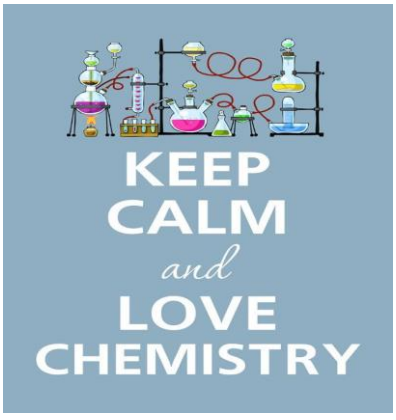
Roding Valley High School

A Level Chemistry Transition booklet

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.

What is included:

- Book recommendations
- Movie recommendations
- Guidance on how to make notes
- **Research activities – you must complete all of the research tasks.**
- **Pre-knowledge topics – you must complete all (answers are at the end).**
- Ideas for day trips
- Science on social media
- Science websites
- Science things to do



The compulsory activities highlighted in red must be submitted on google classroom. Please use the code thd6mfz to join the classroom and complete any additional work set here.

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 prepped with all of your GCSE knowledge

CGP – 'Head start to Chemistry' and 'Essential Maths Skills' books

MaChemGuy – Prepare for A-Level Chemistry

ASFC Chemistry – Starting A-Level Chemistry

You MUST bring this to your first Chemistry Lesson in Year 12 and give it to your teacher

GCSE to A-Level Chemistry – Transition Work

Atomic Structure

GCSE questions

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

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

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

The centre of the atom is the _____ .

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

James Chadwick proved the existence of the _____ .

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

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

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

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

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

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

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

_____

_____

A_r = _____ **(2)**

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

Element **X** is

_____(

1)

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

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

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

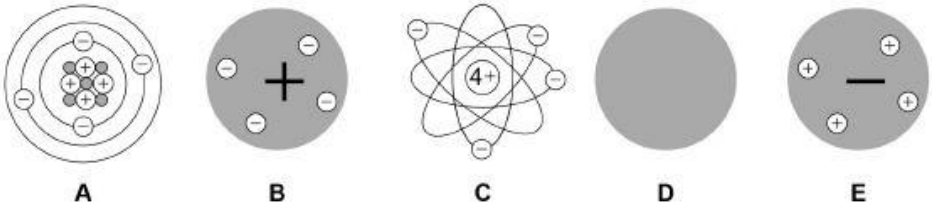
_____

_____

_____

____Radius = _____ m **(2)**

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



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

A		B		C		D		E	

(1)

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

A		B		C		D		E	

(1)

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

A		B		C		D		E	

(1)

(d) Define the mass number of an atom.

_____

_____

_____**(1)**

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

The percentage abundance of each isotope is:

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

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

< 69.5 ☐

Between 69.5 and 70.0 ☐

Between 69.5 and 70.0 ☐

Between 70.0 and 70.5 ☐

> 70.5 ☐

(1)

A-Level question to give a go!

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

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

(Total 1 mark)

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

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

_____

_____

_____**(1)**

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

Give a reason for your answer.

Chemical properties

_____

Reason

_____

_____

_____ **(2)**

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} ⬭

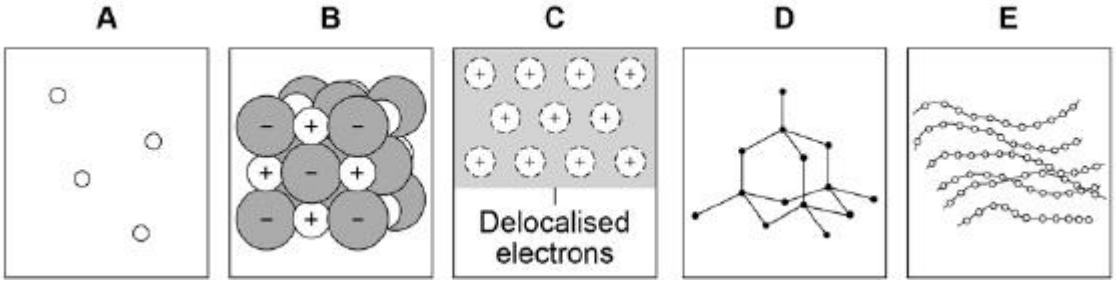
D 7.2×10^{25} ⬭

(Total 1 mark)

Bonding

GCSE questions

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



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

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

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

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

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

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

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

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

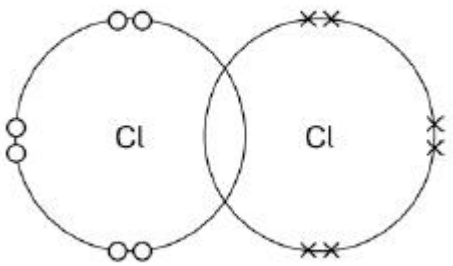
(e) A chlorine atom has 7 electrons in the outer shell.

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

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

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

Figure 2



(1)

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

Strong covalent bonds ☐

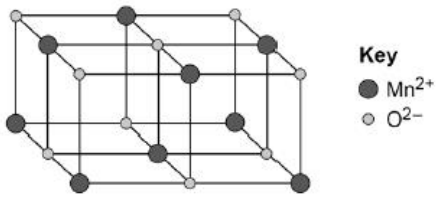
Strong forces between molecules ☐

Weak covalent bonds ☐

Weak forces between molecules ☐

(1)

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



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

_____

_____Empirical formula =

_____ **(1)**

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

Atoms move around in the liquid ☐

Electrons move around in the liquid ☐

Ions move around in the liquid ☐

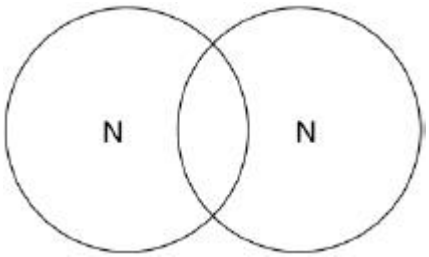
Molecules move around in the liquid ☐

(1)

Q5. This question is about structure and bonding.

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

Show only the electrons in the outer shell.



(2)

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

_____

_____

_____

_____

_____**(3)**

(c) Graphite and fullerenes are forms of carbon. Graphite is soft and is a good conductor of electricity.

Explain why graphite has these properties. Answer in terms of structure and bonding.

_____

_____

_____

_____

_____

_____**(4)**

A-Level question to give a go!

