH(g) \longrightarrow 3C(g) + 8H(g) + O(g)$$

	C—H	C—C	C—O	O—H
Mean bond dissociation enthalpy / kJ mol^{-1}	412	348	360	463

A −4751 ⬭

B −4403 ⬭

C +4403 ⬭

D +4751 ⬭

(Total 1 mark)

Q9. Hydrogen is produced by the reaction of methane with steam. The reaction mixture reaches a state of dynamic equilibrium.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +206 \text{ kJ mol}^{-1}$$

Some enthalpy data is given in the table.

Bond	C–H	O–H	H–H	C≡H

Bond enthalpy / kJ mol^{-1}	413	463	436	To be calculated

Use the information in the table and the stated enthalpy change to calculate the missing bond enthalpy.

A 234 ⬭

B 1064 ⬭

C 1476 ⬭

D 1936 ⬭

(Total 1 mark)

5. Kinetics

GCSE questions

Q7. When sodium thiosulfate solution reacts with dilute hydrochloric acid, the solution becomes cloudy.

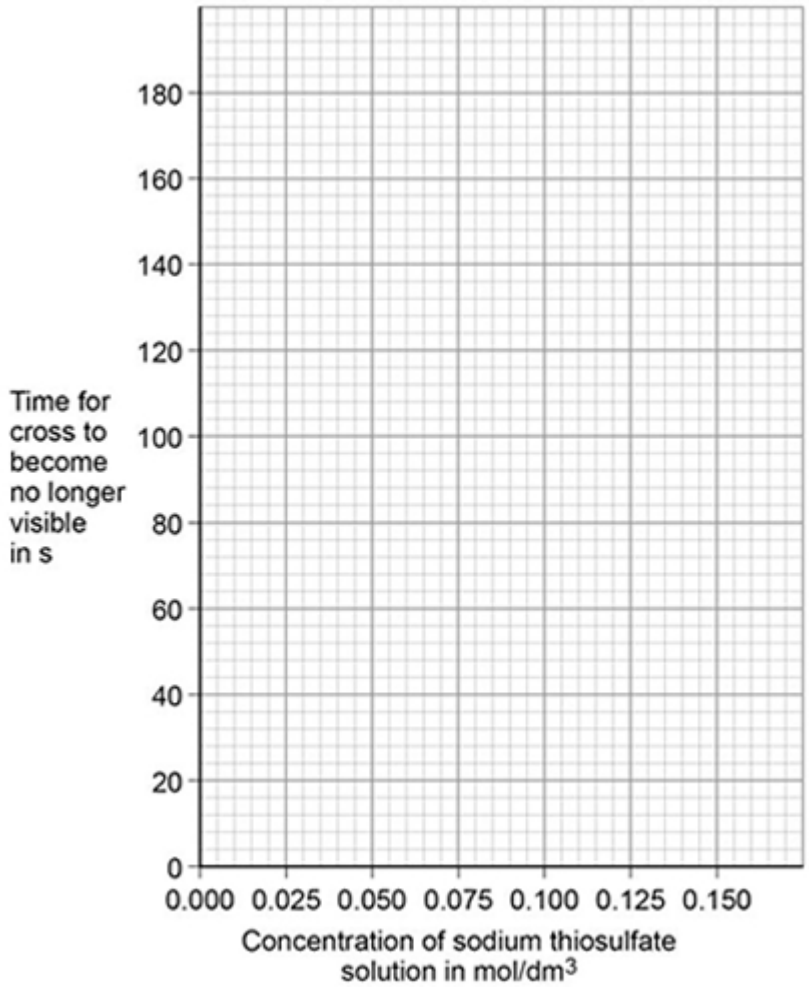
The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\,HCl(aq) \rightarrow 2\,NaCl(aq) + SO_2(g) + H_2O(l) + S(s)$$

Some students used this reaction to investigate the effect of concentration on rate of reaction. The table shows the students' results.

Concentration of sodium thiosulfate solution in mol / dm^3	Time for cross to become no longer visible in s
0.020	170
0.040	90
0.060	82
0.080	42
0.100	34
0.120	30
0.140	28

(a) Plot the data from the table above on the graph below. Draw a line of best fit.



(3)

The students repeated the investigation two more times. They obtained similar results each time.

(b) The students analysed their results to give a conclusion and an explanation for their investigation.

Conclusion: 'The higher the concentration, the lower the rate of reaction.'

Explanation: 'At higher concentrations, the particles have more energy, so they are moving faster. Therefore the collisions are more energetic.'

The students are not correct.
Give a **correct** conclusion **and** explanation for the results of the investigation.

Conclusion _____

_____

Explanation _____

_____

_____

_____**(3)**

(c) A solution containing 0.18 g of sodium thiosulfate reacts with dilute hydrochloric acid in 2 minutes.

