Mr and Molar Volume of Gases- Chemical Formulae & Chemical Equations

Question Paper

Level	GCSE
Subject	Chemistry
Exam Board	Edexcel IGCSE
Module	Single Award (Paper 2C)
Topic	Principles of Chemistry
Sub-Topic	Chemical Formulae & Chemical Equations
Booklet	Question Paper

Time Allowed: **68 minutes**

Score: **/57**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

1 Sulfur dioxide, SO_2, is used as a preservative in wine.

The sulfur dioxide content of a wine can be found by titration. A chemist found that 25.0 cm^3 of a sample of wine reacted with exactly 15.00 cm^3 of 0.0010 mol/dm^3 aqueous iodine, $I_2(aq)$.

The equation for the reaction is

$$SO_2(aq) + I_2(aq) + 2H_2O(I) \rightarrow SO_4^{2-}(aq) + 2I^-(aq) + 4H^+(aq)$$

(a) Calculate the amount, in moles, of iodine in 15.00 cm^3 of a 0.0010 mol/dm^3 solution.

(2)

(b) Deduce the amount, in moles, of sulfur dioxide in 25.0 cm^3 of the wine.

(1)

(c) Calculate the concentration, in mol/dm^3, of sulfur dioxide in the wine.

(2)

(d) Calculate the concentration, in g/dm^3, of sulfur dioxide in the wine.

(2)

(e) A concentration of sulfur dioxide that is greater than 0.16 g/dm^3 makes wine unpleasant to drink.

Use the value you have calculated in (d) to state whether the wine is drinkable.

(1)

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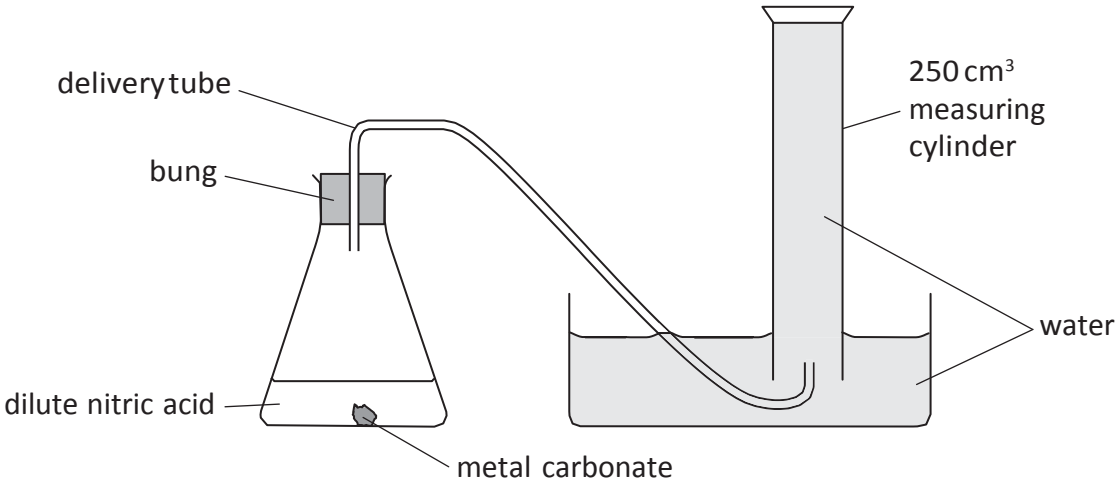
.....

(Total for Question 1 = 8 marks)

2 A student set up this apparatus to measure the volume of carbon dioxide given off when a sample of a carbonate of a Group 2 metal was reacted with dilute nitric acid.



She weighed out some of the carbonate and put it in a conical flask. She then added an excess of dilute nitric acid.

After adding the acid she placed the bung and delivery tube into the conical flask.

She measured the total volume of gas collected at room temperature and pressure (rtp) in the measuring cylinder.

Her results are shown in the table.

Mass of Group 2 carbonate	0.888 g
Volume of gas collected	144 cm^3

The equation for the reaction is

$$XCO_3(s) + 2HNO_3(aq) \rightarrow X(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$

where X is the symbol for the Group 2 metal.

