CHEMISTRY A LEVEL TRANSITION WORK

Past Paper Questions from OCR GCSE GATEWAY

Please complete all the questions in this booklet. These questions are based on GCSE exam questions and are designed to test your knowledge of the Chemistry you have studied thus far.

The following are the units that you will study over the two-year course, many elements of which, build on your knowledge and understanding from GCSE.

Module 1 – Development of practical skills in chemistry

Module 2 – Foundations in chemistry

Module 3 – Periodic table and energy

Module 4 – Core organic chemistry

Module 5 – Physical chemistry and transition elements

Module 6 – Organic chemistry and analysis

The content you study over the two year course will be examined as outlined below:

Periodic table, elements and physical chemistry	2 hours 15 minutes	37%
Synthesis and analytical techniques	2 hours 15 minutes	37%
Unified chemistry	1 hour 30 minutes	26%

Good luck and we look forward to seeing you in September!

2 **(a)** An element **X** has the electronic structure 2.8.8.2.

Explain how you can tell that element **X** is calcium.

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..... **[1]**

(b) Chlorine has the electronic structure 2.8.7.

Chlorine, Cl_2, is a covalent molecule.

Use the 'dot and cross' model to describe the bonding in a molecule of chlorine, Cl_2.

You only need to draw the outer shell electrons.

[2]

(c) Sodium chloride, NaCl, contains sodium ions, Na^+, and chloride ions, Cl^-.

Explain why sodium ions are positively charged and chloride ions are negatively charged.

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..... **[2]**

(d) Chlorine reacts with sodium bromide solution.

Look at the **ionic** equation for this reaction.

$$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$$

Explain why chlorine is **reduced** in this reaction.

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..... **[1]**

(e) Chlorine also reacts with potassium iodide solution, KI.

Iodine and potassium chloride are made.

Construct a **balanced symbol** equation for this reaction.

..... **[2]**

[Total: 8]

3 Lithium, Li, is in Group 1 of the Periodic Table.

Laura's teacher adds a small piece of lithium to a bowl of water.

The lithium reacts with the water, H_2O.

The lithium moves about on the surface of the water.

Laura sees bubbles of hydrogen, H_2, being made.

The piece of lithium gets smaller and smaller until it has completely reacted.

A solution of lithium hydroxide, LiOH, is made.

Caesium, Cs, is another element in Group 1.

Predict, including a balanced symbol equation, how the reaction of **caesium** with water compares with the reaction of **lithium** with water.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

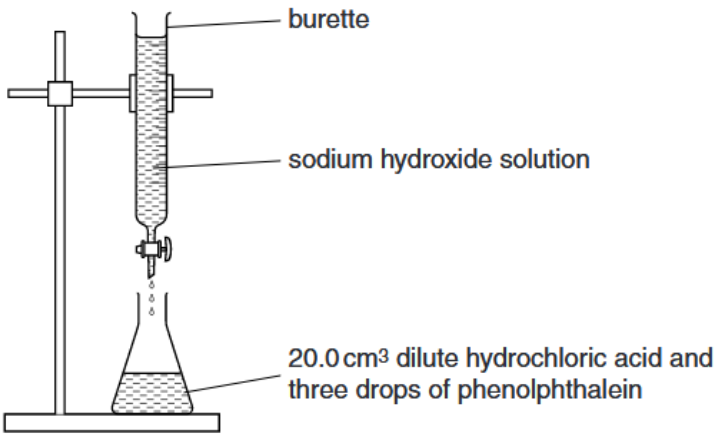
[Total: 6]

7 This question is about acid-base titrations.

Brian neutralises dilute hydrochloric acid with sodium hydroxide solution.

He wants to find out the concentration of the sodium hydroxide solution.

Look at the apparatus.



Brian adds sodium hydroxide solution slowly until the phenolphthalein changes colour.

He does the titration four times.

Look at Brian's results.

Titration number	**1**	**2**	**3**	**4**
Volume of sodium hydroxide added in cm^3	25.9	24.9	25.1	25.0

Brian calculates the mean volume of sodium hydroxide solution to be 25.0 cm^3.

(a) Titration 1 was not included in the calculation of the mean volume of sodium hydroxide added.

Suggest why.

..... **[1]**

(b) Look at the equation for the reaction.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

The mean volume of sodium hydroxide solution used is 25.0 cm^3.

Brian uses 20.0 cm^3 of hydrochloric acid.

The concentration of the hydrochloric acid is 0.100 mol/dm^3.

Calculate the concentration of the sodium hydroxide in mol/dm^3.

answer ..... mol/dm^3 **[3]**

(c) Phenolphthalein is a single indicator.