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

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

(Total 1 mark)

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

A $CaNO_3$ ⬭

B $Ca(NO_3)_2$ ⬭

C Ca_2NO_2 ⬭

D $Ca(NO_2)_2$ ⬭

(Total 1 mark)

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

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

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

_____(Total 5 marks)

Energetics

GCSE questions

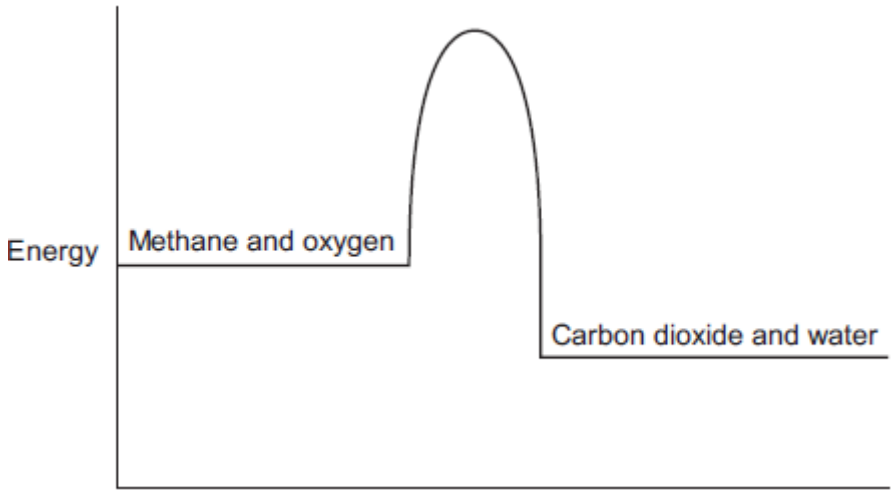
Q6. Methane (CH_4) is used as a fuel.

(a) Methane burns in oxygen.

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

Draw and label arrows on the diagram to show:

- the activation energy
- the enthalpy change, *ΔH*.



(2)

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

$$CH_4 + \_\_\_\_\_ \longrightarrow CO_2 + \_\_\_\_\_$$

(2)

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

_____

_____

_____

_____

_____ **(3)**

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

Some bond dissociation energies are given in the table.

Bond	**Bond dissociation energy**

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

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

_____

_____

_____

_____

_____ **(3)**

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

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

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

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

CH_3Br has a lower boiling point than CH_3Cl ☐

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

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

Chlorine is more reactive than bromine. ☐

(1)

A-Level question to give a go!

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

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

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

A −4751 ⬭

B −4403 ⬭

C +4403 ⬭

D +4751 ⬭

(Total 1 mark)

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

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

Some enthalpy data is given in the table.

Bond	C–H	O–H	H–H	C≡H
Bond enthalpy / kJ mol^{-1}	413	463	436	To be calculated

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

A 234 ⬭

B 1064 ⬭

C 1476 ⬭

D 1936 ⬭

(Total 1 mark)

Kinetics

GCSE questions

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

The equation for the reaction is:

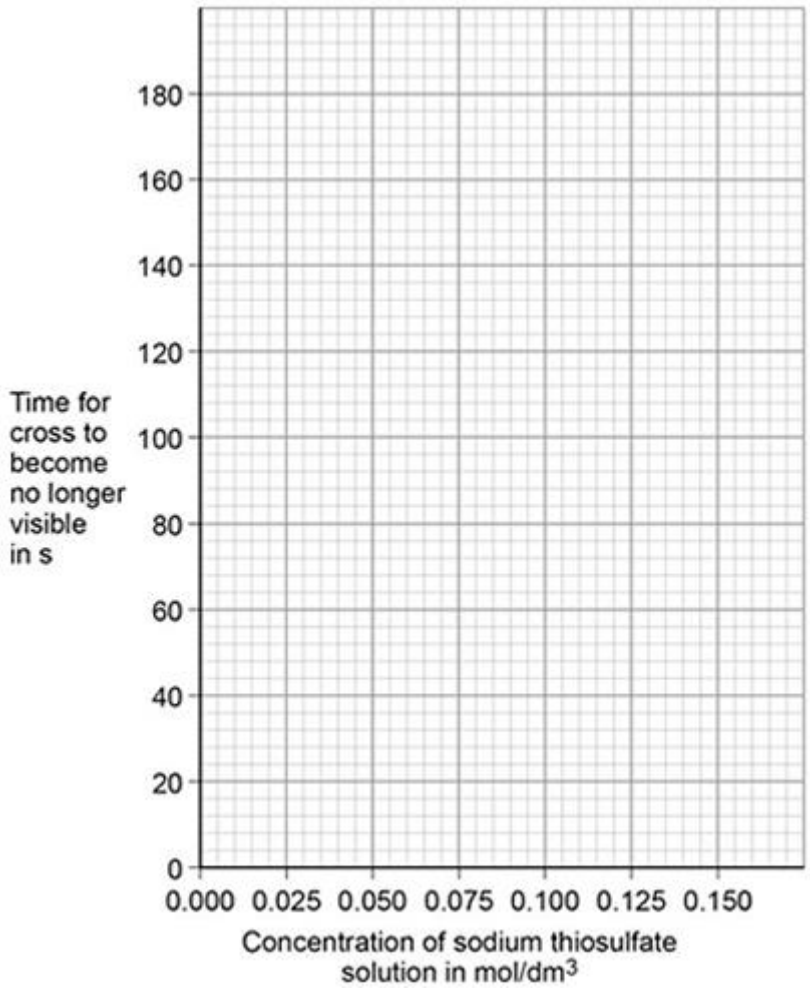
$$Na_2S_2O_3(aq) + 2\,HCl(aq) \longrightarrow 2\,NaCl(aq) + SO_2(g) + H_2O(l) + S(s)$$

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

Concentration of sodium	**Time for cross to become no**

thiosulfate solution in mol / dm^3	longer visible in s
0.020	170
0.040	90
0.060	82
0.080	42
0.100	34
0.120	30
0.140	28

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



(3)

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

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

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

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

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

Conclusion

_____

_

_____

_____

Explanation

_____

__

_____

_____

_____

_____**(3)**

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

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

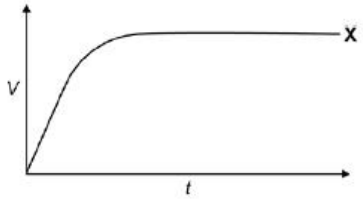
_____

_____

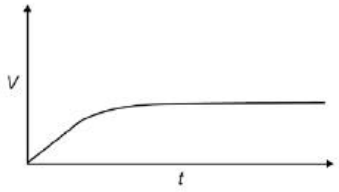
_____Mean rate of reaction = _____ g / s **(3)**

A-Level question to give a go!