Calculate the mean rate of reaction in g / s. Give your answer in standard form.

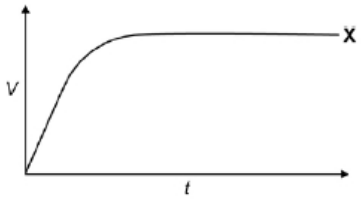
_____

_____

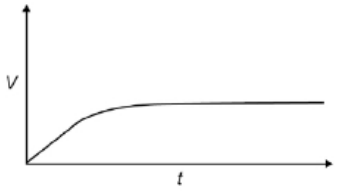
_____Mean rate of reaction = _____ g / s **(3)**

A-Level question to give a go!

Q10. Line **X** in the diagram represents the volume (V) of gas formed with time (t) in a reaction between an excess of magnesium and aqueous sulfuric acid.



Which line represents the volume of hydrogen formed, at the same temperature and pressure, when the concentration of sulfuric acid has been halved?

A 

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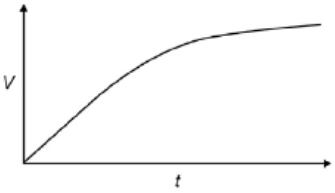
B 

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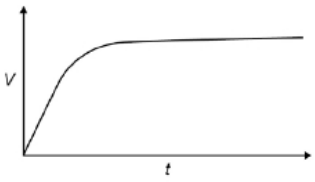
C 

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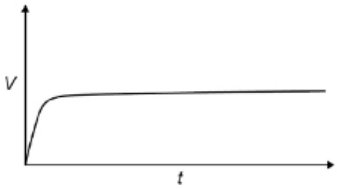
D 

⬭

(Total 1 mark)

Q11. The gas-phase reaction between hydrogen and chlorine is very slow at room temperature.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

(a) Define the term *activation energy*.

_____

_____ **(2)**

(b) Give **one** reason why the reaction between hydrogen and chlorine is very slow at room temperature.

_____

_____ **(1)**

(c) Explain why an increase in pressure, at constant temperature, increases the rate of reaction between hydrogen and chlorine.

_____

_____ **(2)**

(d) Explain why a small increase in temperature can lead to a large increase in the rate of reaction between hydrogen and chlorine.

_____

_____ **(2)**

(e) Give the meaning of the term *catalyst*.

_____

_____ **(1)**

(f) Suggest **one** reason why a solid catalyst for a gas-phase reaction is often in the form of a powder.

_____ **(1)**

6. Chemical Equilibria, Le Chatelier's Principle and K_c

GCSE questions

Q8. In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst.

The equation for the reaction is: C_2H_4 (g) + H_2O (g) $\rightleftharpoons$ C_2H_5OH (g)

(a) The forward reaction is exothermic.

Use Le Chatelier's Principle to predict the effect of increasing temperature on the amount of ethanol produced at equilibrium. Give a reason for your prediction.

_____

_____ **(2)**

(b) Explain how increasing the pressure of the reactants will affect the amount of ethanol produced at

equilibrium.

_____

_____ **(2)**

A-Level question to give a go!

Q12. Which statement is **not** correct about the industrial preparation of ethanol by the hydration of ethene at 300 °C?

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \quad \Delta H = -46 \text{ kJ mol}^{-1}$$

A The reaction is catalysed by an acid. ○

B The higher the pressure, the higher the equilibrium yield of ethanol. ○

C The higher the temperature, the higher the equilibrium yield of ethanol. ○

D A low equilibrium yield of ethanol is acceptable because unreacted ethene is recycled. ○

(Total 1 mark)

Q13. The forward reaction in this equilibrium is endothermic

$$COCl_2\,(g) \rightleftharpoons CO(g) + Cl_2\,(g)$$

Which statement is correct?

A If the total pressure is increased at constant temperature, the proportion of $COCl_2$ in the equilibrium mixture will decrease ○

B Use of a catalyst will increase the proportion of $COCl_2$ in the equilibrium mixture at constant temperature and pressure ○

C Reducing the equilibrium concentration of CO will increase the value of the equilibrium constant ○

D Raising the temperature from 373 K to 473 K will increase the value of the equilibrium constant ○

(Total 1 mark)

7. Oxidation, Reduction and Redox equations

GCSE questions

Q9. This question is about halogens and their compounds.

(a) What is the ionic equation for the reaction of chlorine with potassium iodide? Tick **one** box.

$Cl_2 + 2K \rightarrow 2KCl$ ☐

$2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$ ☐

$I^- + Cl \rightarrow I + Cl^-$ ☐

$I^- + K^+ \rightarrow KI$ ☐

(1)

Q10. Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two-stage industrial process.

