WORCESTER
SIXTH FORM COLLEGE

Progression - Chemistry

Get ready for A-level!
A guide to help you get ready for A-level Chemistry, including everything from topic guides to days out and online learning courses.

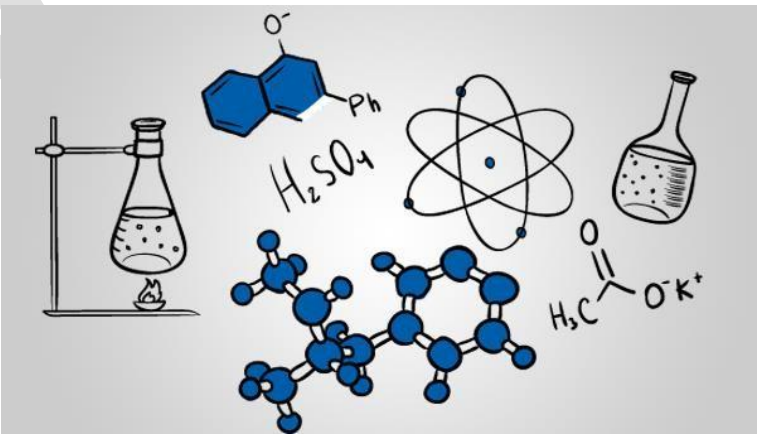
Making the transition to A level Chemistry

This pack contains a programme of activities and resources to prepare you to start A level in Chemistry in September. 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.

It is split into 5 parts:

1. Thinking of studying A Level Chemistry at Worcester Sixth Form College?
2. Transition tasks including skills to be completed before September. Mark your work using a different coloured pen. Bring all completed & marked tasks with you to show your teacher.
3. Baseline assessment- to be completed by September and marked by your new teacher. Bring this with you.
4. Optional tasks – these are highly useful if you are considering studying Chemistry or a science related subject at University. Attempt a minimum of five **different** tasks from the list.
5. Mark scheme for transition tasks – please use to check and assess your work.

https://www.my-mooc.com/en/mooc/chemistry1/



1. Thinking of studying A Level Chemistry at Worcester Sixth Form College?

We teach the **OCR A** specification.

Here is a brief summary of the topics we cover over the two-year course. If you want to find out more about each of these topics, you can find the full specification on the OCR website:

https://www.ocr.org.uk/qualifications/as-and-a-level/chemistry-a-h032-h432-from-2015/specification-at-a-glance/

Content overview:

Module 1: Development of practical skills in chemistry

- Practical skills assessed in the practical endorsement and written exam

Module 2: Foundations in chemistry

- Atoms, compounds, molecules and equations
- Amount of substance
- Acid–base and redox reactions
- Electrons, bonding and structure

Module 3: Periodic table and energy

- The periodic table and periodicity
- Group 2 and the halogens
- Qualitative analysis
- Enthalpy changes
- Reaction rates and equilibrium

Module 4: Core organic chemistry

- Hydrocarbons
- Alcohols and haloalkanes
- Organic synthesis
- Analytical techniques (IR and MS)

Year 2:

Module 5: Physical chemistry and transition elements

Module 6: Organic chemistry and analysis

2. Tasks to complete before September

In order to prepare for the course, you need to complete all of the tasks in this section, including the baseline assessment. Before you begin, find a folder to store this booklet and all the notes that you make on the tasks. **You need to bring in this folder at the start of the course.** Make sure that your notes are neat and well-organised!

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

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

You MUST **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 prepared with all of your GCSE knowledge. You may find these websites helpful:

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

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.

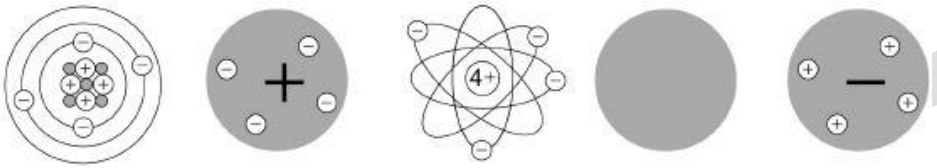
_____

_____

_____

_____Radius = _____ m **(2)**

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



A B C D E

(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)**

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} ⬭

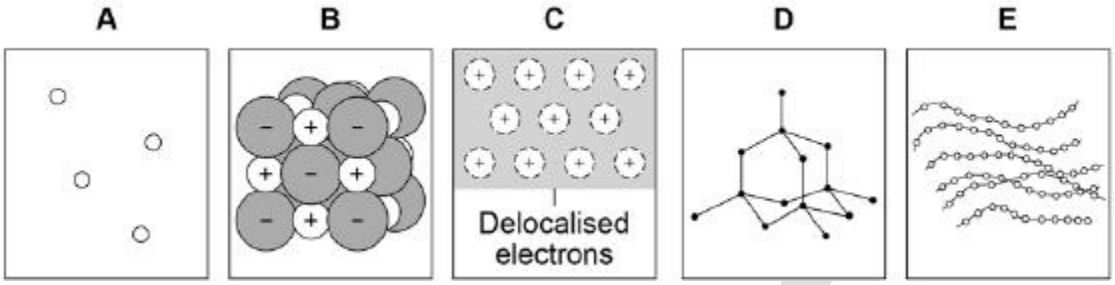
C 6.8×10^{25} ⬭

D 7.2×10^{25} ⬭

(Total 1 mark)

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)

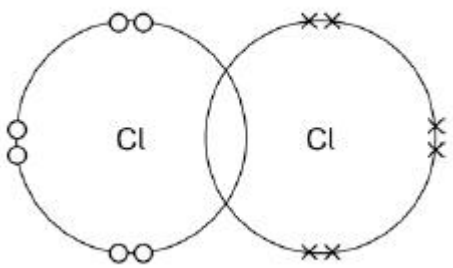
(e) A chlorine atom has 7 electrons in the outer shell.

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 ☐

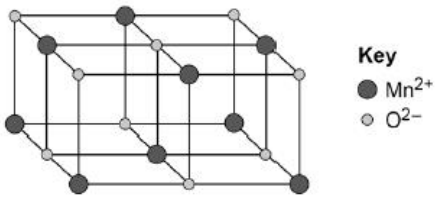
Strong forces between molecules ☐

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 ☐

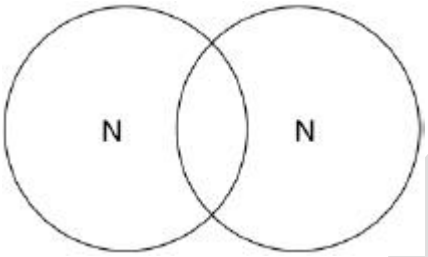
Molecules move around in the liquid ☐

(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)

GCSE questions

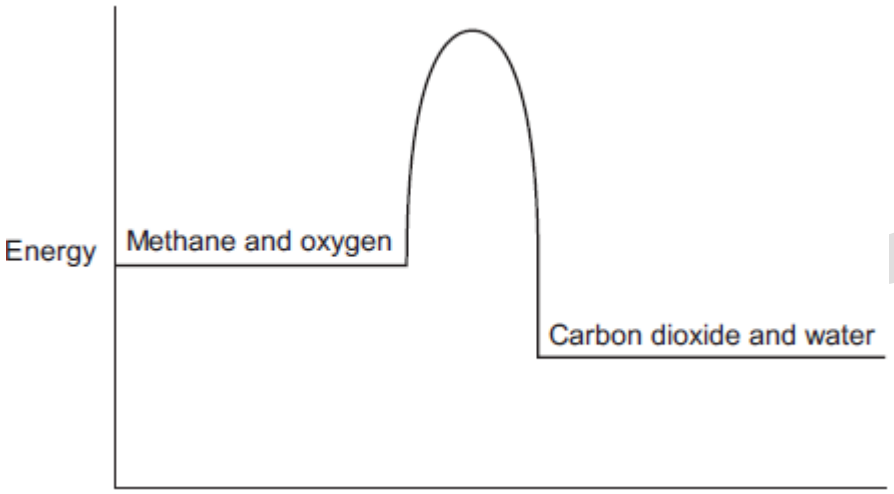
Q6. Methane (CH_4) is used as a fuel.

(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.

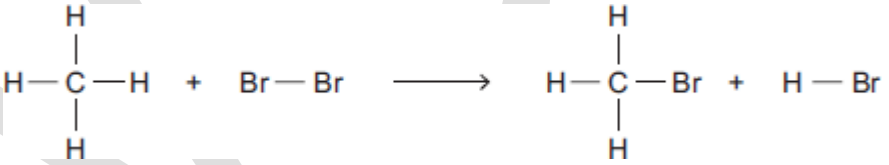
_____

_____

_____

_____ **(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=O
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)

GCSE questions

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

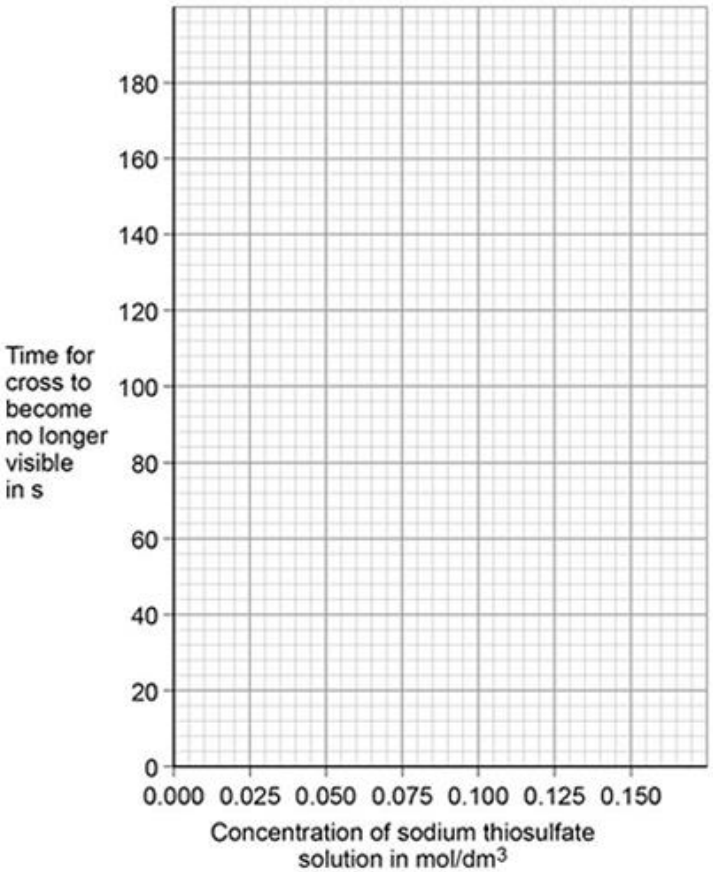
The equation for the reaction is:

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

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.