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



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

A 

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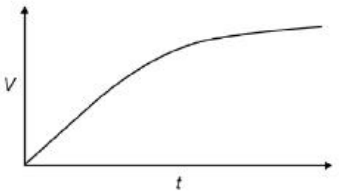
B 

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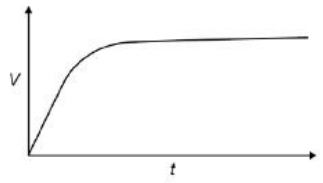
C 

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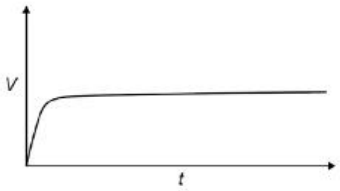
D 

○

(Total 1 mark)

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

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

(a) Define the term *activation energy*.

_____

_____

_____ **(2)**

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

_____

_____

_____ **(1)**

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

_____

_____

_____**(2)**

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

_____

_____

_____**(2)**

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

_____

_____

_____**(1)**

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

_____

_____**(1)**

Chemical Equilibria, Le Chatelier's Principle and K_c

GCSE questions

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

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

(a) The forward reaction is exothermic.

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

_____

_____

_____**(2)**

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

_____

_____

_____ **(2)**

A-Level question to give a go!

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

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

A The reaction is catalysed by an acid. ⬭

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

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

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

(Total 1 mark)

Q13. The forward reaction in this equilibrium is endothermic

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

Which statement is correct?

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

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

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

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

(Total 1 mark)

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.

$Na \longrightarrow$ _____ + _____

(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)

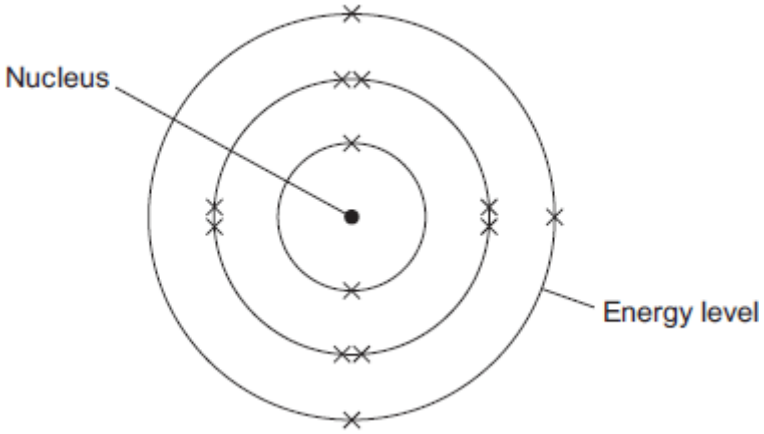
(b) Complete the sentence.

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 _____ .

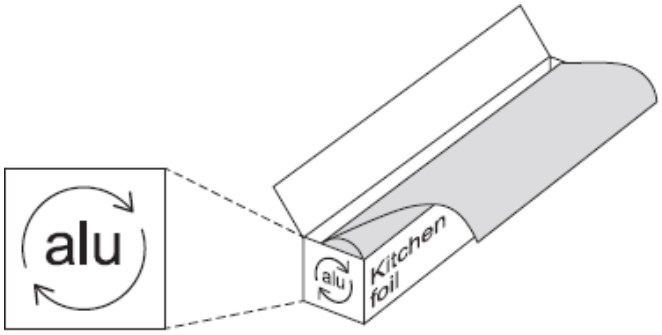
(2)

(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 lead

Use information from the table to answer these questions.

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

_____

_____**(1)**

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

_____

_____**(1)**

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

_____

_____**(1)**

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

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

_____

_____

_____**(1)**

(ii) Balance the equation for the reaction.

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

(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)**

Group 7 – The Halogens

GCSE questions

Q13. The halogens are elements in Group 7.

(a) Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom.

_____**(1)**

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

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

Giant covalent ☐

Ionic lattice ☐

Metallic structure ☐

Small molecule ☐

(1)

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

F ☐

F_2 ☐

F^2 ☐

2F ☐

(1)

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

The table below shows the student's observations.

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

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

_____

_____

_____

_____

_____ **(3)**

A-Level question to give a go!

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

A AgBr

B AgI

C NaBr

D NaI

(Total 1 mark)

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

A a white precipitate soluble in concentrated aqueous ammonia

B a white precipitate insoluble in concentrated aqueous ammonia

C a cream precipitate soluble in concentrated aqueous ammonia

D a yellow precipitate insoluble in concentrated aqueous ammonia

(Total 1 mark)

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 °C
A	C_4H_{10}	0
B		36
C	C_6H_{14}	69
D	C_7H_{16}	98

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

C_4H_{12} ☐

C_5H_{12} ☐

C_5H_{12} ☐

C_6H_{12} ☐

(1)

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

Ratio = 2 : _____

(1)

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

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

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

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

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

Carbon ☐

Carbon dioxide ☐

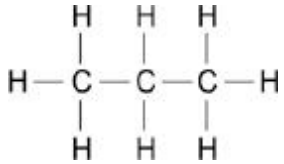
Hydrogen ☐

Sulfur dioxide ☐

Water ☐

(2)

The diagram shows the displayed structure of a hydrocarbon molecule.



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

Butane ☐

Ethane ☐

Methane ☐

Propane ☐

(1)

Q16. This question is about hydrocarbons.

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

Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}

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

_____

_____**(1)**

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

Alcohols ☐

Alkanes ☐

Alkenes ☐

Carboxylic acids ☐

(1)

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

$C_3H_8 + 5O_2 \rightarrow 3$ _____ + 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 ☐

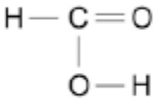
C ☐

D ☐

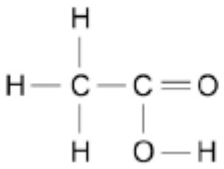
(1)

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

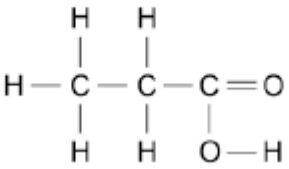
A



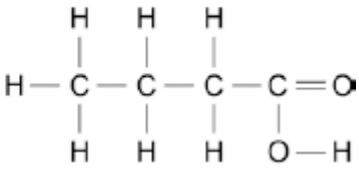
B



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 ☐

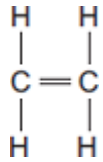
Propene ☐

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.

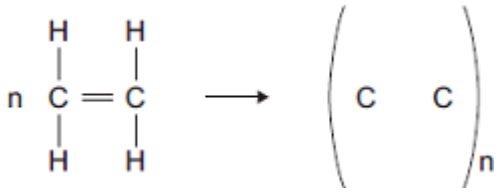
Complete the equation to show the formula of the other product.

$C_{10}H_{22} \longrightarrow C_2H_4 +$ _____

(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.