Stage 1 $TiO_2 + 2\ C + 2\ Cl_2 \longrightarrow TiCl_4 + 2\ CO$

Stage 2 $TiCl_4 + 4\ Na \longrightarrow Ti + 4\ NaCl$

In **Stage 2**, sodium displaces titanium from titanium chloride.

(a) Sodium atoms are oxidised to sodium ions in this reaction. Why is this an oxidation reaction?

_____ **(1)**

(b) Complete the half equation for the oxidation reaction.

Na ⟶ _____ + _____ **(1)**

A-Level question to give a go!

Q14. In which reaction is the metal oxidised?

A $2Cu^{2+} + 4I^- \longrightarrow 2CuI + I_2$ ⬭

B $[Fe(H_2O)_6]^{3+} + Cl^- \longrightarrow [Fe(H_2O)_5(Cl)]^{2+} + H_2O$ ⬭

C $[CoCl_4]^{2-} + 6H_2O \longrightarrow [Co(H_2O)_6]^{2+} + 4Cl^-$ ⬭

D $Mg + S \longrightarrow MgS$ ⬭

(Total 1 mark)

8. Periodicity

GCSE questions

Q11. This question is about metals.

(a) Which unreactive metal is found in the Earth as the metal itself? Tick (✓) **one** box

aluminium ☐

gold ☐

magnesium ☐

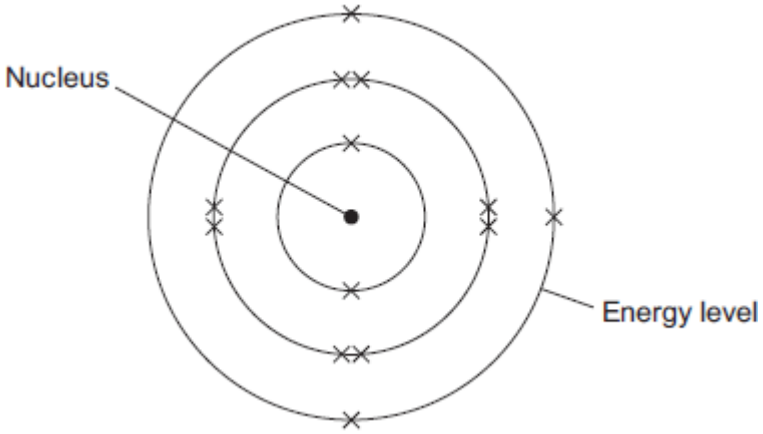
(1)

(b) Complete the sentence.

Aluminium is an element because aluminium is made of only one type of _____ .

(1)

(c) **Figure 1** shows the electronic structure of an aluminium atom.



(i) Use the correct words from the box to complete the sentence.

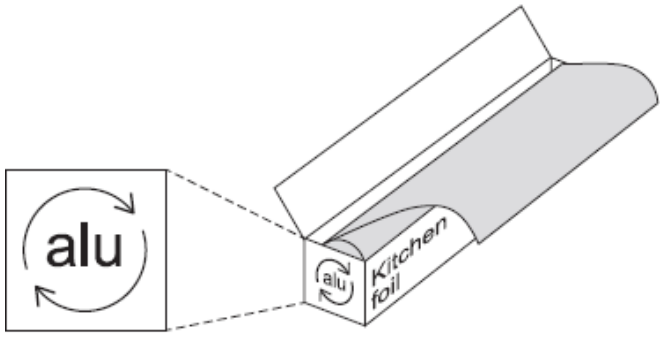
electrons	ions	protons	neutrons	shells

The nucleus of an aluminium atom contains _____ and _____ . **(2)**

(ii) Complete the sentence.

In the periodic table, aluminium is in Group _____ **(1)**

(d) Aluminium is used for kitchen foil. **Figure 2** shows a symbol on a box of kitchen foil.



The symbol means that aluminium can be recycled. It does not show the correct chemical symbol for aluminium.

(i) What is the correct chemical symbol for aluminium? _____ . **(1)**

(ii) Give **two** reasons why aluminium should be recycled.

_____

_____ **(2)**

(e) Aluminium has a low density, conducts electricity and is resistant to corrosion.

Which **one** of these properties makes aluminium suitable to use as kitchen foil? Give a reason for your answer.

_____

_____

_____ **(2)**

A-Level question to give a go!

Q15. Which of the following is a correct statement about the trend in atomic radius across Period 3 of the Periodic Table?

A	radius increases because the atoms have more electrons	⬭
B	radius decreases because nuclear charge increases	⬭
C	radius increases because shielding (screening) increases	⬭
D	radius decreases because shielding (screening) decreases	⬭

(Total 1 mark)

9. Group 2 – The Alkaline Earth Metals

GCSE questions

Q12. This question is about compounds.

(a) The table gives information about the solubility of some compounds.

Soluble compounds
All potassium and sodium salts
All nitrates
Chlorides, bromides and iodides, except those of silver and lead

Use information from the table to answer these questions.