_____

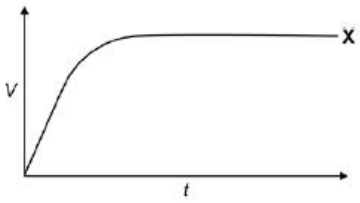
_____

_____

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

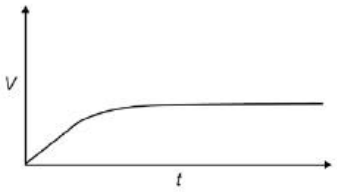
A-Level question to give a go!

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.

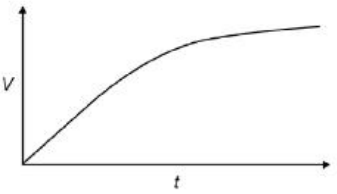


Which line represents the volume of hydrogen formed, at the same temperature and pressure, when the concentration of sulfuric acid has been halved?

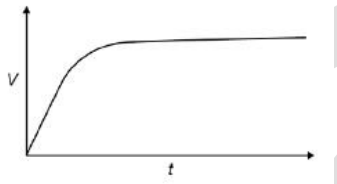
A



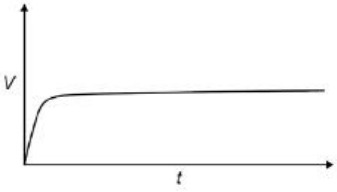
B



C



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)**

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	⬭

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)

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 ☐

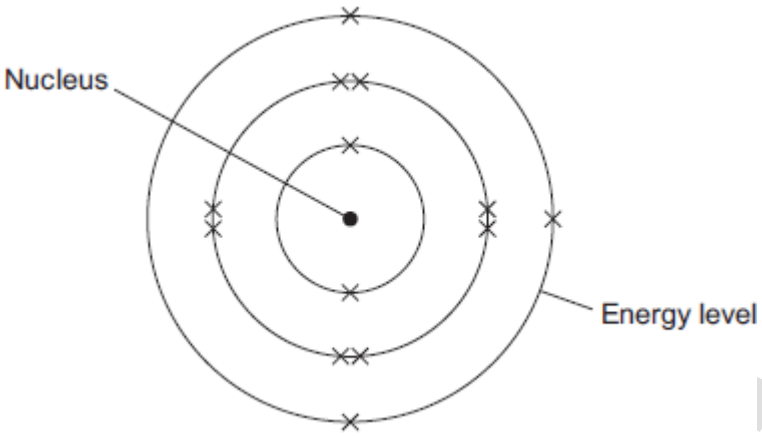
(1)

(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 _____ .

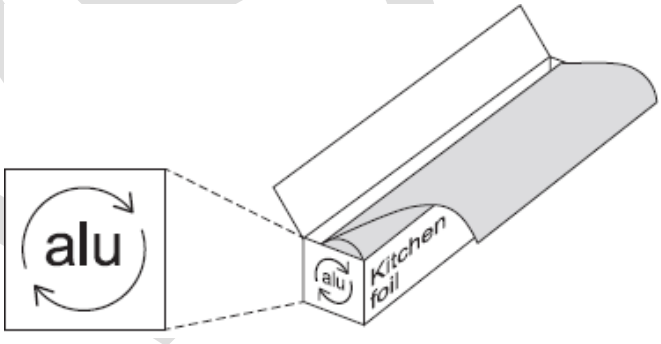
(2)

(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)

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

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)**

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)

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)

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
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 ☐

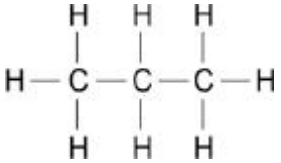
Hydrogen ☐

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.

$C_3H_8 + 5O_2 \rightarrow 3$ _____ +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)**

Halogenalkanes

GCSE questions

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

Test

_____

Result

_____ **(2)**

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 ☐

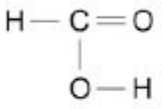
C ☐

D ☐

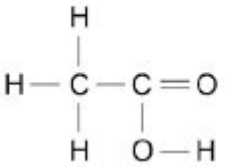
(1)

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

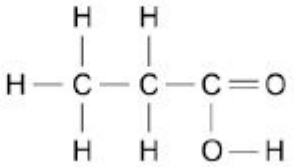
A



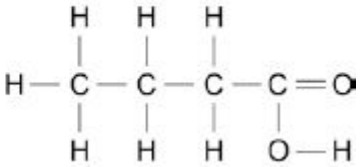
B



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 ☐

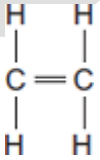
Propene ☐

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.

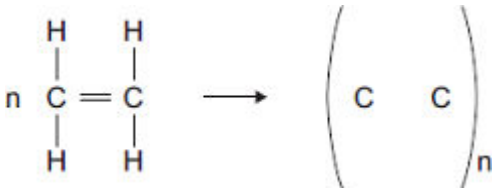
(i) Decane ($C_{10}H_{22}$) can be cracked to produce ethene (C_2H_4) and **one** other product.

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.

_____

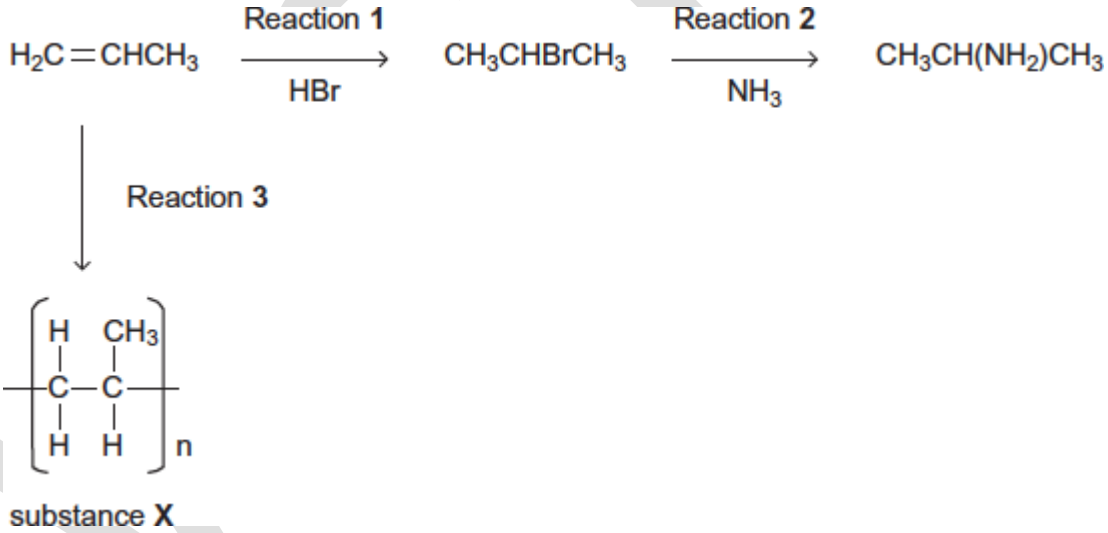
_____

_____

_____ **(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**.

_____

_____

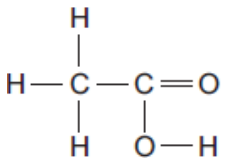
_____ **(2)**

Alcohols

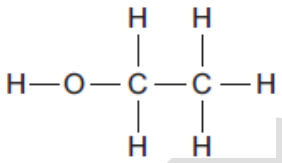
GCSE questions

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.

_____

_____

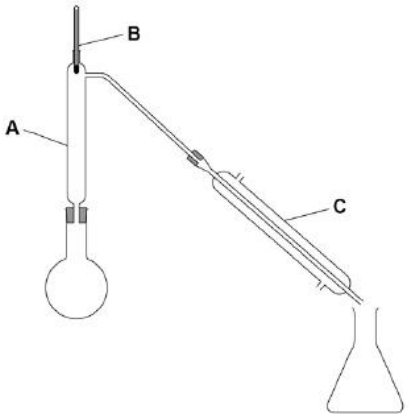
_____

_____

_____ **(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)

Organic Analysis

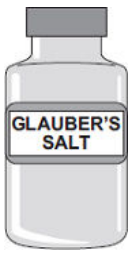
GCSE questions

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.

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.

_____

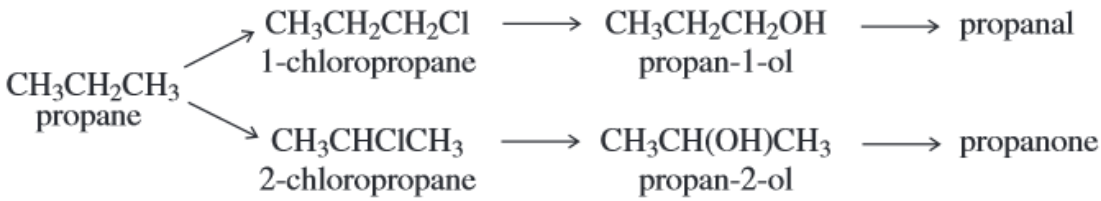
_____

_____

_____ **(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

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 4.

_____ **(1)**

Q3. (a) Cola drinks contain phosphoric acid, H_3PO_4. The two equations show how phosphoric acid can be made from phosphorus.

Balance these two equations.

(i) P_4 + _____ $O_2 \rightarrow P_4O_{10}$

(1)

(ii) P_4O_{10} + _____ $H_2O \rightarrow 4H_3PO_4$

(1)

Some more practice

4) Mg + $O_2 \rightarrow$ MgO

5) H_2 + $O_2 \rightarrow$ H_2O

6) Fe + HCl $\rightarrow$ $FeCl_2$ + H_2

7) CuO + $HNO_3 \rightarrow$ $Cu(NO_3)_2$ + H_2O

8) $Ca(OH)_2$ + HCl $\rightarrow$ $CaCl_2$ + H_2O

9) $KHCO_3$ + $H_2SO_4 \rightarrow$ K_2SO_4 + CO_2 + H_2O

10) Al + $Cl_2 \rightarrow$ $AlCl_3$

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 $\rightarrow$ .....Cu_2S + ...Cu_2O + ...SO_2 + ...$FeSiO_3$

.....Cu_2S + ...Cu_2O $\rightarrow$ .....Cu + ...SO_2 **(2)**

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
- 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
RFM: (1 x 23) + (1 x 14) + (3 x 16) = 85g

2. Na_2O

3. K_3PO_4

4. $CaBr_2$

5. Al_2O_3

6. NH_4OH

7. $(NH_4)_2SO_4$

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.

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

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.

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

A-Level Chemistry Baseline Assessment

Name _____

The following 40 mark assessment is designed to test your recall, analysis and evaluative skills and knowledge.
Remember to use your exam technique: look at the command words and the number of marks each question is worth. This will be handed in to your chemistry teacher on your **first chemistry lesson**.