Universal indicator is a mixed indicator.

Explain why Brian used phenolphthalein rather than universal indicator.

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..... **[2]**

[Total: 6]

1 Look at the table. It shows information about the Group 1 metals.

Element	Symbol	Electronic structure	Melting point in °C	Boiling point in °C	Atomic radius in nm
lithium	Li	2.1	181	1342	0.152
sodium	Na	2.8.1	.....	883	0.185
potassium	K	2.8.8.1	64	760	0.227
rubidium	Rb	2.8.18.8.1	39	688	.....

(a) Predict the melting point of sodium and the atomic radius of rubidium.

Write your answers in the table. **[2]**

(b) Sodium reacts with water.

Sodium hydroxide, NaOH, and hydrogen, H_2, are made.

Write a **balanced symbol** equation for this reaction.

..... **[2]**

(c) The Group 1 elements all react in a similar way.

Explain why.

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..... **[1]**

(d) Sodium reacts with fluorine. Sodium ions and fluoride ions are made.

The electronic structure of fluorine is 2.7.

Draw a 'dot and cross' diagram to show the electronic structure of a sodium ion and of a fluoride ion. Include the charges on the ions.

[2]

[Total: 7]

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2 This question is about atomic structure and bonding.

(a) Atoms are made up of protons, neutrons and electrons.

Complete the table.

Particle	Relative charge	Relative mass
proton	+1	1
neutron	0	.....
electron	.....	0.0005

[2]

(b) Sodium chloride is an **ionic** compound.

Carbon dioxide is a **covalent** compound.

Look at the table.

	Sodium chloride	Carbon dioxide
Formula	$NaCl$	CO_2
Type of particles present	ions	.....
Melting point	.....	low

(i) Complete the table. **[2]**

(ii) Carbon dioxide has a low melting point.

Explain why, using ideas about forces.

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..... **[1]**

[Total: 5]

3 An aluminium atom can be shown as

$$^{27}_{13}Al$$

(a) What can be deduced from this information about the structure of an aluminium atom and the position of aluminium in the Periodic Table?

The quality of written communication will be assessed in your answer to this question.

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(b) Rutherford was a scientist who contributed to the development of the theory of atomic structure.

He worked with two other scientists called Geiger and Marsden.

Write about Geiger and Marsden's experiment and how it contributed to the development of ideas about atomic structure.

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..... **[2]**

[Total: 8]

6 There are many compounds that contain carbon and hydrogen only.

(a) Pentane has the formula $CH_3(CH_2)_3CH_3$.

Calculate the molar mass of pentane.

The relative atomic mass, A_r, of H = 1 and of C = 12.

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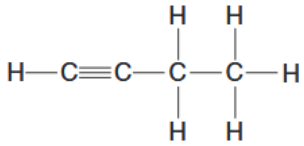
molar mass = ... g/mol **[1]**

(b) Look at the displayed formula for butyne.



What is the **molecular formula** for butyne?

..... **[1]**

(c) Look at the molecular formula of some compounds.

Which **two** compounds have the same **empirical** formula?

Choose from

CH_4 C_2H_2 C_2H_4

C_2H_6 C_3H_4 C_6H_6

answer ..... and ..... **[1]**

(d) David analyses a sample of a gas.

He finds it contains 1.2 g of carbon and 0.4 g of hydrogen.

Calculate the empirical formula for this gas.

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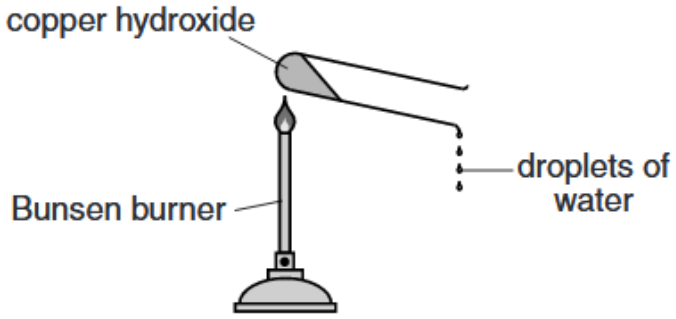
empirical formula is ..... **[2]**

[Total: 5]

7 Jess investigates the thermal decomposition of copper hydroxide.

$$\text{copper hydroxide} \rightarrow \text{copper oxide} + \text{water}$$

Look at the apparatus she uses.



She measures the mass of copper hydroxide at the start.

She then heats the copper hydroxide for 5 minutes.

Jess lets the apparatus cool down.

She then measures the mass of copper oxide made.

Jess does the experiment four more times.