(i) Name a soluble compound that contains silver ions.

_____ **(1)**

(ii) Name a soluble compound that contains carbonate ions.

_____ **(1)**

(b) Metal oxides react with acids to make salts. What type of compound is a metal oxide?

_____ **(1)**

(c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

(i) State how solid lead nitrate can be obtained from lead nitrate solution.

_____

_____ **(1)**

(ii) Balance the equation for the reaction.

$$PbO + HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$$

(1)

(iii) Give the total number of atoms in the formula $Pb(NO_3)_2$

_____ **(1)**

A-Level question to give a go!

Q16. (a) Nickel is a metal with a high melting point.

(i) Explain, in terms of its structure and bonding, why nickel has a high melting point.

_____

_____

_____

_____ **(2)**

(ii) Draw a labelled diagram to show the arrangement of particles in a crystal of nickel.
In your answer, include at least six particles of each type.

(2)

(iii) Explain why nickel is ductile (can be stretched into wires).

_____

_____ **(1)**

10. Group 7 – The Halogens

GCSE questions

Q13. The halogens are elements in Group 7.

(a) Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom. _____ **(1)**

(b) Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide? Tick **one** box.

Giant covalent ☐

Ionic lattice ☐

Metallic structure ☐

Small molecule ☐

(1)

(c) What is the formula for fluorine gas? Tick **one** box.

F ☐

F_2 ☐

F^2 ☐

2F ☐

(1)

A student mixes solutions of halogens with solutions of their salts.

The table below shows the student's observations.

	Potassium chloride (colourless)	**Potassium bromide (colourless)**	**Potassium iodide (colourless)**
Chlorine (colourless)		Solution turns orange	Solution turns brown
Bromine (orange)	No change		Solution turns brown
Iodine (brown)	No change	No change	

(d) Explain how the reactivity of the halogens changes going down Group 7. Use the results in the table above.

_____

_____

_____

_____ **(3)**

A-Level question to give a go!

Q17. An aqueous solution of a white solid gives a yellow precipitate with aqueous silver nitrate. The formula of the white solid could be

A AgBr

B AgI

C NaBr

D NaI

(Total 1 mark)

Q18. What will you see when a solution of silver nitrate is added to a solution containing bromide ions, and concentrated aqueous ammonia is added to the resulting mixture?

A a white precipitate soluble in concentrated aqueous ammonia

B a white precipitate insoluble in concentrated aqueous ammonia

C a cream precipitate soluble in concentrated aqueous ammonia

D a yellow precipitate insoluble in concentrated aqueous ammonia

(Total 1 mark)

11. Introduction to Organic Chemistry

GCSE questions

Q14. Scientists found that a compound contained:

22.8% sodium; 21.8% boron; and 55.4% oxygen.

Use the percentages to calculate the empirical formula of the compound.

Relative atomic masses (A_r): B = 11; O = 16; Na = 23

To gain full marks you **must** show all your working.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____Empirical formula = _____**(Total 5 marks)**

A-Level question to give a go!

Q19. An organic compound is found to contain 40.0% carbon, 6.7% hydrogen and 53.3% oxygen.

Which of the following compounds could this be?

A Ethanol ⬭

B Ethanoic acid ⬭

C Methanol ⬭

D Methanoic acid ⬭

(Total 1 mark)

12. Alkanes

GCSE questions

Q15. This question is about hydrocarbons.

The table gives information about four hydrocarbons. The hydrocarbons are four successive members of a homologous series.

Hydrocarbon	Formula	Boiling point in °C
A	C_4H_{10}	0
B		36
C	C_6H_{14}	69
D	C_7H_{16}	98

(a) What is the formula of hydrocarbon **B**? Tick (✓) **one** box.

C_4H_{12} ☐

C_5H_{12} ☐

C_5H_{12} ☐

C_6H_{12} ☐

(1)

(b) What is the simplest ratio of carbon : hydrogen atoms in a molecule of hydrocarbon **A**?

Ratio = 2 : _____ **(1)**

(c) Which hydrocarbon is a gas at room temperature (25 °C)? Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(d) Which hydrocarbon is most flammable? Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(e) Which **two** substances are produced when a hydrocarbon **completely** combusts in air? Tick (✓) **two** boxes.

Carbon ☐

Carbon dioxide ☐

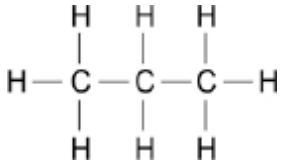
Hydrogen ☐

Sulfur dioxide ☐

Water ☐

(2)

The diagram shows the displayed structure of a hydrocarbon molecule.



(f) What is the name of the hydrocarbon in the diagram above? Tick (✓) **one** box.

Butane ☐

Ethane ☐

Methane ☐

Propane ☐

(1)

Q16. This question is about hydrocarbons.