1. Write the formula of the ions:
a. potassium ion
b. silver ion
c. ammonium ion
d. zinc ion
e. magnesium ion

[5]

2. Write the formula of the ions:
a. sulfate ion
b. hydride ion
c. bromide ion
d. suilfide ion
e. phosphate ion

[5]

3. Write the formula of:
a. sulfuric acid
b. nitric acid
c. ammonia
d. calcium hydroxide
e. sodium carbonate

[5]

4. Give the oxidation state of the underlined atom in the following chemicals.
Useful information: H=+1, K=+1, Na=+1, Mg=+2, O=-2, Cl=-1

a) $\underline{C}O_2$ b) $\underline{S}O_3$ c) $H_2\underline{S}O_4$ d) $\underline{Al}Cl_3$

e) $\underline{Cr}_2O_3$ f) $Na\underline{N}O_3$ g) $\underline{V}Cl_4$

[7]

5. Balance the following equations:

a) C_3H_8 + ___ O_2 → ___ CO_2 + ___ H_2O

b) ___ HCl + $Mg(OH)_2$ → $MgCl_2$ + ___ H_2O

c) Na_2CO_3 + ___ HCl → ___ NaCl + ___ H_2O + CO_2

6. Calculate the relative formula masses of the following:
Atomic masses: H=1, O=16, S=32.1, C=12, Ca=40.1, Na=23, Cl=35.5, Zn=64.4

a) $CaCl_2$ b) H_2CO_3 c) Na_2SO_4 d) C_3H_7OH e) $Zn(NO_3)_2$ [5]

7. Vinegar is a solution of ethanoic acid (CH_3COOH) in water. A student carried out a titration of a sample of vinegar. He used a pipette to measure exactly 25.0 cm^3 of vinegar into a flask, added an indicator and titrated it with a 1.00 mol dm^{-3} solution of sodium hydroxide (NaOH).

$$CH_3COOH + NaOH \mid CH_3COONa + H_2O$$

The student found that his average titration was 27.50 cm^3

c= n/v c= concentration ($moldm^{-3}$), n=amount in moles, v=volume (dm^3)

n= m/M n= amount in moles, m=mass (g), M= formula mass

1 dm^3= 1000 cm^3

a. Using the chemical equation, how many moles of sodium hydroxide will react with 1 mole of ethanoic acid?

[1]

b. How many moles of sodium hydroxide are in 27.50 cm^3 of 1.00 mol dm^{-3} sodium hydroxide? [1]

c. How many moles of ethanoic acid are in 25.0 cm^3 of the vinegar sample? [1]

d. How many moles of ethanoic acid are in 1 dm^3 of vinegar?

[1]

e. Ethanoic acid has a molecular mass of 60. What mass of ethanoic acid is present in 1dm^3 of vinegar?

[1]

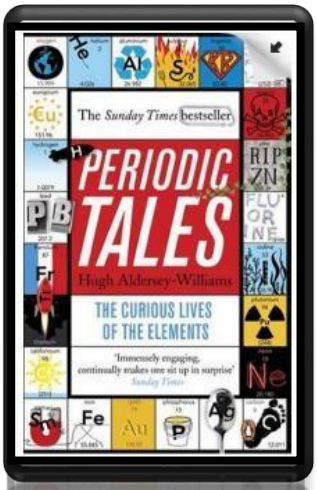
Total score _____

Teacher comment _____

4. Optional activities that you may enjoy:

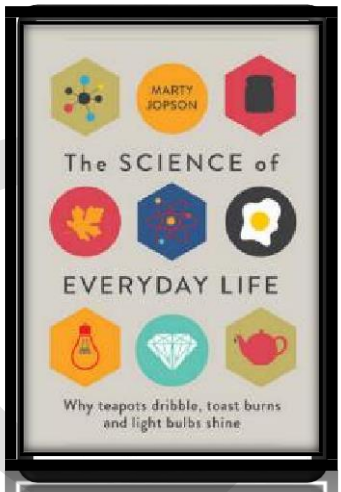
Book Recommendations

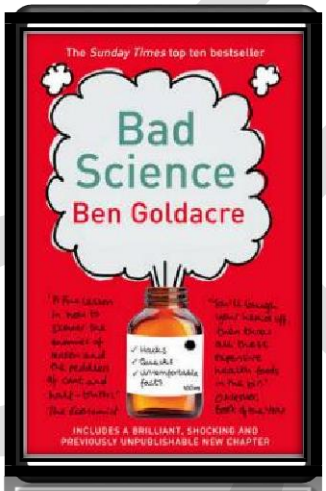
Kick back this summer with a good read. The books below are all popular science books and great for extending your understanding of chemistry



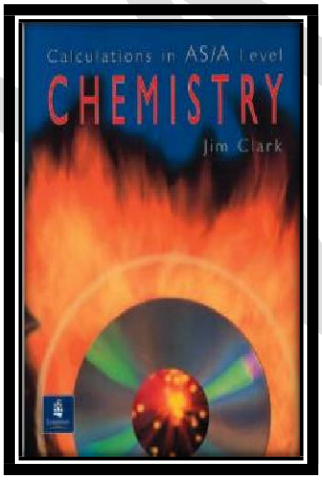
Periodic Tales: The Curious Lives of the Elements
This book covers the chemical elements, where they come from and how they are used. There are loads of fascinating insights into uses for chemicals you would have never even thought about.

The Science of Everyday Life: Why Teapots Dribble, Toast Burns and Light Bulbs Shine
The title says it all really, lots of interesting stuff about the things around your home!

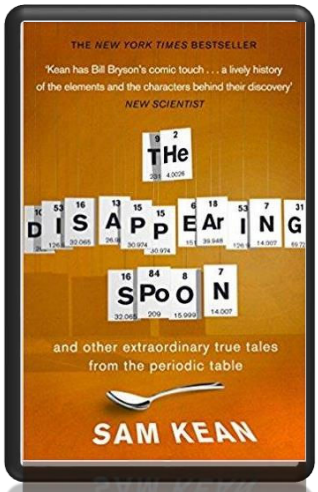




Bad Science
Here Ben Goldacre takes apart anyone who published bad / misleading or dodgy science – this book will make you think about everything the advertising industry tries to sell you by making it sound 'sciencey'. Bad Medicine is also worth a read.



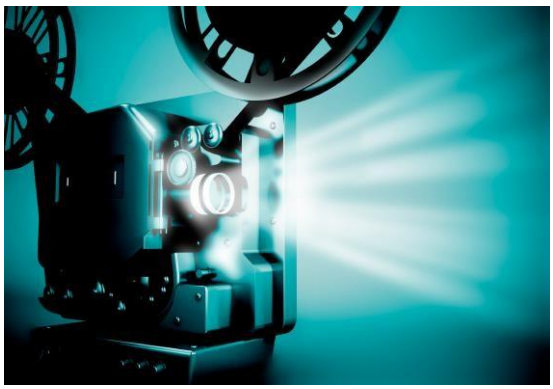
Calculations in AS/A Level Chemistry
If you struggle with the calculations side of chemistry, this is the book for you. Covers all the possible calculations you are ever likely to come across. Brought to you by the same guy who wrote the excellent chemguide.co.uk website.

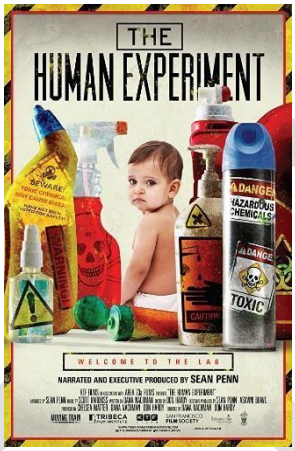


One of our crowning scientific achievements is also a treasure trove of passion, adventure, betrayal and obsession. **The Disappearing Spoon** follows the elements, their parts in human history, finance, mythology, conflict, the arts, medicine and the lives of the (frequently) mad scientists who discovered them.

Movie Recommendations

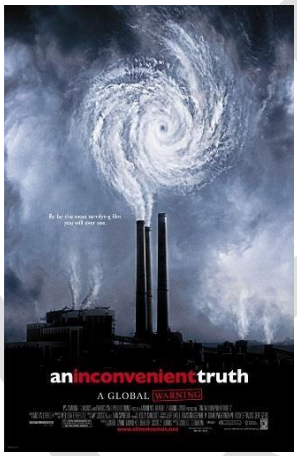
Everyone loves a good story and everyone loves some great science. Here are some of the picks of the best films based on real life scientists and discoveries. You won't find Jurassic Park on this list! Great watching for a rainy day.



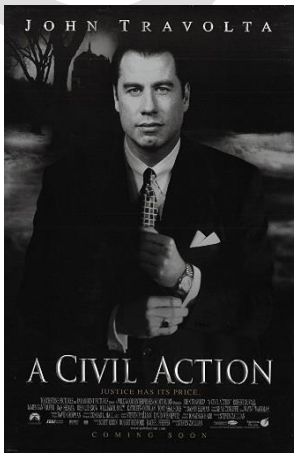


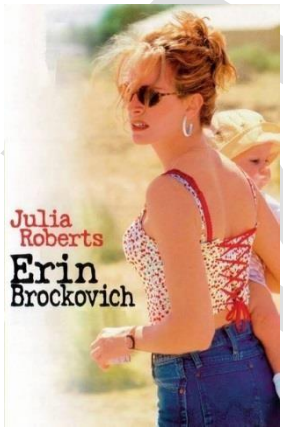
The Human Experiment (2013)
A documentary that explores chemicals found in everyday household products.

An Inconvenient Truth (2006)
Al Gore, former presidential candidate campaigns to raise public awareness of the dangers of global warming and calls for immediate action to curb its destructive effects on the environment.
(See also: An Inconvenient Sequel, 2017)

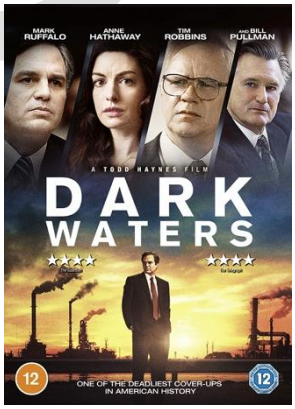


A Civil Action (1998)
A tenacious lawyer takes on a case involving a major company responsible for causing several people to be diagnosed with leukemia due to the town's water supply being contaminated, at the risk of bankrupting his firm and career.





Erin Brokovich (2000)
Based on a true story. An unemployed single mother becomes a legal assistant and almost single-handedly brings down a California power company accused of polluting a city's water supply.

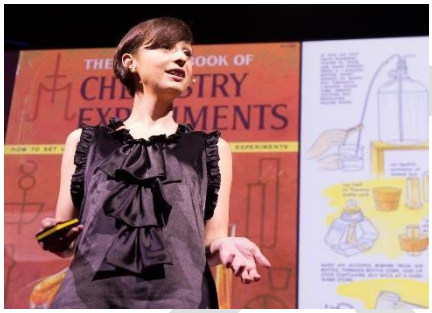


Dark Waters (2019)
A corporate defense attorney takes on an environmental lawsuit against Dupont (makers of Teflon) that exposes a lengthy history of pollution.