_____

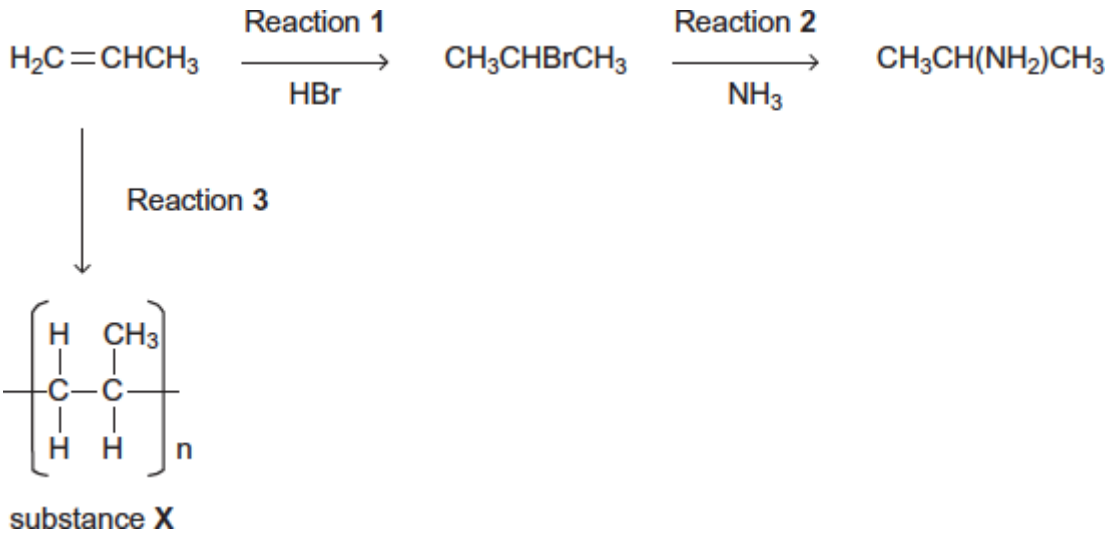
_____

_____

_____**(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**.

_____

_____

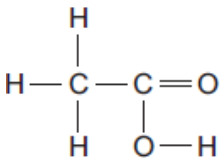
_____(2)

Alcohols

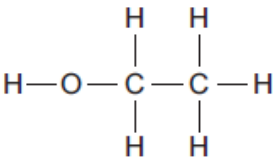
GCSE questions

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.

_____

_____

_____

_____

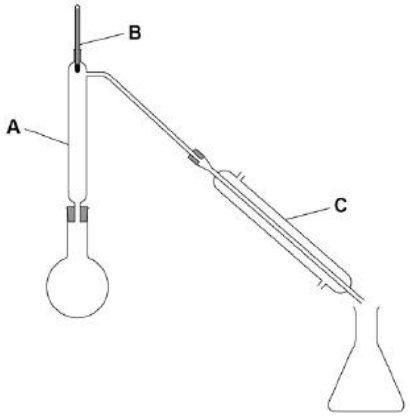
_____(2)

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 sulfate

sodium chloride

sodium nitrate

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.

_____

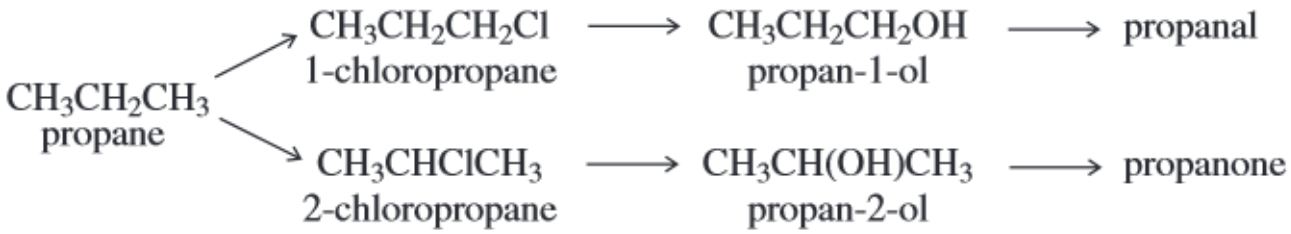
_____

_____

_____**(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 3.

_____

_____**(1)**

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

Balance these two equations.

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

(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 → $FeCl_2$ + H_2

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

8) $Ca(OH)_2$ + HCl → $CaCl_2$ + 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 ⟶ .....Cu_2S + ...Cu_2O + ...SO_2 + ...$FeSiO_3$

.....Cu_2S + ...Cu_2O ⟶ .....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

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

Prefix	Symbol	Multiplication factor		
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	μ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000

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

1. The mass of water in a test tube.

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

3. The radius of a gold atom.

4. The volume of water in a burette.

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

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

Rewrite the following quantities.

7. 0.00122 metres in millimetres

8. 104 micrograms in grams

9. 1.1202 kilometres in metres

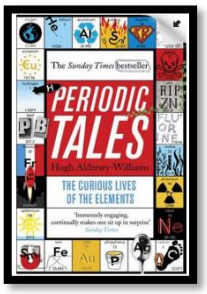
10. 70 decilitres in millilitres

11. 70 decilitres in litres

12. 10 cm^3 in litres

Book Recommendations

Periodic Tales: The Curious Lives of the Elements (Paperback) Hugh Aldersey-Williams

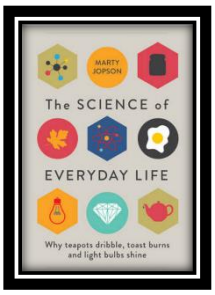


ISBN-10: 0141041455

http://bit.ly/pixlchembook1

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 (Hardback) Marty Jopson

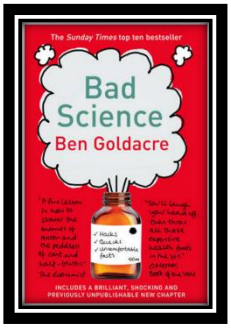


ISBN-10: 1782434186

http://bit.ly/pixlchembook2

The title says it all really, lots of interesting stuff about the things around you home!

Bad Science (Paperback) Ben Goldacre

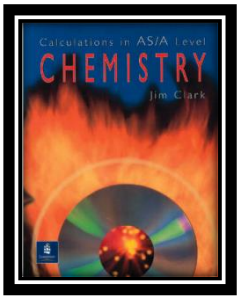


ISBN-10: 000728487X

http://bit.ly/pixlchembook3

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 'sciency'.

Calculations in AS/A Level Chemistry (Paperback) Jim Clark



ISBN-10: 0582411270

http://bit.ly/pixlchembook4

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.

Salters' Advanced Chemistry: Chemical Storylines

Do not feel you need to buy the latest edition (unless you are doing Salters chemistry!) You can pick up an old edition for a few pounds on ebay, gives you a real insight into how chemistry is used to solve everyday problems from global pollution through feeding to world to making new medicines to treat disease.