(a) The names and formulae of three hydrocarbons in the same homologous series are:

Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}

The next member in the series is pentane. What is the formula of pentane?

_____ **(1)**

(b) Which homologous series contains ethane, propane and butane? Tick **one** box.

Alcohols ☐

Alkanes ☐

Alkenes ☐

Carboxylic acids ☐

(1)

(c) Propane (C_3H_8) is used as a fuel. Complete the equation for the complete combustion of propane.

C_3H_8 + $5O_2$ → 3 _____ + 4 _____

(2)

(d) Octane (C_8H_{18}) is a hydrocarbon found in petrol. Explain why octane is a hydrocarbon.

_____

_____ **(2)**

(e) The table below gives information about the pollutants produced by cars using diesel or petrol as a fuel.

Fuel	Relative amounts of pollutants		
	Oxides of Nitrogen	Particulate matter	Carbon dioxide
Diesel	31	100	85
Petrol	23	0	100

Compare the pollutants from cars using diesel with those from cars using petrol.

_____

_____

_____

_____ **(3)**

(f) Pollutants cause environmental impacts. Draw **one** line from each pollutant to the environmental impact caused by the pollutant.

Pollutant	Environmental impact caused by the pollutant
	Acid rain
Oxides of nitrogen	Flooding
	Global dimming
Particulate matter	Global warming
	Photosynthesis

(2)

A-Level question to give a go!

Q20. Which correctly represents an incomplete combustion of pentane?

A $C_5H_{12} + 8O_2 \longrightarrow 5CO_2 + 6H_2O$ ⬭

B $C_5H_{12} + 8O_2 \longrightarrow 4CO + CO_2 + 6H_2O$ ⬭

C $C_5H_{12} + 6O_2 \longrightarrow 4CO + CO_2 + 6H_2O$ ⬭

D $C_5H_{12} + 5O_2 \longrightarrow 4CO + CO_2 + 4H_2O + 2H_2$ ⬭

(Total 1 mark)

Q21. Tetradecane ($C_{14}H_{30}$) is an alkane found in crude oil. When tetradecane is heated to a high temperature, one molecule of tetradecane decomposes to form one molecule of hexane and three more molecules.

Which of the following could represent this reaction?

A $C_{14}H_{30} \longrightarrow C_6H_{14} + C_4H_8 + 2C_2H_4$ ⬭

B $C_{14}H_{30} \longrightarrow C_6H_{14} + C_6H_{12} + C_2H_4$ ⬭

C $C_{14}H_{30} \longrightarrow C_5H_{12} + 3C_3H_6$ ⬭

D $C_{14}H_{30} \longrightarrow C_6H_{14} + C_2H_6 + 2C_3H_6$ ⬭

(Total 1 mark)

Q22. Petrol contains saturated hydrocarbons. Some of the molecules in petrol have the molecular formula C_8H_{18} and are referred to as octanes. These octanes can be obtained from crude oil by fractional distillation and by cracking suitable heavier fractions.

Petrol burns completely in a plentiful supply of air but can undergo incomplete combustion in a car engine.

(a) State the meaning of both the words *saturated* and *hydrocarbon* as applied to the term *saturated hydrocarbon*. Name the homologous series to which C_8H_{18} belongs.

_____

_____

_____

_____

_____ **(3)**

(b) Outline the essential features of the fractional distillation of crude oil that enable the crude oil to be separated into fractions.

_____

_____

_____

_____

_____

_____ **(4)**

13. Halogenalkanes

GCSE questions

Q17. During the test for unsaturation – a haloalkane is made. Describe the test for unsaturation

Test _____

Result _____ **(2)**

14. Alkenes

GCSE questions

Q18. This question is about organic compounds. Hydrocarbons can be cracked to produce smaller molecules.

The equation shows the reaction for a hydrocarbon, $C_{18}H_{38}$

$$C_{18}H_{38} \rightarrow C_6H_{14} + C_4H_8 + 2\,C_3H_6 + C_2H_4$$

(a) Which product of the reaction shown is an alkane? Tick **one** box.

- C_2H_4 ☐
- C_3H_6 ☐
- C_4H_8 ☐
- C_6H_{14} ☐

(1)

(b) The table below shows the boiling point, flammability and viscosity of $C_{18}H_{38}$ compared with the other hydrocarbons shown in the equation.

	Boiling point	**Flammability**	**Viscosity**
A	highest	lowest	highest
B	highest	lowest	lowest
C	lowest	highest	highest
D	lowest	highest	lowest

Which letter, **A**, **B**, **C** or **D**, shows how the properties of $C_{18}H_{38}$ compare with the properties of C_2H_4, C_3H_6, C_4H_8 and C_6H_{14}? Tick **one** box.