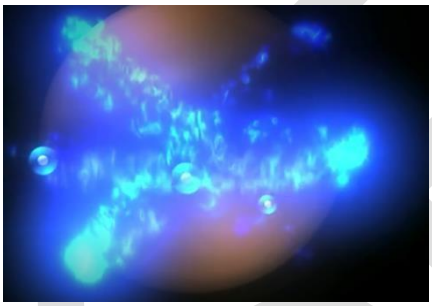
TED Talks

If you have 30 minutes to spare, here are some great presentations (and free!) from world leading scientists and researchers on a variety of topics. They provide some interesting answers and ask some thought-provoking questions. Use the link or scan the QR code to view:

Play with Smart Materials
Available at :
https://www.ted.com/talks/catarina_mota_play_with_smart_materials Ink that conducts electricity; a window that turns from clear to opaque at the flip of a switch; a jelly that makes music. All this stuff exists, it's time to play with it. A tour of surprising and cool new materials.



Just how small is an atom?
Available at :
https://www.ted.com/talks/just_how_small_is_an_atom
Just how small are atoms? Really, really, really small. This fast-paced animation from TED-Ed uses metaphors (imagine a blueberry the size of a football stadium!) to give a visceral sense of just how small atoms are.



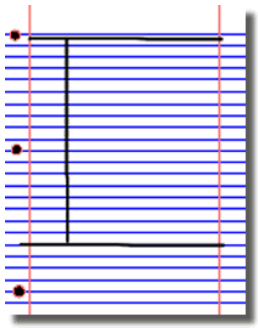
Battling Bad Science
Available at :
https://www.ted.com/talks/ben_goldacre_battling_bad_science#t-44279
Every day there are news reports of new health advice, but how can you know if they're right? Doctor and epidemiologist Ben Goldacre shows us, at high speed, the ways evidence can be distorted, from the blindingly obvious nutrition claims to the very subtle tricks of the pharmaceutical industry.

How Spectroscopy Could Reveal Alien Life
Available at :
https://www.ted.com/talks/garik_israelian_what_s_inside_a_star
Garik Israelian is a spectroscopist, studying the spectrum emitted by a star to figure out what it's made of and how it might behave. It's a rare and accessible look at this discipline, which may be coming close to finding a planet friendly to life.

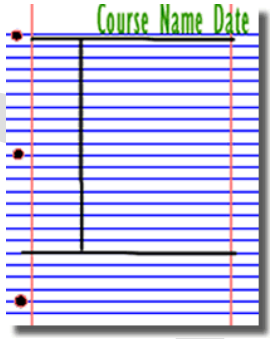
Research Activities

Research, reading and note making are essential skills for A level chemistry study. For the following task you are going to produce 'Cornell Notes' to summarise your reading.

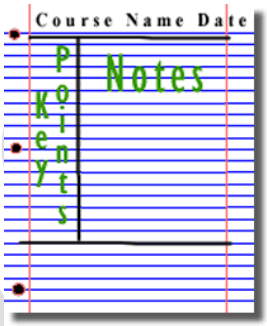
1. Divide your page into three sections like this



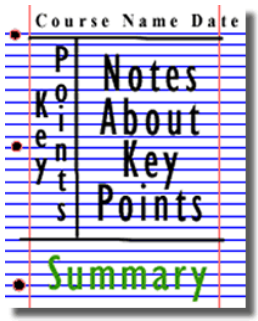
2. Write the name, date and topic at the top of the page



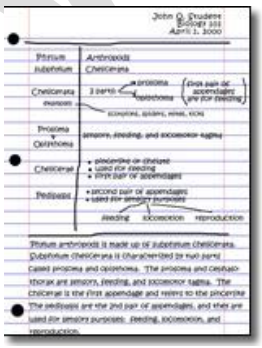
3. Use the large box to make notes. Leave a space between separate idea. Abbreviate where possible.



4. Review and identify the key points in the left hand box



5. Write a summary of the main ideas in the bottom space

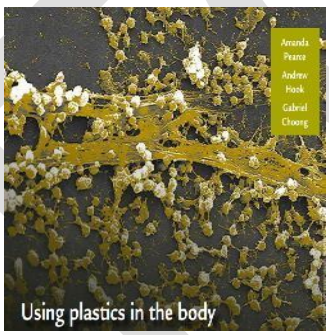


Images taken from http://coe.jmu.edu/learningtoolbox/cornellnotes.html

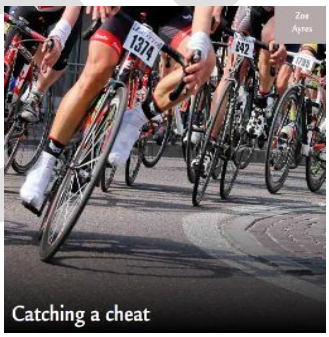
Research Activities

Aimed at students aged 14-19, Catalyst magazine is packed with interesting articles on cutting-edge science, interviews and new research written by leading academics. It also includes a booklet of teacher's notes, full of ideas and lesson plans to bring the articles to life in the classroom.
For each of the following topics you are going to use the resources to produce one page of Cornell style notes.
Use the links of scan the QR code to take you to the resources.

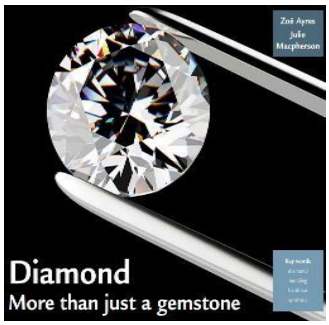
Topic 1: Using Plastics in the Body
Available at:
https://www.stem.org.uk/resources/elibrary/resource/382317/using-plastics-body
This Catalyst article looks at how scientists are learning to use polymers for many medical applications, including implants, bone repairs and reduction in infections.



Topic 2: Catching a Cheat
Available at:
https://www.stem.org.uk/system/files/elibrary-resources/2017/03/Catching%20a%20cheat.pdf This Catalyst article looks at analytical chemists who are involved in many kinds of testing, including drug testing to catch cheats in sport.



Topic 3: Diamond: More than just a gemstone
Available at:
https://www.stem.org.uk/system/files/elibrary-resources/2017/02/Diamond%20more%20than%20just%20a%20gemstone.pdf
This Catalyst article looks at diamond and graphite which are allotropes of carbon. Their properties, which depend on the bonding between the carbon atoms, are also examined.



Topic 4: The Bizarre World of High Pressure Chemistry
Available at:
https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27_1_the_bizarre_world_of_high_pressure_chemistry.pdf
This Catalyst article investigates high pressure chemistry and discovers that, when put under extreme pressure, the properties of a material may change dramatically.

Topic 5: Microplastics and the Oceans
Available at:
https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27_1_microplastics_%20and_the_oceans.pdf
This Catalyst article looks at microplastics. Microplastics are tiny particles of polymer used in many products. They have been found to be an environmental pollutant especially in oceans.

Science on Social Media

Science communication is essential in the modern world and all the big scientific companies, researchers and institutions have their own social media accounts. Here are some of our top tips to keep up to date with developing news or interesting stories:

Follow on Twitter:
Satlers' Institute - Our activities include Festivals of Chemistry; Chemistry Camps; Curricula; Awards for Technicians, Graduates, A Level Students; and Seminars
@salters_inst

Daily A Level Chemistry Facts – Daily Chemistry Facts (Based on the A-Level AQA spec but most facts work with all)
@chemAlevels

Chemistry News –The latest chemistry news from only the best sources
@chemistrynews

Compound Interest– Graphics exploring everyday #chemistry. Winner of @absw 2018 science blog award
@compoundchem

Chemistry World – Chemistry magazine bringing you the latest chemistry news and research every day. Published by the Royal Society of Chemistry.
@ChemistryWorld

Royal Society of Chemistry - Promote, support and celebrate chemistry. Follow for updates on latest activities
@RoySocChem

Periodic Videos– Chemistry video series by @BradyHaran & profs at the Uni of Nottingham - also see @sixtysymbols & @numberphile
@periodicvideos

Find on Facebook:
Science Now - Science Now is a dedicated community that helps spread science news in all fields, from physics to biology, medicine to nanotechnology, space and beyond!

National Science Foundation – As an independent federal agency, NSF fund a significant proportion of basic research. For official source information about NSF, visit www.nsf.gov

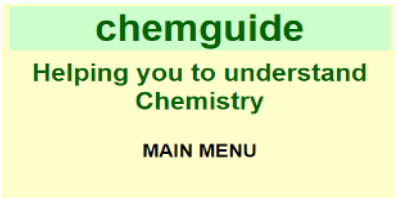
Science News Magazine - Science covers important and emerging research in all fields of science

BBC Science News - The latest BBC Science and Environment News: breaking news, analysis and debate on science and nature around the world

Scientific American - Scientific American is the authority on science and technology for a general audience, with coverage that explains how research changes our understanding of the world and shapes our lives.

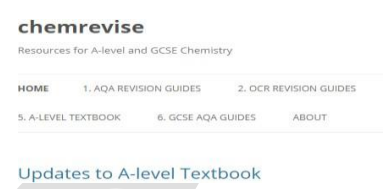
Useful Websites

These websites all offer an amazing collection of resources that you should use again and again throughout your course.



This website is very detailed and identifies other resources which are sharing incorrect or outdated information and suggests the correct materials to use. The site also contains links to the syllabuses of many exam boards which means it is accessible and useful to all students.
https://www.chemguide.co.uk/

Doc Brown is a website dedicated to all three science subjects; physics, chemistry and biology. It provides the user with summarised notes (useful for making flash cards) and practice questions to further their knowledge and understanding.
The site provides resources from a wide range of exam boards including AQA, Edexcel, Chemistry, CCEA, OCR, WJEC, CIE and Salters from GCSE level to A2.
http://www.docbrown.info/



Revision guides for OCR Chemistry, we use them in our work booklets.
https://chemrevise.org/

The free revision website for students studying GCSE and A-levels. S-cool provides revision guides, question banks, revision timetable and more
https://www.s-cool.co.uk/a-level/chemistry

Machemguy videos on you-tube are based on the OCR specification and cover pretty much every topic.
https://www.youtube.com/playlist?list=PLi6oabjl6coxUlfu8syK3K0iFXQIjwDUM

Tons of awesome courses in one awesome channel! Check out the playlists for past courses in physics, philosophy, games, economics, U.S. government and politics, astronomy, anatomy & physiology, world history, biology, literature, ecology, psychology, and of course, chemistry!
https://www.youtube.com/user/crashcourse/featured

Science: Things to do!

Completing a MOOC will look great on your Personal statement and they are dead easy to take part in!