Look at her results.

Experiment number	Mass of copper hydroxide in g	Mass of copper oxide made in g	Mass of water made in g
1	0.50	0.41	
2	1.00	0.82	
3	1.50	1.22	
4	2.00	1.63	
5	2.50	1.90	

Jess predicts that the mass of water made is directly proportional to the mass of copper hydroxide heated.

Is this prediction supported by her results?

Complete the table and use the data to explain your answer.

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..... [3]

[Total: 3]

1 Look at the electronic structures of some atoms.

Atom	Electronic structure
W	2.8.1
X	2.8.4
Y	2.8.7
Z	2.8.8

(a) (i) One of the atoms is a metal which makes a positive ion.

Which one? Choose from the table.

answer ..... [1]

(ii) One of the atoms has a stable electronic structure and is unreactive.

Which one? Choose from the table.

answer ..... [1]

(iii) Two of the atoms can combine together by **transferring** electrons to form an **ionic** bond.

Which two? Choose from the table.

..... and ..... [1]

(b) Ammonia has the formula, NH_3.

The electronic structure of nitrogen is 2.5.

The electronic structure of hydrogen is 1.

Draw a 'dot and cross' diagram to show the **covalent** bonding in ammonia.

Show all the electrons.

[2]

(c) Sodium chloride is an **ionic** compound.

Sodium chloride

- will not conduct electricity when it is a solid
- will conduct electricity when it is dissolved in water.

Explain these two observations in terms of structure and bonding.

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..... **[2]**

Look at Pete's results.

Sample	Addition of sodium hydroxide solution	Addition of barium chloride solution
A	blue solid made	white solid made
B	brown solid made	no reaction

Pete thinks that sample **A** is copper sulfate.

He thinks that sample **B** is iron(III) sulfate.

Is Pete right about **each** sample?

Explain your answer.

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..... **[4]**

5 Space probes have been sent to Mars to analyse the soil.

One compound analysed has the formula $Ca(ClO_4)_2$.

(a) Calculate the molar mass of $Ca(ClO_4)_2$.

The relative atomic mass, A_r, of O = 16, of Cl = 35.5 and of Ca = 40.

molar mass ..... g/mol **[1]**

(b) A compound with the formula K_2FeO_4 has also been discovered on Mars.

A sample of K_2FeO_4 is analysed.

The 1.00 g sample contains 0.39 g of potassium and 0.28 g of iron.

Calculate the percentage by mass of oxygen in this sample of K_2FeO_4.

percentage by mass = ... % **[2]**

(c) Another compound found on Mars has the molecular formula C_4H_{10}.

What is the **empirical** formula for this compound?

..... **[1]**

(d) Another compound found on Mars contains iron and oxygen.

The compound contains 70% by mass of iron and 30% by mass of oxygen.

Calculate the empirical formula of this compound.

The relative atomic mass, A_r, of O = 16 and of Fe = 56.

empirical formula is ..... **[3]**

6 This question is about acids.

Nitric acid, HNO_3, is a strong acid and propanoic acid, C_2H_5COOH, is a weak acid.

David investigates the reaction of both of these acids with calcium carbonate.

David does two experiments

- the first with nitric acid
- the second with propanoic acid.

Each time he puts 50 cm^3 of 2.0 mol/dm^3 acid into a conical flask.

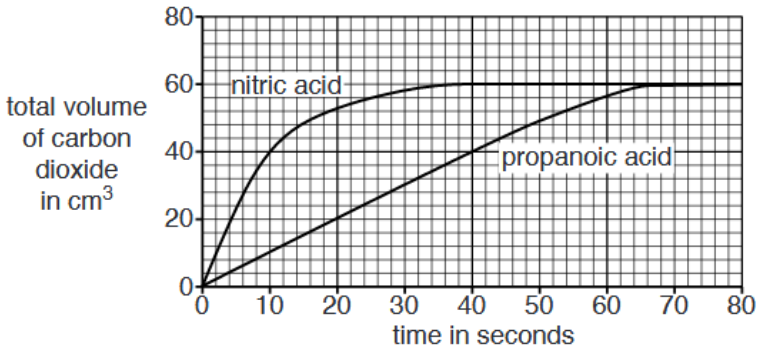
He then adds the same mass of calcium carbonate to each acid.

David measures the total volume of carbon dioxide made every 10 seconds.

(a) Draw a labelled diagram of the apparatus David can use in these experiments.

[2]

(b) Look at the graph of David's results.



The two lines are different shapes because the strength of each acid is different.

Write about the difference between a strong and a weak acid and explain why the two lines are different.

The quality of written communication will be assessed in your answer to this question.