- **A** ☐
- **B** ☐
- **C** ☐
- **D** ☐

(1)

(c) The hydrocarbon C_4H_8 was burnt in air. Incomplete combustion occurred.

Which equation, **A**, **B**, **C** or **D**, correctly represents the incomplete combustion reaction?

- **A** $C_4H_8 + 4O \rightarrow 4CO + 4H_2$
- **B** $C_4H_8 + 4O_2 \rightarrow 4CO + 4H_2O$
- **C** $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$
- **D** $C_4H_8 + 8O \rightarrow 4CO_2 + 4H_2$

Tick **one** box.

A ☐

B ☐

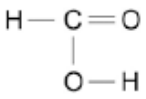
C ☐

D ☐

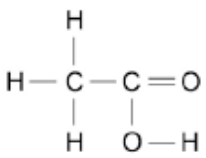
(1)

(d) Propanoic acid is a carboxylic acid. Which structure, **A**, **B**, **C** or **D**, shows propanoic acid?

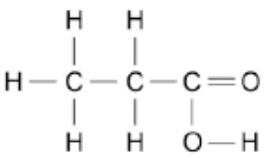
A



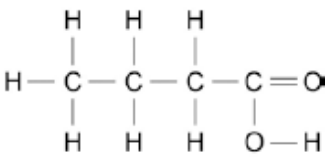
B



C



D



Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(e) Propanoic acid is formed by the oxidation of which organic compound? Tick **one** box.

Propane ☐

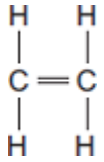
Propene ☐

Propanol ☐

Polyester ☐

(1)

Q19. A molecule of ethene (C_2H_4) is represented as:



(a) A sample of ethene is shaken with bromine water. Complete the sentence.

The bromine water turns from orange to _____ **(1)**

(b) Most ethene is produced by the process of cracking.

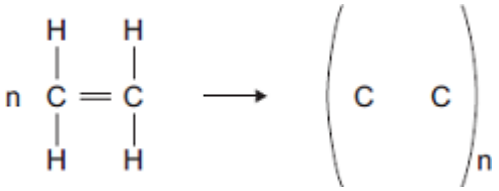
(i) Decane ($C_{10}H_{22}$) can be cracked to produce ethene (C_2H_4) and **one** other product.

Complete the equation to show the formula of the other product.

$$C_{10}H_{22} \longrightarrow C_2H_4 + _____$$ **(1)**

(c) Many molecules of ethene join together to produce poly(ethene).

(i) Complete the structure of the polymer in the equation.



(2)

(ii) Some carrier bags are made from poly(ethene). Some carrier bags are made from cornstarch. Suggest **two** benefits of using cornstarch instead of poly(ethene) to make carrier bags.

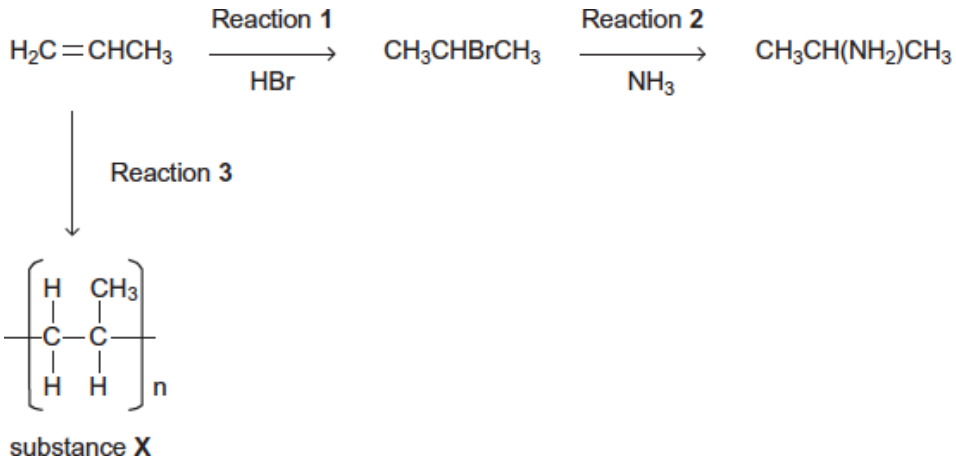
_____

_____

_____ **(2)**

A-Level question to give a go!

Q23. Consider the following reactions.



(a) State the type of reaction in Reaction **3**. Give the name of substance **X**.

_____

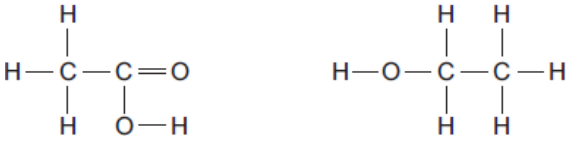
_____ **(2)**

15. Alcohols

GCSE questions

Q20. The diagrams represent two compounds, **A** and **B**.