W… UCAS? N…
act.
MOOCs are online courses run by nearly all universities. They are short FREE courses that you take part in. They are usually quite specialist, but aimed at the public, not the genius!
There are lots of websites that help you find a course, such as edX and Future learn.
You can take part in any course, but there are usually start and finish dates. They mostly involve taking part in web chats, watching videos and interactives.

2. Mark scheme

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 nucleus

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

James Chadwick proved the existence of the neutron.

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

The two types of particle with the same mass are the neutron and the proton. **(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.

Ar = (63 x 70) + (65 x 30) = 6360 = 63.65g

100 100

Ar = 63.65g

(2)

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

Element **X** is Copper, Cu. **(1)**

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

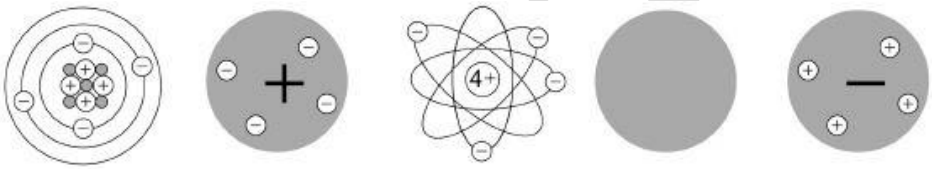
The radius of the centre of the atom is $\frac{1}{10000}$ the radius of the atom.

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

Radius of this atom = (1/10000) x 1.2×10^{-10} = 1.2×10^{-14}

Radius = 1.2×10^{-14}

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



A B C D E

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

A	B	C	D	E
	x			

(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
		x		

(1)

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

A	B	C	D	E
x				

(1)

(d) Define the mass number of an atom.

Mass of an atom is equal to the number of protons and number of neutrons (in the nucleus).

(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 ☒ x

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	x
D	19	18	23	○

Use the P.T to look up the atomic number, which is 19 and equals no. of protons. Take this away from the mass number, 41 and you are left with 22 neutrons. Because the particle is a cation, it has lost an electron so there should be

(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.

Each atom differs in the number of neutrons.

Magnesium-24 has 12 neutrons, magnesium-25 has 13 neutrons and magnesium-26 has 14 neutrons.

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

Give a reason for your answer.

Chemical properties there is no change in their chemical reactivity…

Reason …this is because chemical reactivity/ property is determined by the electron configuration / number of outer electrons and not neutrons. **(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:

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

? 11.0g

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.

Moles $CuCl_2$ = mass/Mr = 11.0 / (63.5 + (35.5 x 2) = 11.0 / 134.5 = 0.081784…mol (keep value in calculator)

Molar ratio: $CuCl_2$: $CuCO_3$ is 1:1 therefore, moles $CuCO_3$ = 0.081784…mol

∴ Mass $CuCO_3$ = Mr x moles = (63.5 + 12 + (16 x 3)) x 0.081784….

= 123.5 x 0.081784…

= 10.10037

Mass $CuCO_3$ = 10.1g **(4)**

Give answers to 3sf

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

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{expected yield}} \times 100$$

$$79.1 = \frac{\text{actual yield}}{} \times 100$$

10.1

(79.1 x 10.1)/100 = actual yield

= 7.9891

Actual mass of copper chloride produced = 8.00 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.

Desired product here is copper (II) chloride and you need to use the big numbers, too.

$$\%\text{atom economy} = \frac{63.5 + (35.5 \times 2)}{(63.5 + 16) + 2 \times (1 + 35.5)} \times 100$$

$$= \frac{134.5}{(79.15 + 73)} \times 100$$

$$= 88.399\ldots$$

Percentage atom economy = 88.4% **(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.

There are more by-products in reaction 1, as there are two, whereas in reaction 2 there is only 1. This means that less reactant atoms make up the desired product in reaction 1 thus having a lower %atom economy. **(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% x

C 51.1% ⬭

D 72.8% ⬭

Glucose moles = 1440/180 = 8
Molar ratio 1:2 therefore, moles ethanol = 8 x 2 = 16
Expected mass of ethanol = 16 x 46 = 736g
%yield = (268/736) x 100 = 36.4%

(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} x

B 7.2×10^{22} ⬭

C 6.8×10^{25} ⬭

D 7.2×10^{25} ⬭

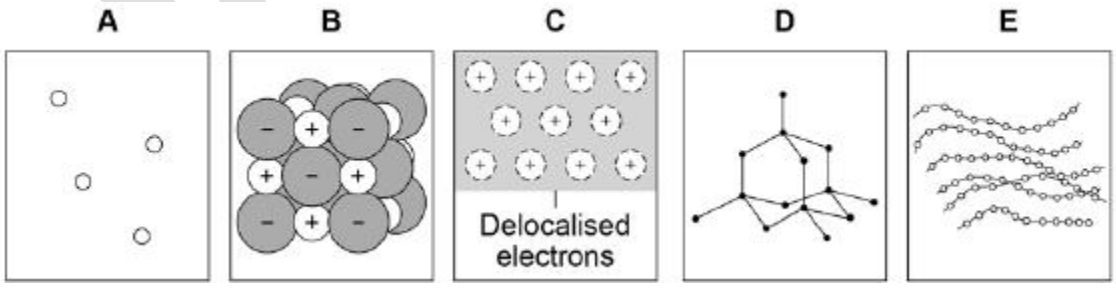
1 mole = Avogadro's constant
Mr propane, C_3H_8 = (3x12) + (8x1) = 44g
Moles propane = 5.0 / 44 = 0.1136
Propane molecules = 0.1136 x 6.022 x 10^{23}
= 6.84 x 10^{22}

(Total 1 mark)

Bonding

GCSE questions

Q4. Figure 1 shows the structure of five substances.



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

A x **B** ⬭ **C** ⬭ **D** ⬭ **E** ⬭

(1)

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

A ☐ **B** ☐ **C** ☐ **D** ☒ x **E** ☐

(1)

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

A ☐ **B** ☐ **C** ☒ x **D** ☐ **E** ☐

(1)

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

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☒ x

(1)

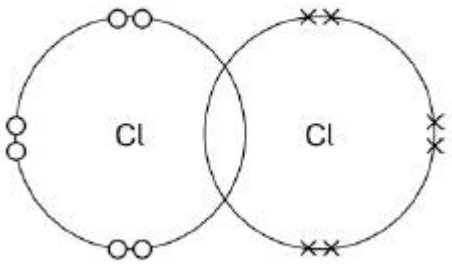
(e) A chlorine atom has 7 electrons in the outer shell.

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



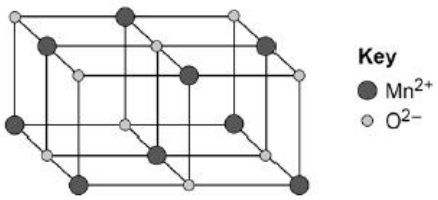
(1)

(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	☒ x

(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**.

Each manganese ion is bonded to four oxygen ions, and vice versa, therefore molecular formula is Mn4O4. This simplest ratio of 4:4 is 1:1 therefore MnO is the empirical formula.

Empirical formula = MnO **(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	x
Molecules move around in the liquid	

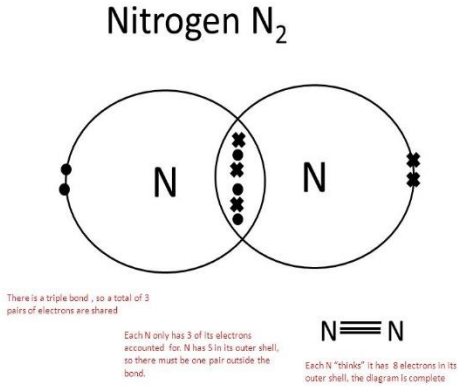
(1)

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)



1 mark for the correct number of electrons shared
1 mark for the remaining outer electrons.

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

Nitrogen has a simple covalent structure whereby small N2 molecules are held together by weak intermolecular forces.

These require a small amount of energy to overcome, which accounts for the low boiling point. **(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.

Graphite is soft (lubricant) because the hexagonal carbon layers are held together by weak intermolecular forces. So when pressure is applied to graphite, e.g. when writing with a pencil, the layers slide over each other easily, leaving a mark.

Graphite conducts electricity because there are delocalised / free moving electrons that move through the structure when it is used, e.g. as an electrode. The delocalised electrons carry the charge through the structure.

(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	x
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 $Ca(NO_3)_2$ x

C Ca_2NO_2

D $Ca(NO_2)_2$

Nitrate (V) means the nitrogen in this ion has a charge of +5, which means it is the NO_3^- ion. Because each O is -2 and so total negative charge = -6 and if the overall charge is -1 then N must be +5.
Ca is in group 2 so it has a +2 charge:
Ca^{2+} NO_3^-
The charges must balance so we need 1 Ca^{2+} ion and 2 NO_3^- ions.

(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)

Structures		
M1 Bromine is (simple) molecular / simple molecules	1	Chemical Error penalties
M2 Magnesium is metallic / consists of (positive) ions in a (sea) of delocalised electrons	1	If Br_2 (covalent) bonds broken lose M3 and M4
Strength		If eg Mg molecules or Mg ionic bonds lose M2 and M4
M3 Br_2 has weak (van der Waals) forces between the molecules / weak IMFs	1	
M4 so more energy is needed to overcome the Stronger (metallic) bonds or converse. The comparison could be direct or implied.	1	
Liquid range		
M5 Mg has a much greater liquid range because forces of attraction in liquid / molten metal are strong(er) OR converse argument for Br_2	1	Must refer to liquid range to score M5

Energetics

GCSE questions

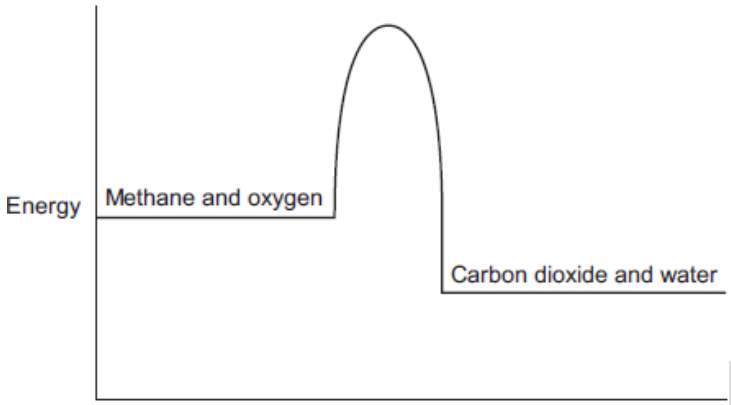
Q6. Methane (CH_4) is used as a fuel.

(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.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2\,H_2O$$

(ii) Explain why, in terms of the energy involved in bond breaking and bond making, the combustion of methane is exothermic. **(3)**

More energy has been released from bonds forming (in the products)…

…..than is being taken in for bonds breaking (in reactants).

Therefore, overall the reaction loses heat energy to the surroundings.

