AQA – Amount of substance – AS Chemistry P1

1. June/ 2020/Paper_1/No.2

0 2 This question is about a titration.

A student dissolves an unknown mass of sodium hydroxide in water to make 200 cm^3 of an aqueous solution.

A 25.0 cm^3 sample of this sodium hydroxide solution is placed in a conical flask and is titrated with 0.150 mol dm^{-3} sulfuric acid.

The equation for this reaction is shown.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

Table 1 shows the results of the titrations.

Table 1

Titration	Rough	1	2	3
Final reading / cm^3	20.75	40.35	21.05	40.60
Initial reading / cm^3	0.00	20.75	1.20	21.05
Titre / cm^3	20.75	19.60	19.85	19.55

0 2 . 1 Calculate the mass of sodium hydroxide used to make the original solution.

[5 marks]

Mass of sodium hydroxide _____ g

0 2 . 2 The student uses a funnel to fill the burette with sulfuric acid before starting the titration. After filling, the student forgets to remove the funnel from the top of the burette.

Suggest why this might affect the titre volume recorded.

[1 mark]

0 2 . 3 State **one** advantage of using a conical flask rather than a beaker for the titration.

[1 mark]

2. June/ 2020/Paper_1/No.3

0 3 This question is about time of flight (TOF) mass spectrometry.

0 3 . 1 Define the term relative atomic mass.

[2 marks]

0 3 . 2 A sample of krypton is ionised using electron impact.

The mass spectrum of this sample of krypton has four peaks.

Table 2 shows data from this spectrum.

Table 2

m/z	82	83	84	86
Relative intensity	6	1	28	8

Calculate the relative atomic mass (A_r) of this sample of krypton.
Give your answer to 1 decimal place.

[2 marks]

A_r _____

0 3 . 3 In a TOF mass spectrometer, ions are accelerated to the same kinetic energy (*KE*).

The kinetic energy of an ion is given by the equation $KE = \frac{1}{2}mv^2$

Where:
KE = kinetic energy / J
m = mass / kg
v = speed / m s^{-1}

In a TOF mass spectrometer, each $^{84}Kr^+$ ion is accelerated to a kinetic energy of 4.83×10^{-16} J and the time of flight is 1.72×10^{-5} s

Calculate the length, in metres, of the TOF flight tube.

The Avogadro constant, $L = 6.022 \times 10^{23}$ mol^{-1}

[4 marks]

Length of flight tube _____ m

3. June/ 2020/Paper_1/No.8

0 8 This question is about a volatile liquid, **A**.

0 8 . 1 A student does an experiment to determine the relative molecular mass (M_r) of liquid **A** using the apparatus shown in **Figure 2**.

The student injects a sample of **A** into a gas syringe in an oven.

At the temperature of the oven, liquid **A** vaporises.

Figure 2

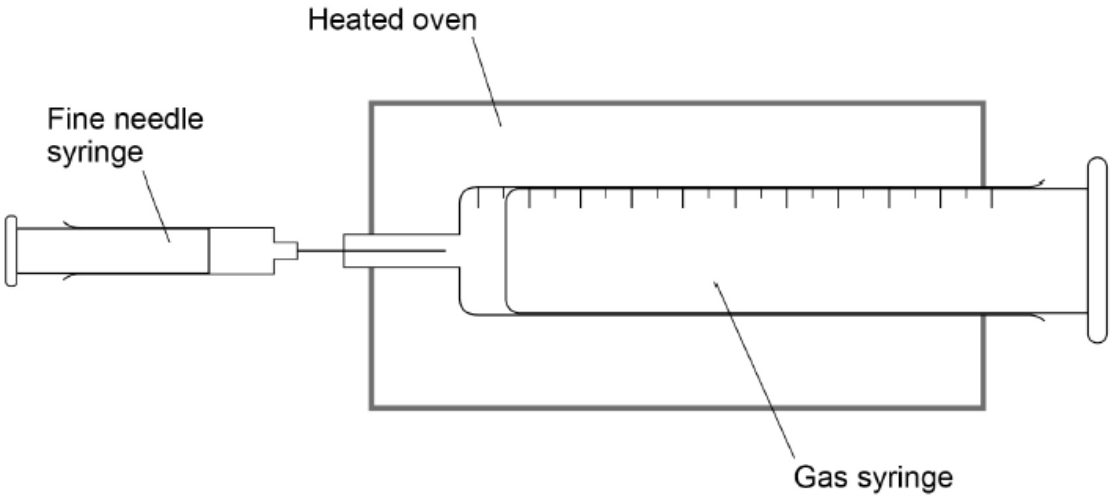

Table 3 shows the student's results.