(a) (i) Calculate the amount, in moles, of carbon dioxide gas collected.
(Assume that one mole of gas has a volume of 24 000 cm^3 at rtp)

(2)

Amount of carbon dioxide gas collected = ... mol

(ii) Deduce the amount, in moles, of the carbonate that reacted.

(1)

Amount of carbonate reacted = ... mol

(iii) Using the mass of the carbonate and your answer to (a)(ii), calculate the relative formula mass (M_r) of this carbonate.

Give your answer to the nearest whole number.

(2)

Relative formula mass = ...

(iv) Calculate a value for the relative atomic mass of the Group 2 metal, X, and use the Periodic Table on page 2 to suggest its identity.

(3)

Relative atomic mass of X = ...

Identity of X = ...

(b) After the student had completed the experiment she was told that the metal carbonate was calcium carbonate.

She calculated that 0.888 g of calcium carbonate would produce 213 cm^3 of carbon dioxide.

She was certain that she had measured the mass of the metal carbonate correctly.

Suggest **two** reasons why the volume of gas she collected was less than 213 cm^3.

(2)

1 .....

.....

2 .....

.....

(Total for Question 2 = 10 marks)

3 Tungsten is a useful metal. It has the chemical symbol W.

(a) One method of extracting tungsten involves heating a tungsten compound (WO_3) with hydrogen.

(i) Suggest the chemical name of WO_3

(1)

.....

(ii) Balance the equation for the reaction between WO_3 and hydrogen.

(1)

..... WO_3 + ... H_2 → ..... W + ... H_2O

(iii) Why is this reaction described as reduction?

(1)

.....

.....

(b) Scheelite is an ore of tungsten.

The main compound in scheelite has the percentage composition by mass Ca = 13.9%, W = 63.9%, O = 22.2%.

Calculate the empirical formula of this compound.

(3)

empirical formula = ...

(c) Tungsten can also be obtained by reacting tungsten fluoride with hydrogen.

The equation for this reaction is

$$WF_6 + 3H_2 \rightarrow W + 6HF$$

(i) In an experiment, a chemist used 59.6 g of tungsten fluoride.

What is the maximum mass of tungsten he could obtain from 59.6 g of tungsten fluoride?

Relative formula mass of tungsten fluoride = 298

(2)

maximum mass = ... g

(ii) Starting with a different mass of tungsten fluoride, he calculates that the mass of tungsten formed should be 52.0 g. In his experiment he actually obtains 47.5 g of tungsten.

What is the percentage yield of tungsten in this experiment?

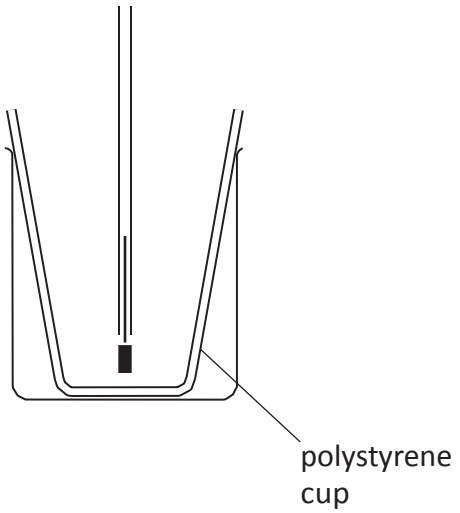
(2)

percentage yield = ... %

(Total for Question 3 = 10 marks)

4 A student investigated the neutralisation of acids by measuring the temperature changes when alkalis were added to acids of known concentrations.

He used this apparatus to add different volumes of sodium hydroxide solution to a fixed volume of dilute nitric acid.



He used this method.

- measure the temperature of 25.0 cm^3 of the acid in the polystyrene cup
- add the sodium hydroxide solution in 5.0 cm^3 portions until a total of 30.0 cm^3 has been added

(a) State two properties of the sodium hydroxide solution that should be kept constant for each 5.0 cm^3 portion.