(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)**

Bonds breaking = (4 x C-H) + (1 x Cl-Cl)

= (4 x 413) + (1 x 243) = 1895

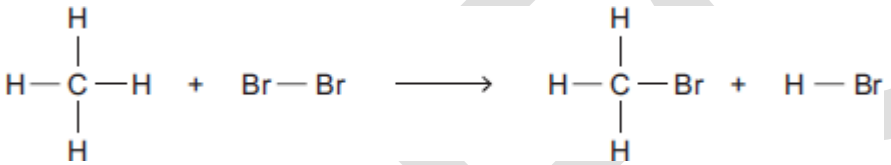
Bonds forming = (3 x C-H) + (1 x C-Cl) + (1 x H-Cl)

= (3 x 413) + (1 x 327) + (1 x 432) = 1998

Energy change or enthalpy change = ∑bonds breaking – ∑bonds forming

= 1895 - 1998 = -103 kJ/mol

(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. x

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

Chlorine is more reactive than bromine. ☐

So this means that less energy was given out than was taken in. So either the bonds formed in the products here are weaker or the bonds in reactants are stronger.

(1)

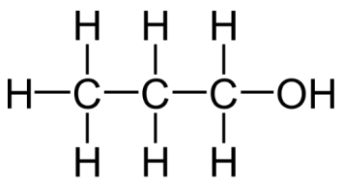
	C—H	C—C	C—O	O—H
Mean bond dissociation enthalpy / kJ mol^{-1}	412	348	360	463

A −4751 ⬭

B −4403 ⬭

C +4403 x

D +4751 ⬭



A-Level question to give a go!

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

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

It's useful to draw the molecule out! See above.

Bonds breaking = (7 x C-H) + (2 x C-C) + (1 x C-O) + (1 x O-H)
= (7 x 412) + (2 x 348) + 360 + 463 = +4403
(and because energy is needed it is a positive value)

(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=O
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 x

C 1476 ○

D 1936 ○

(Total 1 mark)

Enthalpy/energy change = bonds breaking – bonds forming
+206 = ((413 x 4) + (2 x 463)) – ((3 x 436) + C≡O)
+ 206 = 2578 – (1308 + C≡O)
+ 206 = 2578 – 1308 - C≡O
C≡O = 2578 – 1308 -206
= 1064

Kinetics

GCSE questions

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

The equation for the reaction is:

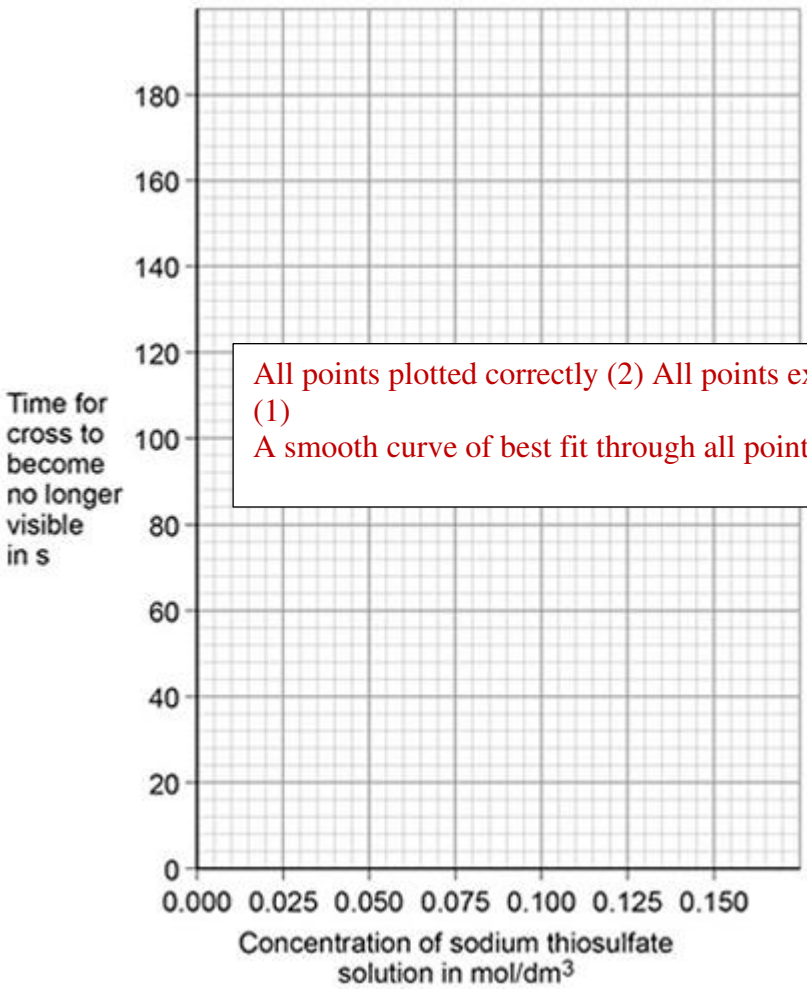
$$Na_2S_2O_3(aq) + 2\,HCl(aq) \longrightarrow 2\,NaCl(aq) + SO_2(g) + H_2O(l) + S(s)$$

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.



All points plotted correctly (2) All points except for one (1)
A smooth curve of best fit through all points (1)

(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 The higher the concentration, the higher the rate of reaction (or the quicker the reaction).

Explanation The higher the concentration, the more particles there are in a given volume, which means that they are more likely to collide with each other/higher chances of collisions happening. This leads to more frequent collisions between particles /an increase in the number of collisions between particles and the reaction happens quicker.

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 = quantity of reactant (or product)

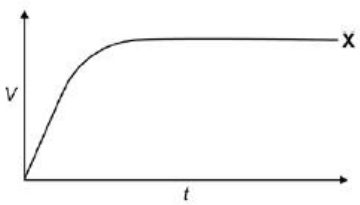
time

= 0.18 / (60 x 2) *time needs to be converted to seconds*

Mean rate of reaction = 1.5×10^{-3} g / s **(3)**

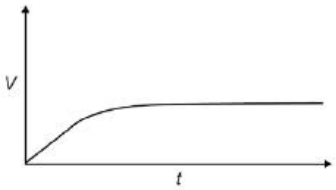
A-Level question to give a go!

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.



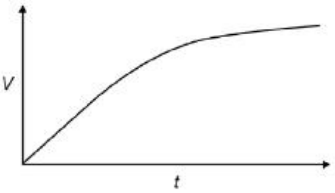
Which line represents the volume of hydrogen formed, at the same temperature and pressure, when the concentration of sulfuric acid has been halved?

A



[x]

B



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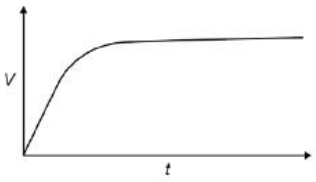
C



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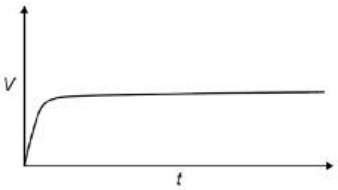


[ ]

(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*.

It is the minimum amount of energy needed to start a reaction. **(2)**

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

The reaction does not have the activation energy needed at room temperature. **(1)**

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

At a higher pressure, the hydrogen and chlorine gas molecules are closer together in a given volume. Therefore, they are more likely to collide with each other leading to more frequent collisions. **(2)**

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

A small increase in temperature, for instance a spark, can be enough to meet the activation energy and get the reaction going, which increases its rate of reaction. **(2)**

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

A catalyst is a chemical that speeds up the rate of reaction, without itself being used up. **(1)**

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

This is because in powder form, it has a large surface area which leads to more reactions happening on its surface, leading to a faster reaction. **(1)**

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: $C_2H_4\ (g) + H_2O\ (g) \rightleftharpoons C_2H_5OH\ (g)$ + heat

2 molecules 1 molecule

(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.

Increasing the temperature means that the endothermic reaction will be favoured, i.e. the backward reaction. This is because equilibrium will oppose the high temperature and will lower it by removing the added heat, which will be taken in by the endothermic reaction. This will lower the yield or amount of ethanol. **(2)**

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

Equilibrium will oppose the high pressure and will therefore shift to the RHS in favour of fewer molecules, as there is 1 molecule on the RHS and 2 on the LHS. The side with fewer molecules will exert less pressure, therefore, pressure will be lowered, and the ethanol amount will increase. **(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. x

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

(Total 1 mark)

A high temperature would favour the backward reaction. Clue was enthalpy change value given which is -46, and if it is negative, this means the reaction is exothermic.

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 x

(Total 1 mark)

Any condition that will shift equilibrium to the products side or RHS will increase the equilibrium constant. You will learn about this next year!

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.

$Cl_2 + 2K \rightarrow 2KCl$ ☐

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

$I^- + Cl \rightarrow I + Cl^-$ ☐

$I^- + K^+ \rightarrow KI$ ☐

(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?

Na has lost an electron. Loss of electrons is oxidation so sodium has been oxidised. **(1)**

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

$Na \longrightarrow Na+ + e-$ **(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 $Mg + S \longrightarrow MgS$ x

(Total 1 mark)

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	x
magnesium	

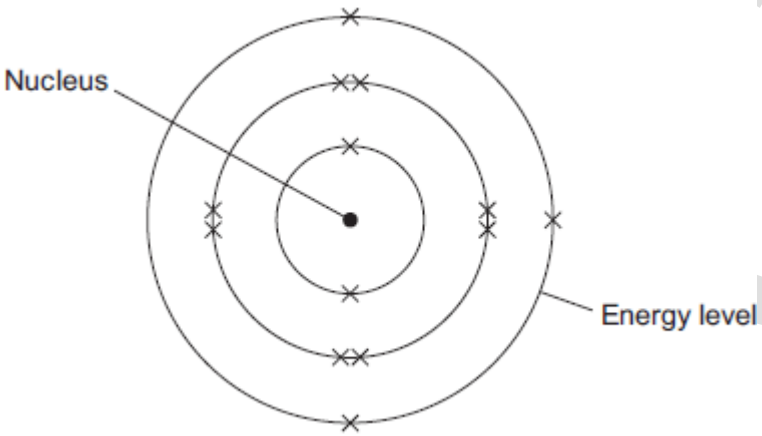
(1)

(b) Complete the sentence.

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

(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**

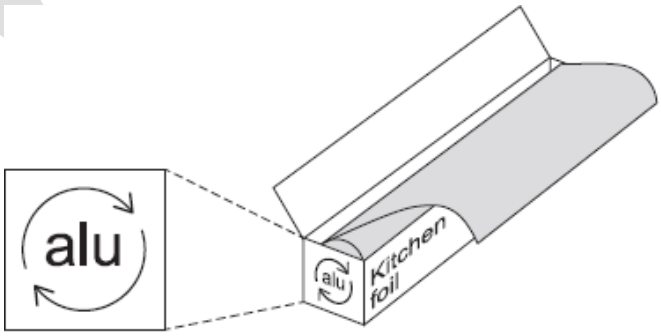
The nucleus of an aluminium atom contains protons and neutrons . **(2)**

(ii) Complete the sentence.