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(c) Look at the balanced symbol equation for the reaction of calcium carbonate with nitric acid.

$$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + CO_2 + H_2O$$

(i) David's experiment with nitric acid makes 60 cm^3 of carbon dioxide at room temperature and pressure.

How many moles of carbon dioxide are made at the end of the reaction?

One mole of carbon dioxide has a volume of 24 000 cm^3 at room temperature and pressure.

moles of carbon dioxide = ... **[1]**

(ii) Calculate the mass of calcium carbonate needed to make this amount of carbon dioxide.

The relative formula mass, M_r, of calcium carbonate, $CaCO_3$, is 100.

mass of calcium carbonate = ... g **[1]**

7 In a closed system a reversible reaction will form an equilibrium mixture.

(a) Which of the following statements are true for a reversible reaction at **equilibrium**?

Tick (✓) the **two** correct answers.

The rate of the forward reaction is faster than the rate of the backward reaction.	☐
The position of equilibrium will not change if more product is added.	☐
The concentration of the reactants does not change.	☐
The rate of the forward reaction is the same as the rate of the backward reaction.	☐
The concentration of the reactants is the same as the concentration of the products.	☐
The position of equilibrium moves to the left when product is removed from the equilibrium.	☐

[2]

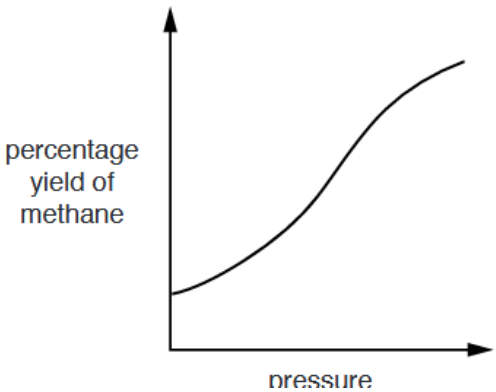
(b) Methane is a fuel that can be made by the reaction between carbon dioxide and hydrogen.

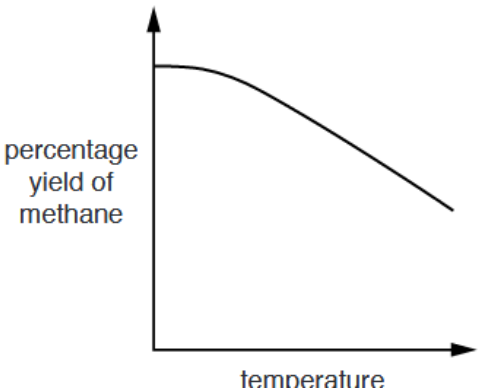
$$CO_2(g) + 4H_2(g) \rightleftharpoons CH_4(g) + 2H_2O(g)$$

Paul predicts that

- the reaction is exothermic
- there are more moles of gas on the right-hand side of the equation.

Look at the two graphs.





Do the graphs support Paul's predictions?

Explain your answer.

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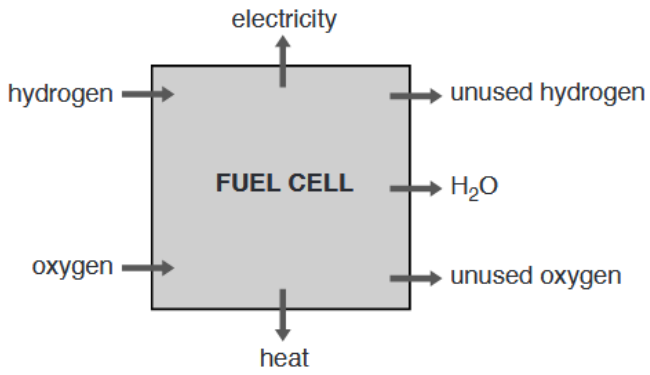
9 Fuel cells are used to make electricity.

Look at the diagram. It shows what happens in a fuel cell.



(a) In this fuel cell, hydrogen, H_2, reacts with oxygen, O_2.

Water, H_2O, is made.

Write a **balanced symbol** equation for this reaction.

..... **[2]**

(b) The reaction between hydrogen and oxygen is **exothermic**.

Draw and label an energy level diagram for the reaction between hydrogen and oxygen

[2]

(c) Fuel cells are used to provide electrical energy in spacecraft.

Write down one **other advantage** of using fuel cells in spacecraft.

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..... **[1]**

(d) Hydrogen-oxygen fuel cells produce water.

Water is not a pollutant.

Fuel cells still cause pollution.

Write down two ways that fuel cells can cause pollution.

1 .....

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2 .....

..... **[2]**