(2)

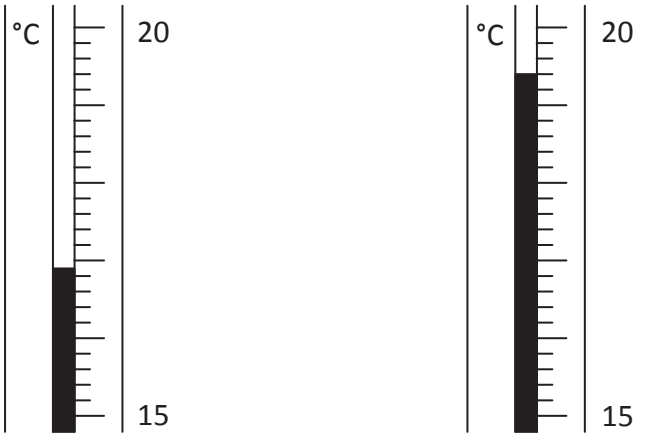
1 .....

.....

2 .....

.....

(b) The diagram shows the thermometer readings in one experiment.



before adding alkali after adding alkali

Write down the thermometer readings and calculate the temperature change.

(3)

temperature after adding alkali ..... °C

temperature before adding alkali ..... °C

temperature change ..... °C

(c) The student carried out the experiment three times.

The table shows his results.

Volume of alkali added in cm^3	Temperature in °C		
	experiment 1	experiment 2	experiment 3
0.0	17.4	16.6	15.9
5.0	18.5	21.0	18.0
10.0	19.6	24.5	20.0
15.0	20.5	23.6	22.2
20.0	21.4	22.7	23.6
25.0	22.5	21.4	22.8
30.0	23.4	20.5	22.0

The teacher said that only the results for experiment 3 showed the expected increase and decrease in temperature.

(i) Why was there no temperature decrease in experiment 1?

(1)

☒ **A** The alkali was added too quickly

☒ **B** The starting temperature of the acid was too high

☒ **C** The acid concentration was half what it should have been

☒ **D** The volume of acid used was 50.0 cm^3 instead of 25.0 cm^3

(ii) Why were the temperature increases in experiment 2 much greater than expected?

(1)

☒ **A** The starting temperature of the acid was too high

☒ **B** The acid concentration was double what it should have been

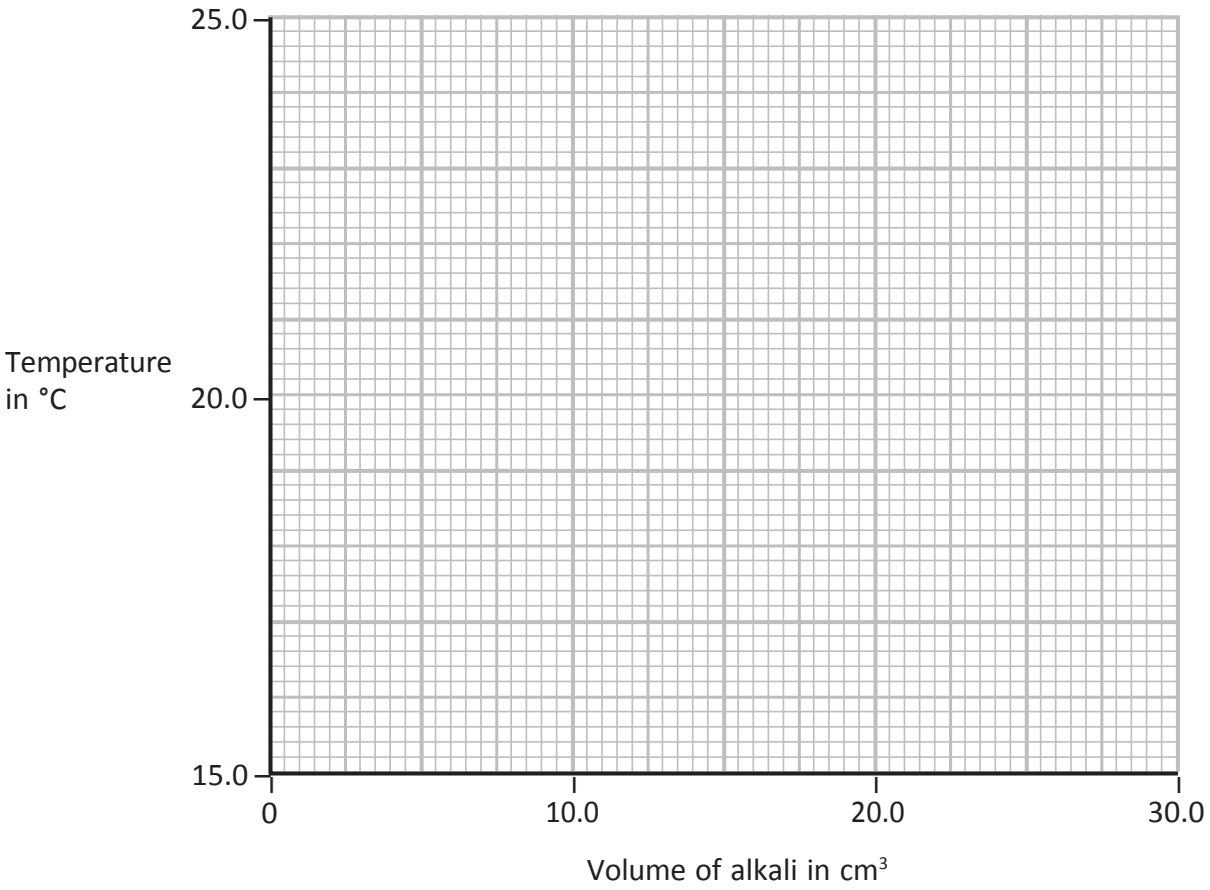
☒ **C** The volume of acid used was 50.0 cm^3 instead of 25.0 cm^3