Videos to watch online

Rough science – the Open University – 34 episodes available

Real scientists are 'stranded' on an island and are given scientific problems to solve using only what they can find on the island.

Great fun if you like to see how science is used in solving problems.

There are six series in total

http://bit.ly/pixlchemvid1a

http://www.dailymotion.com/playlist/x2igjq_Rough-Science_rough-science-full-series/1#video=xxw6pr

or

http://bit.ly/pixlchemvid1b

https://www.youtube.com/watch?v=lUoDWAt259I

A thread of quicksilver – The Open University

A brilliant history of the most mysterious of elements – mercury. This program shows you how a single substance led to empires and war, as well as showing you come of the cooler properties of mercury.

http://bit.ly/pixlchemvid2

https://www.youtube.com/watch?v=t46lvTxHHTA

10 weird and wonderful chemical reactions

10 good demonstration reactions, can you work out the chemistry of …. any… of them?

http://bit.ly/pixlchemvid3

https://www.youtube.com/watch?v=0Bt6RPP2ANI

Chemistry in the Movies

Dantes Peak 1997: Volcano disaster movie.

Use the link to look at the Science of acids and how this links to the movie.
http://www.open.edu/openlearn/science-maths-technology/science/chemistry/dantes-peak

http://www.flickclip.com/flicks/dantespeak1.html

http://www.flickclip.com/flicks/dantespeak5.html

Fantastic 4 2005 &2015: Superhero movie

Michio Kaku explains the "real" science behind fantastic four http://nerdist.com/michio-kaku-explains-the-real-science-behind-fantastic-four/

http://www.flickclip.com/flicks/fantastic4.html

Research activities

Use your online searching abilities to see if you can find out as much about the topic as you can. Remember it you are a prospective A level chemist, you should aim to push **your** knowledge.

You can make a 1-page summary for each one you research using Cornell notes:

http://coe.jmu.edu/learningtoolbox/cornellnotes.html

Task 1: The chemistry of fireworks

What are the component parts of fireworks? What chemical compounds cause fireworks to explode? What chemical compounds are responsible for the colour of fireworks?

Task 2: Why is copper sulfate blue?

Copper compounds like many of the transition metal compounds have got vivid and distinctive colours – but why?

Task 3: Aspirin

What was the history of the discovery of aspirin, how do we manufacture aspirin in a modern chemical process?

Task 4: The hole in the ozone layer

Why did we get a hole in the ozone layer? What chemicals were responsible for it? Why were we producing so many of these chemicals? What is the chemistry behind the ozone destruction?

Task 5: ITO and the future of touch screen devices

ITO – indium tin oxide is the main component of touch screen in phones and tablets. The element indium is a rare element and we are rapidly running out of it. Chemists are desperately trying to find a more readily available replacement for it. What advances have chemists made in finding a replacement for it?

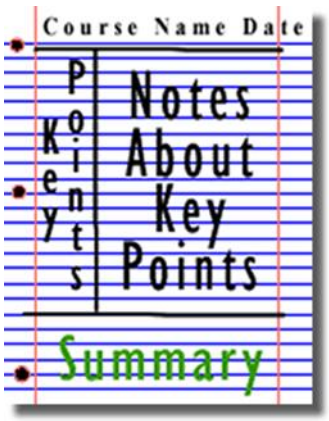


Figure 1: http://coe.jmu.edu/learningtoolbox/images/noteb4.gif

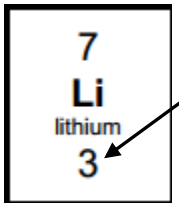
Pre-Knowledge Topics

Chemistry topic 1 – Electronic structure, how electrons are arranged around the nucleus

A periodic table can give you the proton / atomic number of an element, this also tells you how many electrons are in the ***atom***.

You will have used the rule of electrons shell filling, where:

The first shell holds up to 2 electrons, the second up to 8, the third up to 8 and the fourth up to 18 (or you may have been told 8).



Atomic number =3, electrons = 3, arrangement 2 in the first shell and 1 in the second or

Li = 2,1

At **A level** you will learn that the electron structure is more complex than this, and can be used to explain a lot of the chemical properties of elements.

The 'shells' can be broken down into 'orbitals', which are given letters:'s' orbitals, 'p' orbitals and 'd' orbitals.

You can read about orbitals here:

http://bit.ly/pixlchem1

http://www.chemguide.co.uk/atoms/properties/atomorbs.html#top

Now that you are familiar with s, p and d orbitals try these problems, write your answer in the format:

$1s^2$, $2s^2$, $2p^6$ etc.

Q1.1 Write out the electron configuration of:

a) Ca b) Al c) S d) Cl e) Ar f) Fe g) V h) Ni i) Cu j) Zn k) As

Q1.2 Extension question, can you write out the electron arrangement of the following ***ions***:

a) K^+ b) O^{2-} c) Zn^{2+} d) V^{5+} e) Co^{2+}

Chemistry topic 2 – Oxidation and reduction

At GCSE you know that oxidation is adding oxygen to an atom or molecule and that reduction is removing oxygen, or that oxidation is removing hydrogen and reduction is adding hydrogen. You may have also learned that oxidation is removing electrons and reduction is adding electrons.

At A level we use the idea of ***oxidation number*** a lot!

You know that the metals in group 1 react to form ions that are +1, i.e. Na^+ and that group 7, the halogens, form -1 ions, i.e. Br -.

We say that sodium, when it has reacted has an oxidation number of +1 and that bromide has an oxidation number of -1.

All atoms that are involved in a reaction can be given an oxidation number.

An element, Na or O_2 is always given an oxidation state of zero (0), any element that has reacted has an oxidation state of + or -.

As removing electrons is **reduction**, if, in a reaction the element becomes **more** negative it has been reduced, if it becomes more positive it has been oxidised.

-5 0 +5

You can read about the rules for assigning oxidation numbers here:

http://www.dummies.com/how-to/content/rules-for-assigning-oxidation-numbers-to-elements.html

Elements that you expect to have a specific oxidation state actually have different states, so for example you would expect chlorine to be -1, it can have many oxidation states: NaClO, in this compound it has an oxidation state of +1

There are a few simple rules to remember:

Metals have a + oxidation state when they react.

Oxygen is 'king' it always has an oxidation state of -2

Hydrogen has an oxidation state of +1 (except metal hydrides)

The charges in a molecule must cancel.