Compound A **Compound B**



(a) (i) Compound **B** is an alcohol. Name compound **B**.

_____ **(1)**

(ii) Use the correct answer from the box to complete the sentence.

burned	**decomposed**	**oxidised**

To form compound **A**, compound **B** is _____ **(1)**

(iii) Compounds **A** and **B** are both colourless liquids.

A test tube contains a colourless liquid, which could be either compound **A** or compound **B**. Describe a simple **chemical** test to show which compound, **A** or **B**, is in the test tube.

_____

_____

_____

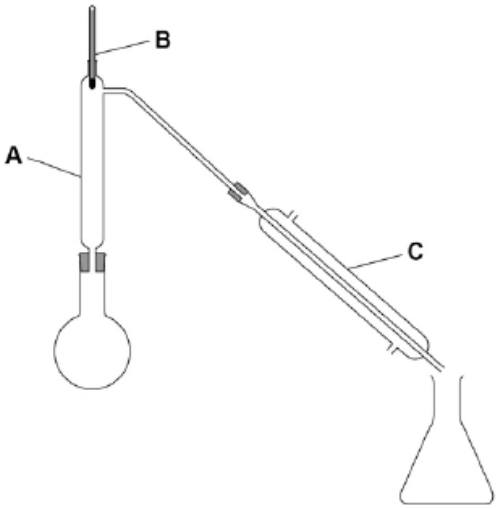
_____ **(2)**

A-Level question to give a go!

Q24. A group of students wanted to produce a biofuel to power the central heating system in their school. They collected scraps of fruits and vegetables from the kitchens and fermented them with yeast, in the absence of air, in order to produce ethanol.

The aqueous mixture was filtered to remove the remaining solids.

The students then set up the apparatus shown in the diagram below and placed the aqueous mixture in the round bottomed flask.



(a) Describe how the students would use this apparatus to collect a sample of ethanol. Include in your answer the functions of the parts of the apparatus labelled **A**, **B** and **C**.

(6)

16. Organic Analysis

GCSE questions

Q21. Four bottles of chemicals made in the 1880s were found recently in a cupboard during a Health and Safety inspection at Lovell Laboratories.

Sodium carbonate

sodium chloride

sodium nitrate

sodium sulfate

The chemical names are shown below each bottle.

(a) You are provided with the following reagents:

- aluminium powder
- barium chloride solution acidified with dilute hydrochloric acid
- dilute hydrochloric acid
- silver nitrate solution acidified with dilute nitric acid
- sodium hydroxide solution.
- limewater
- red litmus paper

(i) Describe tests that you could use to show that these chemicals are correctly named.

(ii)

In each case give the reagent(s) you would use **and** state the result.

Test and result for carbonate ions:

Test and result for chloride ions:

_____

_____

Test and result for nitrate ions:

_____

_____

Test and result for sulfate ions:

_____

_____ **(4)**

(ii) Suggest why a flame test would **not** distinguish between these four chemicals.

_____ **(1)**

(b) Instrumental methods of analysis linked to computers can be used to identify chemicals. Give **two** advantages of using instrumental methods of analysis.

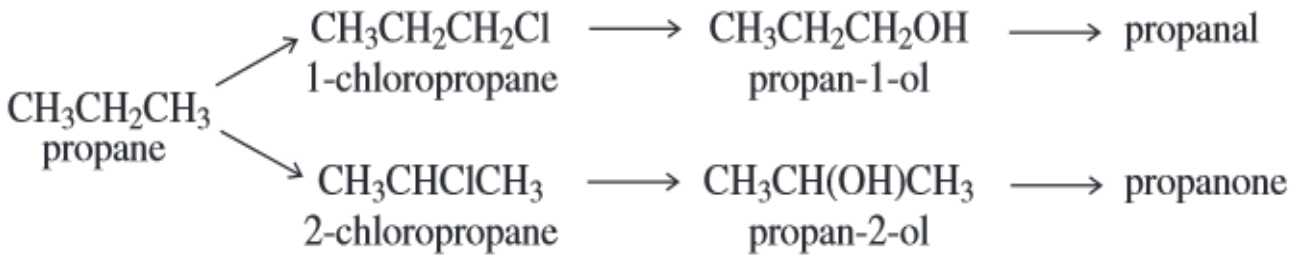
_____

_____

_____ **(2)**

A-Level question to give a go!

Q25. Consider the following scheme of reactions.



(a) High resolution mass spectrometry of a sample of propane indicated that it was contaminated with traces of carbon dioxide.

Use the data in the table to show how precise M_r values can be used to prove that the sample contains both of these gases.

Atom	Precise relative atomic mass
^{12}C	12.00000
^{1}H	1.00794
^{16}O	15.99491

_____

_____ **(2)**

GCSE to A-Level Chemistry – Skills Transition

17. Balancing Equations

Use this method to help you https://www.youtube.com/watch?v=ab0gYBdHU-k

GCSE questions

Q1. (a) Balance these chemical equations.