☒ **D** The alkali was added in 10.0 cm^3 portions but were recorded as 5.0 cm^3 portions

(d) Plot the results of experiment 3 on the grid.

Draw a straight line of best fit through the first four points, and another straight line of best fit through the last three points. Make sure that the two lines cross.

(4)



(e) The point where the lines cross indicates the volume of alkali added to exactly neutralise the acid and also the maximum temperature reached.

Record these values.

(2)

volume of alkali ..... cm^3

maximum temperature ..... °C

(f) Another student used sulfuric acid instead of nitric acid in her experiments. She started with 25.0 cm^3 of sulfuric acid of concentration 0.650 mol/dm^3.

She added 0.500 mol/dm^3 sodium hydroxide solution until the acid was completely neutralised.

The equation for this reaction is

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

(i) Calculate the amount, in moles, of sulfuric acid used. **(2)**

amount = ... mol

(ii) Calculate the amount, in moles, of sodium hydroxide needed to neutralise this amount of sulfuric acid.

(1)

amount = ... mol

(iii) Calculate the volume, in cm^3, of sodium hydroxide solution needed to neutralise this amount of sulfuric acid.

(2)

volume = ... cm^3

(Total for Question 4 = 18 marks)

5 (a) The first two members of the homologous series of alcohols are methanol and ethanol.

(i) Give two characteristics of the compounds in a homologous series.

(2)

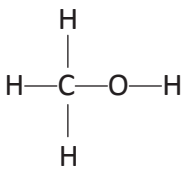
1 .....

.....

2 .....

.....

(ii) The displayed formula for methanol is



Suggest a displayed formula for ethanol, CH_3CH_2OH

(1)

(b) The table shows the two different processes for making ethanol on a large scale.

Process	Explanation
batch process	the fermentation of sugars with yeast
continuous process	the hydration of ethene (produced from crude oil) with steam

Compare the two processes in terms of

the rate at which the ethanol can be produced

the purity of the product

the use of finite resources

(3)

(c) The equation for the fermentation of glucose is

$$C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2$$

A mass of 3 600 kg of glucose was completely fermented.

(i) Calculate the amount, in moles, of glucose that was fermented.
(M_r of glucose = 180)

(2)

amount of glucose = ... mol

(ii) Deduce the amount, in moles, of ethanol produced in this reaction.

(1)

amount of ethanol = ... mol

(iii) Calculate the volume, in dm^3 at rtp, of carbon dioxide produced in this reaction.
(1 mol of carbon dioxide occupies 24 dm^3 at rtp)

(2)

volume of carbon dioxide = ... dm^3

(Total for Question 5 = 11 marks)