Examples: Sodium nitrate, $NaNO_3$ sulfate ion, SO_4^{2-}

Na +1 3x O^{2-} $4xO^{2-}$ and 2- charges 'showing'

+1 -6 -8 -2

To cancel: N = +5 S = +6

Q2.1 Work out the oxidation state of the **underlined** atom in the following:

a) $MgCO_3$ b) SO_3 c) $NaClO_3$ d) MnO_2 e) Fe_2O_3 f) V_2O_5

g) $KMnO_4$ h) $Cr_2O_7^{2-}$ i) Cl_2O_4

Chemistry topic 3 – Isotopes and mass

You will remember that an isotopes are elements that have differing numbers of neutrons. Hydrogen has 3 isotopes; H_1^1 H_1^2 H_1^3

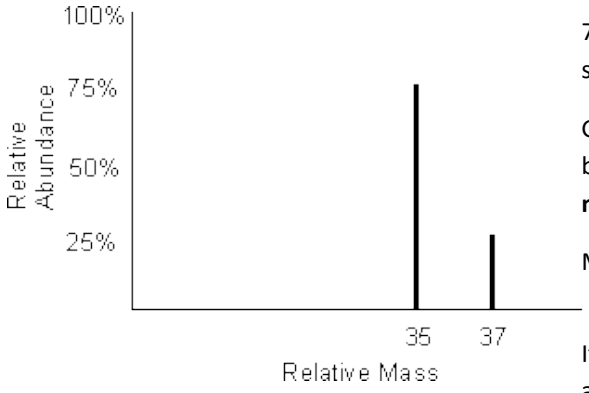
Isotopes occur naturally, so in a sample of an element you will have a mixture of these isotopes. We can accurately measure the amount of an isotope using a **mass spectrometer**. You will need to understand what a mass spectrometer is and how it works at A level. You can read about a mass spectrometer here:

http://bit.ly/pixlchem3
http://www.kore.co.uk/tutorial.htm
http://bit.ly/pixlchem4
http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-TN-MASS-SPECTROMETRY.PDF

Q3.1 What must happen to the atoms before they are accelerated in the mass spectrometer?

Q3.2 Explain why the different isotopes travel at different speeds in a mass spectrometer.

A mass spectrum for the element chlorine will give a spectrum like this:



75% of the sample consist of chlorine-35, and 25% of the sample is chlorine-37.

Given a sample of naturally occurring chlorine ¾ of it will be Cl-35 and ¼ of it is Cl-37. We can calculate what the **mean** mass of the sample will be:

Mean mass = $\frac{75}{100} \times 35 + \frac{25}{100} \times 37 = 35.5$

If you look at a periodic table this is why chlorine has an atomic mass of 35.5.

http://www.avogadro.co.uk/definitions/ar.htm

An A level periodic table has the masses of elements recorded much more accurately than at GCSE. Most elements have isotopes and these have been recorded using mass spectrometers.

GCSE

11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9
27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17

A level

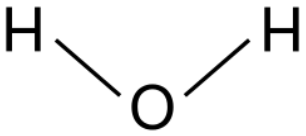
10.8 $^{5}_{}$**B** boron	12.0 $^{6}_{}$**C** carbon	14.0 $^{7}_{}$**N** nitrogen	16.0 $^{8}_{}$**O** oxygen	19.0 $^{9}_{}$**F** fluorine
27.0 $^{13}_{}$**Al** aluminium	28.1 $^{14}_{}$**Si** silicon	31.0 $^{15}_{}$**P** phosphorus	32.1 $^{16}_{}$**S** sulphur	35.5 $^{17}_{}$**Cl** chlorine

Given the percentage of each isotope you can calculate the mean mass which is the accurate atomic mass for that element.

Q3.3 Use the percentages of each isotope to calculate the accurate atomic mass of the following elements.

a) Antimony has 2 isotopes: Sb-121 57.25% and Sb-123 42.75%
b) Gallium has 2 isotopes: Ga-69 60.2% and Ga-71 39.8%
c) Silver has 2 isotopes: Ag-107 51.35% and Ag-109 48.65%
d) Thallium has 2 isotopes: Tl-203 29.5% and Tl-205 70.5%
e) Strontium has **4** isotopes: Sr-84 0.56%, Sr-86 9.86%, Sr-87 7.02% and Sr-88 82.56%

Chemistry topic 4 – The shapes of molecules and bonding.



Have you ever wondered why your teacher drew a water molecule like this?

The lines represent a covalent bond, but why draw them at an unusual angle?

If you are unsure about covalent bonding, read about it here:

http://bit.ly/pixlchem5

http://www.chemguide.co.uk/atoms/bonding/covalent.html#top

At A level you are also expected to know how molecules have certain shapes and why they are the shape they are.

You can read about shapes of molecules here:

http://bit.ly/pixlchem6

http://www.chemguide.co.uk/atoms/bonding/shapes.html#top

Q4.1 Draw a dot and cross diagram to show the bonding in a molecule of aluminium chloride ($AlCl_3$)

Q4.2 Draw a dot and cross diagram to show the bonding in a molecule of ammonia (NH_3)

Q4.3 What is the shape and the bond angles in a molecule of methane (CH_4)?

Chemistry topic 5 – Chemical equations

Balancing chemical equations is the stepping stone to using equations to calculate masses in chemistry.

There are loads of websites that give ways of balancing equations and lots of exercises in balancing.

Some of the equations to balance may involve strange chemical, don't worry about that, the key idea is to get balancing right.

http://bit.ly/pixlchem7

http://www.chemteam.info/Equations/Balance-Equation.html

This website has a download; it is safe to do so:

http://bit.ly/pixlchem8

https://phet.colorado.edu/en/simulation/balancing-chemical-equations

Q5.1 Balance the following equations

a. $H_2 + 0_2 \rightarrow H_20$

b. $S_8 + 02 \rightarrow S0_3$

c. $HgO \rightarrow Hg + O_2$

d. $Zn + HCl \rightarrow ZnCl_2 + H_2$

e. $Na + H_20 \rightarrow NaOH + H_2$

f. $C_{10}H_{16} + Cl_2 \rightarrow C + HCl$

g. $Fe + O_2 \rightarrow Fe_2O_3$

h. $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

i. $Fe_2O_3 + H_2 \rightarrow Fe + H_2O$

j. $Al + FeO \rightarrow Al_2O_3 + Fe$

Chemistry topic 6 – Measuring chemicals – the mole

From this point on you need to be using an A level periodic table, not a GCSE one you can view one here:

http://bit.ly/pixlpertab

https://secondaryscience4all.files.wordpress.com/2014/08/filestore_aqa_org_uk_subjects_aqa-2420-w-trb-ptds_pdf.png

Now that we have our chemical equations balanced, we need to be able to use them in order to work out masses of chemicals we need or we can produce.

The ***mole*** is the chemists equivalent of a dozen, atoms are so small that we cannot count them out individually, we weigh out chemicals.