In the periodic table, aluminium is in Group 3 (3 outer electrons).

(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? Al . **(1)**

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

Any two of the following:

Because, the cost of extracting aluminium from its ore is very high compared to recycling it (recycling saves around 90% of the cost of extracting it).

Also, the ore is a finite resource which means that recycling aluminium will conserve ores in the Earth's crust.

Mining ores damages the environment, leaving eye sores and destroying animal habitats. **(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.

It is resistant to corrosion which means that it is safe to use for covering food and will last thus protecting the food.

OR It has a low density which means that it is practical to use in the kitchen when handling it. **(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	x
C	radius increases because shielding (screening) increases	⬭
D	radius decreases because shielding (screening) decreases	⬭

Yes! The atoms do get smaller as we go across a Period. This is due to the increase in the number of protons, as one is added each time, and because shielding stays the same as each Period shares the same energy level/shell. This means that the electrons are pulled in more strongly each time, reducing the atomic radius. We will cover this next year!

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

Use information from the table to answer these questions.

(i) Name a soluble compound that contains silver ions. Silver nitrate **(1)**

(ii) Name a soluble compound that contains carbonate ions. Potassium carbonate or sodium carbonate. **(1)**

(b) Metal oxides react with acids to make salts. What type of compound is a metal oxide? Base. **(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. Lead nitrate is a soluble solid, as all nitrates are soluble. Therefore, by heating and evaporating the water in the solution, we should be able to separate the lead nitrate out as a solid. **(1)**

(ii) Balance the equation for the reaction.

$$PbO + 2\ HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$$

(1)

(iii) Give the total number of atoms in the formula $Pb(NO_3)_2$. 1 + 2 + 6 = 9 **(1)**

A-Level question to give a go!

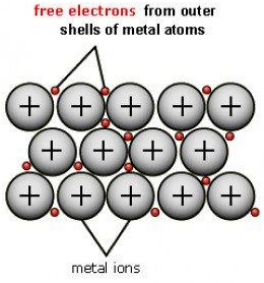
Q16. (a) Nickel is a metal with a high melting point.

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

Nickel cations are held together in a giant metallic structure, surrounded by delocalised electrons. There is a strong electrostatic attraction between the cations and the delocalised electrons, and this attraction is known as metallic bonding, which requires a high amount of energy to overcome. **(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).

Because, the layers of ions (or atoms) in a giant metallic structure are able to slide over each other, which means that the metal can be pulled into wires. **(1)**

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. 7 **(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	x

(1)

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

F	
F_2	x
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.

Halogens become less reactive as we go down group 7. This is shown by the reactions above, whereby chlorine is the most reactive being the highest in the group (of the three). It has reacted with both bromide and iodide ions and displaced them – this is evident from the reactions that have occurred as the solution has changed colour. (1)

Bromine is in the middle, as it is unable to displace chloride ions (no change) because it is less reactive than chlorine, whereas it has managed to displace iodide ions (solution turns brown), showing that it is more reactive than iodine. (1)

Iodine is the least reactive because it is unable to displace either chloride or bromide ions, as both times there has been no change. (1)

(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 x

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 x

D a yellow precipitate insoluble in concentrated aqueous ammonia

(Total 1 mark)

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.

	Na	B	O
%by mass = mass	22.8	21.8	55.4
Ar	23	11	16
Moles (mass/Ar)	0.99	1.98	3.46
÷by smallest	0.99/0.99 = 1	1.98/0.99 = 2	3.46/0.99 = 3.5
Ratio (x2 to get whole numbers)	2	4	7

Answer: $Na_2B_4O_7$

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 X

C Methanol ⬭

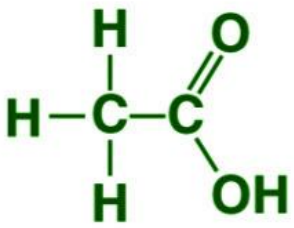
D Methanoic acid ⬭

(Total 1 mark)

Working out:

	C	H	O
%by mass = mass	40.0	6.7	53.3
Ar	12	1	16
Moles (mass/Ar)	3.3	6.7	3.3
÷by smallest	3.3/3.3 = 1	6.7/3.3 = 2	3.3/3.3 = 1
Ratio (x2 to get whole numbers)	1	2	1

$C_1H_2O_1$ is the empirical formula which is the simplest ratio and does not meet any of the molecular formulae of the molecules above. If we double it, we get $C_2H_4O_2$ which is the molecular formula of ethanoic acid.



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
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} ☒ x
C_5H_{10} ☐
C_6H_{12} ☐

(1)

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

Ratio = 2 : **5**
(1)

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

A ☒ x **B** ☐ **C** ☐ **D** ☐

(1)

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

A [x] **B** [ ] **C** [ ] **D** [ ]

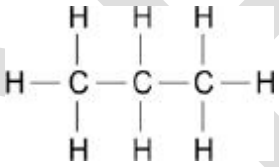
(1)

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

Carbon	[ ]
Carbon dioxide	[x]
Hydrogen	[ ]
Sulfur dioxide	[ ]
Water	[x]

(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	[x]

(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?

C_5H_{12} **(1)**

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

Alcohols	☐
Alkanes	x
Alkenes	☐
Carboxylic acids	☐

(1)

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

$$C_3H_8 + 5O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

(2)

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

Because it is a molecule that is made up of carbon and hydrogen atoms **only**. **(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.

Any 3 points:

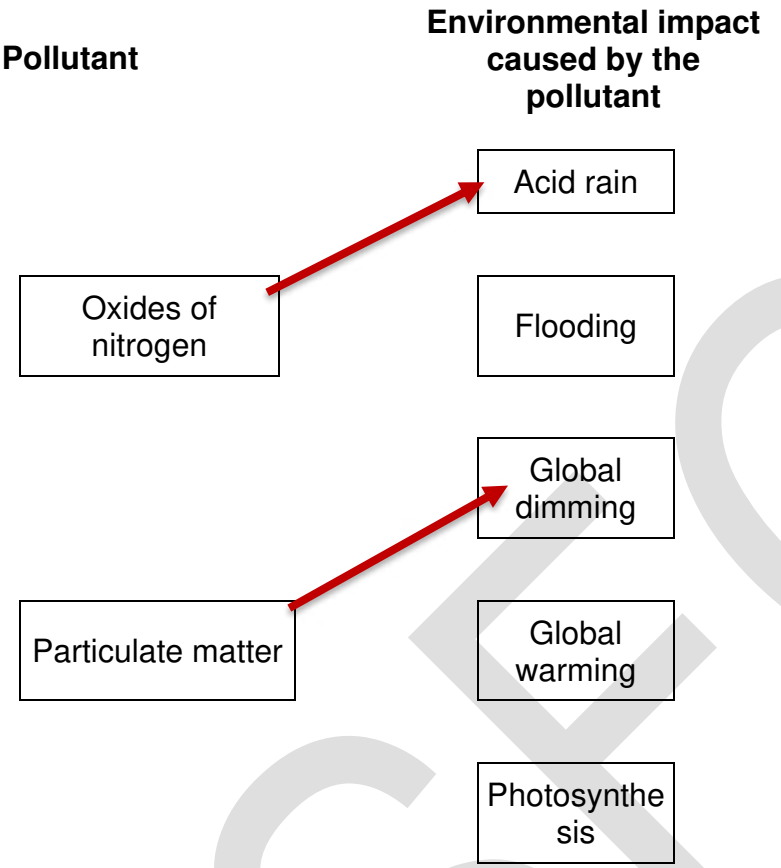
Diesel cars cause more pollution than petrol cars **(1)**

Diesel cars produce more nitrogen oxides than petrol cars which causes acid rain (1)

Diesel cars produce particulates whereas petrol cars do not; particulates cause breathing problems and global dimming, etc (1)

Diesel cars cause less global warming as they produce less carbon dioxide than petrol cars (1).

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



(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 $C_5H_{12} + 6O_2 \longrightarrow 4CO + CO_2 + 6H_2O$ x

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

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

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

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

(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.

Saturated compounds only have single covalent bonds between carbon atoms **(1)**

A hydrocarbon molecule is made up of carbon and hydrogen atoms **only**. (1)

Alkanes (1)

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

Any 4 points from the following:

Crude oil is heated and enters the fractionating column as a gas/vapour **(1)**

The fractionating column is hot at the bottom and gets cooler as you go up the column (1)

The vapour cools down in the column and as each fraction reaches a temperature below its boiling point, it condenses…(1)

Each fraction is made up of different sized hydrocarbons which have different boiling points. (1).

Each fraction is separated based on its boiling point. The shorter hydrocarbon molecules with lower boiling points are distilled at the top whilst the longer hydrocarbon with higher boiling points are distilled nearer the bottom of the column. (1)

Halogenalkanes

GCSE questions

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

Test with bromine water. Add bromine water and shake (1)

Result bromine water is decolourised: changes from an orange solution to a colourless solution **(1)**

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}	x

(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	x
B	☐
C	☐
D	☐

As hydrocarbon molecules get bigger, their boiling point increases, they become less flammable and they become more viscous, i.e. thicker liquids (less runny).

(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 ☒

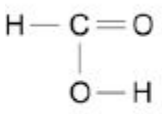
C ☐

D ☐

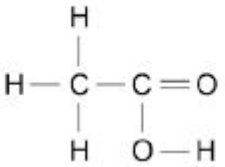
(1)

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

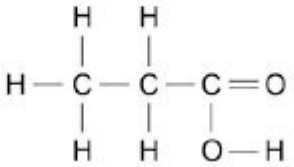
A



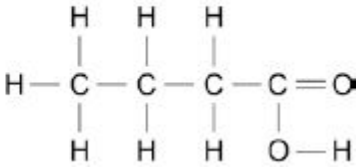
B



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 ☐

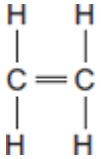
Propene ☐

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 a colourless solution (1)

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

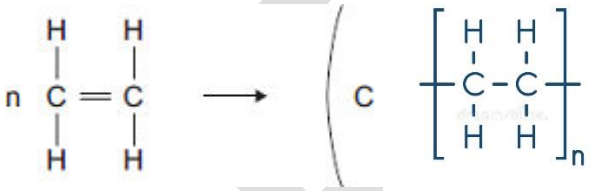
(i) Decane ($C_{10}H_{22}$) can be cracked to produce ethene (C_2H_4) and **one** other product.

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

$$C_{10}H_{22} \longrightarrow C_2H_4 + C_8H_{18}$$

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

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



polyethene **(2)**

(ii) Some carrier bags are made from poly(ethene). Some carrier bags are made from cornstarch.