(i) H_2 + O_2 → H_2O **(1)**

(ii) Al + O_2 → Al_2O_3 **(1)**

(b) Briefly explain why an unbalanced chemical equation cannot fully describe a reaction.

_____

_____

_____ **(2**

Q2. The following passage was taken from a chemistry textbook.

Germanium is a white, shiny, brittle element. It is used in the electronics industry because it is able to conduct a small amount of electricity.

It is made from germanium oxide obtained from flue dusts of zinc and lead smelters.
The impure germanium oxide from the flue dusts is changed into germanium by the process outlined below.

STEP 1 The germanium oxide is reacted with hydrochloric acid to make germanium tetrachloride. This is a volatile liquid in which the germanium and chlorine atoms are joined by covalent bonds.

STEP 2 The germanium tetrachloride is distilled off from the mixture.

STEP 3 The germanium tetrachloride is added to an excess of water to produce germanium oxide and hydrochloric acid.

STEPS 1 to 3 are repeated several times.

STEP 4 The pure germanium oxide is reduced by hydrogen to form germanium.

(a) Balance the equation below which represents the reaction in step 1.

GeO_2 + _____ HCl → $GeCl_4$ + _____ H_2O **(1)**

(b) Write a word equation for the reaction in step 3.

_____ **(1)**

Q3. (a) Cola drinks contain phosphoric acid, H3PO4. The two equations show how phosphoric acid can be made from phosphorus.

Balance these two equations.

(i) P_4 + _____ O_2 → P_4O_{10} **(1)**

(ii) P_4O_{10} + _____ H_2O → $4H_3PO_4$ **(1)**

Some more practice

4) Mg + O_2 → MgO

5) H_2 + O_2 → H_2O

6) Fe + HCl → $FeCl_2$ + H_2

7) CuO + HNO_3→ $Cu(NO_3)_2$ + H_2O

8) $Ca(OH)_2$ + HCl → $CaCl_2$ + H_2O

9) $KHCO_3$ + H_2SO_4 → K_2SO_4 + CO_2 + H_2O

10) Al + Cl_2 → $AlCl_3$

Even more practice - Balancing Equations Game

A-Level question to give a go!

Q11. Copper can be produced from rock that contains $CuFeS_2$

(a) Balance the equations for the two stages in this process.

.....$CuFeS_2$ + ...O_2 + ...SiO_2 ⟶ .....Cu_2S + ...Cu_2O + ...SO_2 + ...$FeSiO_3$

.....Cu_2S + ...Cu_2O ⟶ .....Cu + ...SO_2

(2)

18. Formula Literacy

For each of the following compounds;

- Identify the number of atoms of each element
- The formula of the ions it consists of
- Name it
- Challenge yourself: calculate its RFM

e.g. the first one is done for you:

1. $NaNO_3$

1 x sodium atom, 1 x nitrogen atom, 3 x oxygen atoms

Na+ and NO_3-

Sodium nitrate

Challenge: (1 x 23) + (1 x 14) + (3 x 16) = 85

2. Na_2O

3. K_3PO_4

4. $CaBr_2$

5. Al_2O_3

6. NH_4OH

7. $(NH_4)_2SO_4$

19. SI units

To reduce confusion and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China. The seven SI base units are:

Physical quantity	Usual quantity symbol	Unit	Abbreviation
mass	m	kilogram	kg
length	l or x	metre	m
time	t	second	s
electric current	I	ampere	A
temperature	T	kelvin	K
amount of substance	N	mole	mol

All other units can be derived from the SI base units.

For example, area is measured in square metres (written as m^2) and speed is measured in metres per second (written as ms^{-1}).

It is not always appropriate to use a full unit. For example, measuring the width of a hair or the distance from Manchester to London in metres would cause the numbers to be difficult to work with.

Prefixes are used to multiply each of the units. You will be familiar with centi (meaning 1/100), kilo (1000) and milli (1/1000) from centimetres, kilometres and millimetres.

There is a wide range of prefixes. The majority of quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, a distance of 33 000 m would be quoted as 33 km.

Prefix	Symbol	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}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	μ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000

For the following quantities, which SI unit and most appropriate prefix would you use?

1. The mass of water in a test tube.

2. The time taken for a solution to change colour.

3. The radius of a gold atom.

4. The volume of water in a burette.

5. The amount of substance in a beaker of sugar.

6. The temperature of the blue flame from a Bunsen burner.

Rewrite the following quantities.

7. 0.00122 metres in millimetres

8. 104 micrograms in grams

9. 1.1202 kilometres in metres

10. 70 decilitres in millilitres

11. 70 decilitres in litres

12. 10 cm^3 in litres