For example: magnesium + sulfur → magnesium sulfide

$$Mg + S \rightarrow MgS$$

We can see that one atom of magnesium will react with one atom of sulfur, if we had to weigh out the atoms we need to know how heavy each atom is.

From the periodic table: Mg = 24.3 and S = 32.1

If I weigh out exactly 24.3g of magnesium this will be 1 mole of magnesium, if we counted how many atoms were present in this mass it would be a huge number (6.02×10^{23}!!!!), if I weigh out 32.1g of sulfur then I would have 1 mole of sulfur atoms.

So 24.3g of Mg will react precisely with 32.1g of sulfur, and will make 56.4g of magnesium sulfide.

Here is a comprehensive page on measuring moles, there are a number of descriptions, videos and practice problems.

You will find the first 6 tutorials of most use here, and problem sets 1 to 3.

http://bit.ly/pixlchem9

http://www.chemteam.info/Mole/Mole.html

Q6.1 Answer the following questions on moles.

a) How many moles of phosphorus pentoxide (P_4O_{10}) are in 85.2g?
b) How many moles of potassium in 73.56g of potassium chlorate (V) ($KClO_3$)?
c) How many moles of water are in 249.6g of hydrated copper sulfate(VI) ($CuSO_4.5H_2O$)? For this one, you need to be aware the dot followed by $5H_2O$ means that the molecule comes with 5 water molecules so these have to be counted in as part of the molecules mass.
d) What is the mass of 0.125 moles of tin sulfate ($SnSO_4$)?
e) If I have 2.4g of magnesium, how many g of oxygen(O_2) will I need to react completely with the magnesium? $2Mg + O_2 \rightarrow MgO$

Chemistry topic 7 – Solutions and concentrations

In chemistry a lot of the reactions we carry out involve mixing solutions rather than solids, gases or liquids.

You will have used bottles of acids in science that have labels saying 'Hydrochloric acid 1M', this is a solution of hydrochloric acid where 1 mole of HCl, hydrogen chloride (a gas) has been dissolved in $1dm^3$ of water.

The dm^3 is a cubic decimetre, it is actually 1 litre, but from this point on as an A level chemist you will use the dm^3 as your volume measurement.

http://bit.ly/pixlchem10

http://www.docbrown.info/page04/4_73calcs11msc.htm

Q7.1

a) What is the concentration (in mol dm^{-3}) of 9.53g of magnesium chloride ($MgCl_2$) dissolved in $100cm^3$ of water?
b) What is the concentration (in mol dm^{-3}) of 13.248g of lead nitrate ($Pb(NO_3)_2$) dissolved in $2dm^3$ of water?
c) If I add $100cm^3$ of 1.00 mol dm^3 HCl to $1.9dm^3$ of water, what is the molarity of the new solution?
d) What mass of silver is present in $100cm^3$ of $1moldm^{-3}$ silver nitrate ($AgNO_3$)?
e) The Dead Sea, between Jordan and Israel, contains 0.0526 $moldm^{-3}$ of Bromide ions (Br^-), what mass of bromine is in $1dm^3$ of Dead Sea water?

Chemistry topic 8 – Titrations

One key skill in A level chemistry is the ability to carry out accurate titrations, you may well have carried out a titration at GCSE, at A level you will have to carry them out very precisely **and** be able to describe in detail how to carry out a titration - there will be questions on the exam paper about how to carry out practical procedures.

You can read about how to carry out a titration here, the next page in the series (page 5) describes how to work out the concentration of the unknown.

http://bit.ly/pixlchem11

http://www.bbc.co.uk/schools/gcsebitesize/science/triple_aqa/further_analysis/analysing_substances/revision/4/

Remember for any titration calculation you need to have a balanced symbol equation; this will tell you the ratio in which the chemicals react.

E.g. a titration of an unknown sample of sulfuric acid with sodium hydroxide.

A 25.00cm^3 sample of the unknown sulfuric acid was titrated with 0.100moldm^{-3} sodium hydroxide and required exactly 27.40cm^3 for neutralisation. What is the concentration of the sulfuric acid?

Step 1: the equation $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

Step 2; the ratios 2 : 1

Step 3: how many moles of sodium hydroxide 27.40cm^3 = 0.0274dm^3

number of moles = c x v = 0.100 x 0.0274 = 0.00274 moles

step 4: Using the ratio, how many moles of sulfuric acid

for every 2 NaOH there are 1 H_2SO_4 so, we must have 0.00274/2 =0.00137 moles of H_2SO_4

Step 5: Calculate concentration. concentration = moles/volume ←in dm^3 = 0.00137/0.025 = ***0.0548 moldm^{-3}***

Here are some additional problems, which are harder, ignore the questions about colour changes of indicators.

http://bit.ly/pixlchem12

http://www.docbrown.info/page06/Mtestsnotes/ExtraVolCalcs1.htm

Use the steps on the last page to help you

Q8.1 A solution of barium nitrate will react with a solution of sodium sulfate to produce a precipitate of barium sulfate.

$Ba(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaNO_3(aq)$

What volume of 0.25moldm^{-3}sodium sulfate solution would be needed to precipitate all of the barium from 12.5cm^3 of 0.15 moldm^{-3} barium nitrate?

Chemistry topic 9 – Organic chemistry – functional groups

At GCSE you would have come across **hydrocarbons** such as alkanes (ethane etc) and alkenes (ethene etc). You may have come across molecules such as alcohols and carboxylic acids. At A level you will learn about a wide range of molecules that have had atoms added to the carbon chain. These are called functional groups, they give the molecule certain physical and chemical properties that can make them incredibly useful to us.

Here you are going to meet a selection of the functional groups, learn a little about their properties and how we give them logical names.

You will find a menu for organic compounds here:

http://bit.ly/pixlchem13

http://www.chemguide.co.uk/orgpropsmenu.html#top

And how to name organic compounds here:

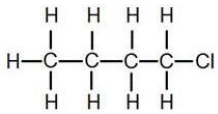
http://bit.ly/pixlchem14

http://www.chemguide.co.uk/basicorg/conventions/names.html#top

Using the two links see if you can answer the following questions:

Q9.1 Halogenoalkanes

What is the name of this halogenoalkane?



How could you make it from butan-1-ol?

Q9.2 Alcohols

How could you make ethanol from ethene?

How does ethanol react with sodium, in what ways is this a) similar to the reaction with water, b) different to the reaction with water?

Q9.3 Aldehydes and ketones

Draw the structures of a) propanal b) propanone

How are these two functional groups different?

Chemistry topic 10 – Acids, bases, pH

At GCSE you will know that an acid can dissolve in water to produce H^+ ions, at A level you will need a greater understanding of what an acid or a base is.