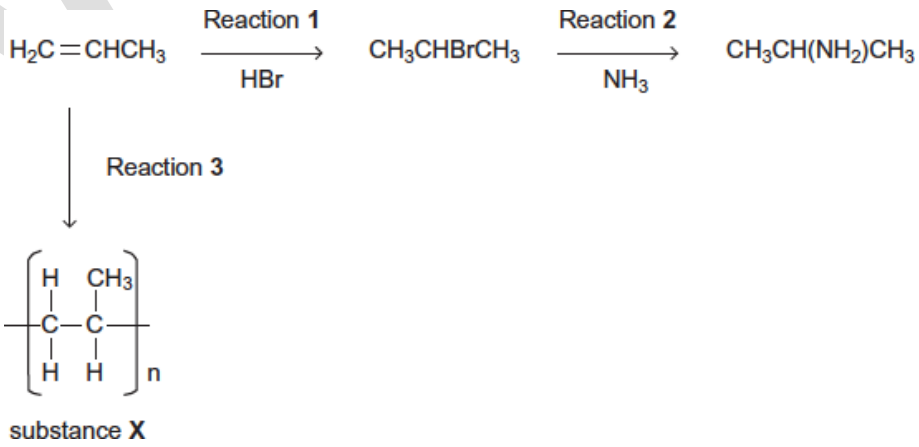
Suggest **two** benefits of using cornstarch instead of poly(ethene) to make carrier bags.

Constarch is a natural compound, which means that it will biodegrade over time (whereas polyethene is non-biodegradable) (1)

This means that constarch carrier bags will not end up in landfill sites (as they will break down) (1).

A-Level question to give a go!

Q23. Consider the following reactions.



substance **X**

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

Addition polymerisation (1)

Polypropene (1)

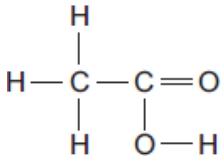
(the monomer is propene so to name a polymer you simply add poly in front of the monomer name)

Alcohols

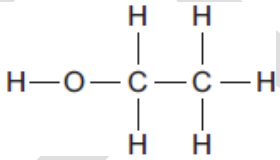
GCSE questions

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

Compound A



Compound B



(a) (i) Compound **B** is an alcohol. Name compound **B**. Ethanol **(1)**

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

burned	**decomposed**	**oxidised**

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

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

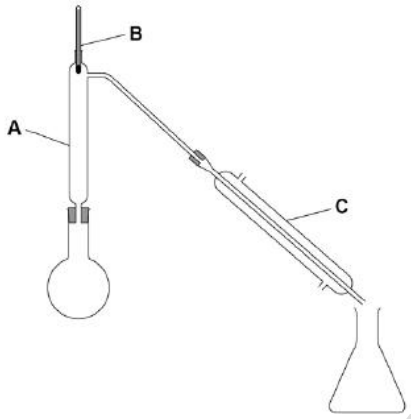
A test tube contains a colourless liquid, which could be either compound **A** or compound **B**. Describe a simple **chemical** test to show which compound, **A** or **B**, is in the test tube.

Add a metal carbonate such as sodium carbonate or calcium carbonate.**(1)**

Fizzing/bubbles/effervescence is observed with compound A whereas no visible change occurs with compound B (1)

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**.

This question is marked using levels of response.

Level 3
All stages are covered and the explanation of each stage is generally correct and virtually complete.

Answer communicates the whole process coherently and shows a logical progression through the distillation apparatus. The first two points in stage 1 are in the correct order and all other steps are in a logical order for carrying out the practical.

5-6 marks

Level 2
All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies.

Answer is mainly coherent and shows a progression through the distillation apparatus.

Some steps in each stage may be out of order and incomplete but the first two points in stage 1 are in the correct order.

3-4 marks

Level 1
Most points are covered but the explanation of each stage may be incomplete or may contain inaccuracies.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning. The first two points in stage 1 are present but not necessarily in the correct order.

1-2 marks

Level 0
Insufficient correct chemistry to warrant a mark.

Omission of heating of the apparatus.

0 marks

Indicative content:

Stage 1

- *Turn on the water.*
- *Heat the flask, with a Bunsen burner.*
- *This causes water and ethanol vapours to be produced.*

Stage 2

- *Vapours pass up the fractionating column A.*
- *Water and ethanol are separated in column A.*
- *Water condenses back into the flask in column A.*

Stage 3

- *Observe the thermometer at B to keep the temperature at or below the boiling point of ethanol.*

Organic Analysis

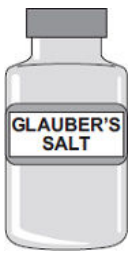
GCSE questions

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.

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

Test and result for carbonate ions:

Reagent: dilute hydrochloric acid **Result:** fizzing/bubbles/effervescence

Test and result for chloride ions:

Reagent: nitric acid followed by silver nitrate solution **Result:** white precipitate

Test and result for nitrate ions:

Reagent: aluminium & sodium hydroxide solution then heat gently. Test the fumes that are released with damp red litmus paper

Result: red litmus paper turns blue as ammonia gas is released which is an alkaline gas

Test and result for sulfate ions:

Reagent: hydrochloric acid followed by barium chloride **Result:** white precipitate

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

Because each solution contains sodium ions, Na+ ions and they will all give the same result: an orange/yellow flame. (1)

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

Any two from the following:

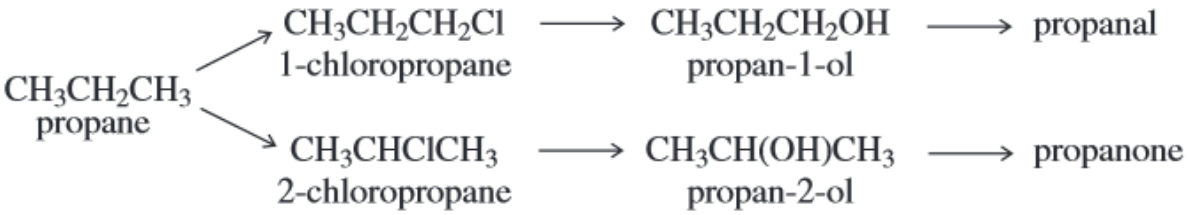
They are quicker (1)

They are more sensitive (1) therefore only small amounts of the sample are required (1)

The results are generated by the computer rather than manually (1)

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

If the sample is contaminated then there would be two peaks in the spectrum: one peak would indicate the presence of propane with Mr = 44.06352g and the other peak would show the presence of carbon dioxide if it equals its Mr = 43.98982g.

GCSE to A-Level Chemistry – Skills Transition

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) $2\ H_2 + O_2 \rightarrow 2\ H_2O$ **(1)**

(ii) $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$ **(1)**

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

An unbalanced equation implies that atoms may have been lost or gained, and mass is conserved in a chemical reaction, i.e. the number of reactant atoms should equal the number of product atoms. (1)

A balanced equation also tells us how many moles of each reactant react with each other completely and how many moles of product are formed. (1)

(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.

$GeO_2 + 4\ HCl \rightarrow GeCl_4 + 2\ H_2O$

(1)

(b) Write a word equation for the reaction in step 4.

germanium tetrachloride + hydrogen → germanium + water **(1)**

Q3. (a) Cola drinks contain phosphoric acid, H_3PO_4. The two equations show how phosphoric acid can be made from phosphorus.

Balance these two equations.

(i) $P_4 + 5\ O_2 \rightarrow P_4O_{10}$

(1)

(ii) $P_4O_{10} + 6\ H_2O \rightarrow 4H_3PO_4$

(1)

Some more practice

4) $Mg + 0.5\ O_2 \rightarrow MgO$ or a multiple so 2 : 1 : 2

5) $H_2 + 0.5\ O_2 \rightarrow H_2O$

6) $Fe + 2\ HCl \rightarrow FeCl_2 + H_2$

7) $CuO + 2\ HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$

8) $Ca(OH)_2 + 2\ HCl \rightarrow CaCl_2 + H_2O$

9) $2\ KHCO_3 + H_2SO_4 \rightarrow K_2SO_4 + 2\ CO_2 + 2\ H_2O$

10) $2\ Al + 3\ Cl_2 \rightarrow 2\ AlCl_3$

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.

$4\ CuFeS_2 + 9.5\ O_2 + 4\ SiO_2 \rightarrow Cu_2S + Cu_2O + 7\ SO_2 + 4\ FeSiO_3$

Or a multiple: $8\ CuFeS_2 + 19\ O_2 + 8\ SiO_2 \rightarrow Cu_2S + Cu_2O + 14\ SO_2 + 8\ FeSiO_3$

$Cu_2S + 2\ Cu_2O \rightarrow 6\ Cu + SO_2$

(2)

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
No. of atoms = 2 + 1 = 3
Formulae of ions = Na^+ O^{2-}
Name = sodium oxide
RFM = (2 x 23) + (1 x 16) = 62g

3. K_3PO_4
No. of atoms = 3 + 1 + 4 = 8
Formulae of ions = K^+ PO_4^{3-}
Name = potassium phosphate
RFM = (3 x 39.1) + (1 x 31) + (4 x 16) = 212.3g

4. $CaBr_2$
No. of atoms = 1 + 2 = 3
Formulae of ions = Ca^{2+} Br^-
Name = calcium bromide
RFM = (1 x 40.1) + (2 x 79.9) = 199.9g

5. Al_2O_3
No. of atoms = 2 + 3 = 5
Formulae of ions = Al^{3+} O^{2-}
Name = aluminium oxide
RFM = (2 x 27) + (3 x 16) = 102g

6. NH_4OH
No. of atoms = 1 + 4 + 1 + 1 = 7
Formulae of ions = NH_4^+ OH^-
Name = ammonium hydroxide
RFM = (1 x 14) + (5 x 1) + (1 x 16) = 35g

7. $(NH_4)_2SO_4$
No. of atoms = (5 x 2) + 1 + 4 = 15 or 2 + 8 + 1 + 4 = 15
Formulae of ions = NH_4^+ SO_4^{2-}
Name = ammonium sulfate
RFM = (2 x 14) + (8 x 1) + 32.1 + (16 x 4) = 132.1g

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. grams

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

3. The radius of a gold atom. nanometres / picometres

4. The volume of water in a burette. centimetres cubed, cm^3

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

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

Rewrite the following quantities.

7. 0.00122 metres in millimetres 1000mm = 1 m therefore 0.00122m x 1000 = 1.22 mm

8. 104 micrograms in grams 1000 000 mg = 1 g therefore 104g /1000 000 = 0.000 104 g

9. 1.1202 kilometres in metres 1000 m = 1 km therefore 1.1202km x 1000 = 1120.2 m

10. 70 decilitres in millilitres 100ml = 1 dl therefore 70 dl x 100 = 7000 ml

11. 70 decilitres in litres 7l or $7dm^3$ 10dl = 1 l therefore 70dl / 10 = 7l

12. 10 cm^3 in litres 0.01 dm^3 1000cm^3 = 1 dm^3 therefore 10cm^3 / 1000 = 0.01 dm^3