Read the following page and answer the questions

http://bit.ly/pixlchem15

http://www.chemguide.co.uk/physical/acidbaseeqia/theories.html#top

Q10.1 What is your new definition of what an acid is?

Q10.2 How does ammonia (NH_3) act as a base?

http://bit.ly/pixlchem16

http://www.chemguide.co.uk/physical/acidbaseeqia/acids.html#top

Q10.3 Ethanoic acid (vinegar) is a weak acid, what does this mean?

Q10.4 What is the pH of a solution of 0.01 $moldm^{-3}$ of the strong acid, hydrochloric acid?

Pre-Knowledge Topics Answers to problems

Q1.1a) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6 4s^2$ b) $1s^2\ 2s^2\ 2p^6 3s^2 3p^1$ c) $1s^2\ 2s^2\ 2p^6 3s^2 3p^4$ d) $1s^2\ 2s^2\ 2p^6 3s^2 3p^5$

e) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6$ f) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^6 4s^2$ g) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^3 4s^2$

h) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^8 4s^2$ i) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^{10}\ 4s^1$ j) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^{10}\ 4s^2$

k) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^3$

Q1.2a) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6$ b) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6$ c) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^{10}$

d) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6$ e) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^7$

==========

Q2.1 a) +4 b) +6 c) +5 d) +4 e) +3 f) +5 g) +7 h) +6 i) +4

==========

Q3.1 They must be ionised / turned into ions

Q3.2 The ions are all given the same amount of kinetic energy, as KE = ½ mv^2 the lighter ions will have greater speed / heavier ions will have less speed.

Q3.3 a) 121.855 b) 67.796 c) 107.973 d) 204.41 e) 87.710 / 87.7102

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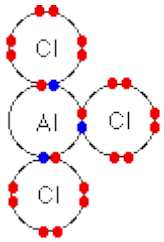
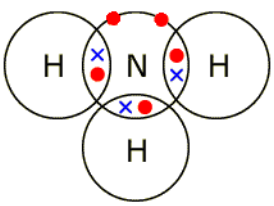
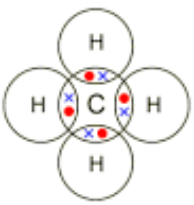
Q4.1

a) 

120° b) 

107° c) 

109.5°

==========

Q5a. $2H_2 + 0_2 \rightarrow 2 H_20$

b. $S_8 + 1202 \rightarrow 8S0_3$

c. $2HgO \rightarrow 2Hg + 0_2$

d. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

e. $2Na + 2H_20 \rightarrow 2NaOH + H_2$

f. $C_{10}H_{16} + 8Cl_2 \rightarrow 10C + 16HCl$

g. $2Fe + 30_2 \rightarrow 2Fe_20_3$

h. $C_6H_{12}0_6 + 60_2 \rightarrow 6 C0_2 + 6 H_20$

i. $Fe_20_3 + 3H_2 \rightarrow 2Fe + 3H_20$

j. $2Al + 3 FeO \rightarrow Al_2O_3 + 3Fe$

Q6.1 a) 85.2/284 = 0.3 moles b) 73.56/122.6 = 0.6 moles c) 249.5/249.5 = 1.0 moles

d) 0.125 x 212.8 = 26.6g e) 2Mg : 2O or 1:1 ratio 2.4g of Mg = 0.1moles so we need 0.1 moles of oxygen (O_2): 0.1 x 32 = 3.2g

7.1 a) 9.53g/95.3 = 0.1 moles, in 100cm^3 or 0.1dm^3 in 1dm^3 0.1moles/0.1dm^3 = 1.0 mol dm^{-3}

b) 13.284g/331.2 = 0.04 moles, in 2dm^3 in 1dm^3 0.04moles /2dm^3 = 0.02 mol dm^{-3}

c) 100cm^3 of 0.1 mol dm^{-3} = 0.01 moles added to a total volume of 2 dm^3 = 0.01moles/2dm^3 = 0.005 mol dm^{-3}

d) in 1dm^3 of 1 mol dm^{-3} silver nitrate, 1 mole of Ag = 107.9g in 0.1dm^3 = 107.9 x 0.1 = 10.79g

e) 0.0526 x 79.7 = 42.0274g

==========

8.1

$Ba(NO_3)_2$: Na_2SO_4

1 : 1 ratio

12.5cm^3 of $Ba(NO_3)_2$ = 0.0125dm^3

0.15 moldm^{-3} x 0.0125dm^3 = 0.001875 moles

same number of moles of sodium sulfate needed, which has a concentration of 0.25 mol dm^{-3}

0.001875 moles / 0.25 mol dm^{-3} = 0.0075 dm^3 or 7.5cm^3

==========

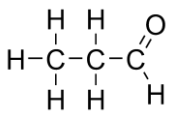
9.1 1-chlorobutane

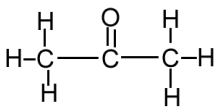
Add butan-1-ol to concentrated HCl and shake

9.2 react ethene with hydrogen gas at high temperature and pressure with a nickel catalyst

The reaction is similar in that it releases hydrogen but different as it proceeds much slower than in water

9.3 propanal propanone





The carbon atom joined to oxygen in propanal has a hydrogen attached to it, it does not in propanone.

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10.1 An acid is a proton donor

10.2 Ammonia can accept a proton, to become NH_4^+

10.3 ethanoic acid has not fully dissociated, it has not released all of its hydrogen ions into the solution.

$CH_3COOH \leftrightharpoons CH_3COO^- + H^+$
Mostly this Very few of these

10.4 pH = -log [0.01] = 2 The pH = 2

Places to visit

1. Go outdoors!
   Have you actually spent any time observing the geology of the area you live in? What rocks or minerals are found in your area? Does your area have a history of extracting minerals? If so what were they, what were they used for, how did they obtain them? Are there any working or remains of mineral extraction industries?

2. Are there any chemical or chemistry based businesses in your area? A big ask, but one that could be really beneficial to you, write them a letter explaining that you are taking A level chemistry and you want to see how chemistry is used in industry and you would like to visit / have some work experience. You never know this could lead to great things!!!!

3. You could also try writing to / searching for your nearest university to see if they are running any summer schools for chemistry – they are usually free and give you the opportunity to experience the laboratories in a university.

4. Science museums.
   You could visit your nearest science museum. They often have special exhibitions that may be of interest to you.
   https://en.wikipedia.org/wiki/List_of_science_museums#United_Kingdom

5. Somerset Earth Science Centre:

   http://www.earthsciencecentre.org.uk

6. The UK Association for Science and Discovery Centres (ASDC)

   This association brings together over 60 major science engagement organisations in the UK.

   http://sciencecentres.org.uk/centres/weblinks.php