Table 3

Mass of fine needle syringe and contents before injecting	11.295 g
Mass of fine needle syringe and contents after injecting	10.835 g
Volume reading on gas syringe before injecting	0.0 cm^3
Volume reading on gas syringe after injecting	178.0 cm^3
Pressure of gas in syringe	100 kPa
Temperature of oven	120 °C

Calculate the M_r of **A**.

Give your answer to 3 significant figures.

The gas constant, $R = 8.31$ J K^{-1} mol^{-1}

[4 marks]

M_r _____

0 8 . 2 The student noticed that some of the liquid injected into the gas syringe did **not** vaporise.

Explain the effect that this has on the M_r calculated by the student.

[2 marks]

_____

_____

_____

_____

_____

Table 3 is repeated here.

Table 3

Mass of fine needle syringe and contents before injecting	11.295 g
Mass of fine needle syringe and contents after injecting	10.835 g
Volume reading on gas syringe before injecting	0.0 cm^3
Volume reading on gas syringe after injecting	178.0 cm^3
Pressure of gas in syringe	100 kPa
Temperature of oven	120 °C

0 8 . 3 Each reading on the balance used to record the mass of the fine needle syringe and contents had an uncertainty of ±0.001 g

Calculate the percentage uncertainty in the mass of liquid **A** injected in this experiment.

[1 mark]

Percentage uncertainty _____

4. June/ 2019/Paper_1/No.6

0 6 A student does an investigation to determine the relative formula mass, M_r, of a solid unknown diprotic acid, H_2A

$$H_2A + 2NaOH \rightarrow Na_2A + 2H_2O$$

- 250 cm^3 of aqueous solution are prepared using 1300 mg of H_2A
- A pipette is used to add 25.0 cm^3 of 0.112 mol dm^{-3} aqueous sodium hydroxide to a conical flask.
- This aqueous sodium hydroxide is titrated with the acid solution.

The titration results are shown in **Table 3**.

Table 3

	Rough	**1**	**2**	**3**
Final volume / cm^3	27.35	26.75	38.90	35.70
Initial volume / cm^3	0.00	0.35	12.15	9.20
Titre / cm^3	27.35	26.40	26.75	26.50

0 6 . 1 Use the results to calculate the M_r of H_2A

[5 marks]

M_r of H_2A _____

0 6 . 2 The uncertainty in using the pipette in this experiment is ±0.06 cm^3

Calculate the percentage uncertainty in using the pipette.

[1 mark]

% uncertainty _____

0 6 . 3 Before adding the solution from the burette in the rough titration, there was an air bubble below the tap.
At the end of this titration the air bubble was not there.

Explain why this air bubble increases the final burette reading of the rough titration.

[1 mark]

_____

_____

_____

0 6 . 4 During the titration the student washed the inside of the conical flask with some distilled water.

Suggest why this washing does **not** give an incorrect result.

[1 mark]

_____

_____

5. June/ 2019/Paper_1/No.7

0 7 This question is about the reactions of magnesium and its compounds.

0 7 . 1 Magnesium is used in one of the stages in the extraction of titanium.

Give an equation for the reaction between titanium(IV) chloride and magnesium.
State the role of magnesium in this reaction.

[2 marks]

Equation

_____

Role of magnesium _____

0 7 . 2 A mixture of magnesium oxide and magnesium hydroxide has a mass of 3200 mg

This mixture is reacted with carbon dioxide to form magnesium carbonate and water.
The mass of water produced is 210 mg

$$Mg(OH)_2 + CO_2 \rightarrow MgCO_3 + H_2O$$

$$MgO + CO_2 \rightarrow MgCO_3$$

Calculate the percentage by mass of magnesium oxide in this mixture.

[4 marks]

% of magnesium oxide _____

6. June/ 2019/Paper_1/No.9

Which sample, measured at room temperature and pressure, contains the greatest number of the stated particles?

[1 mark]

A 1 g of hydrogen molecules ⬭

B 1 g of helium atoms ⬭

C 1 dm^3 of hydrogen molecules ⬭

D 1 dm^3 of helium atoms ⬭

7. June/ 2019/Paper_1/No.10

5.0 g of an oxide of molybdenum contain 4.0 g of molybdenum.

What is the empirical formula of this oxide?

[1 mark]

A MoO_2 ⬭

B Mo_4O_5 ⬭

C Mo_2O_3 ⬭

D Mo_3O_2 ⬭

8. June/ 2019/Paper_1/No.23

What is the percentage yield when 20 g of aluminium are produced from 50 g of aluminium oxide?

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

[1 mark]

A 76% ⬭

B 40% ⬭

C 33% ⬭

D 19% ⬭

9. **June/2021/Paper_1/No.6**

0 6 Calcium sulfide reacts with calcium sulfate as shown.

$$CaS + 3\,CaSO_4 \rightarrow 4\,CaO + 4\,SO_2$$

2.50 g of calcium sulfide are heated with 9.85 g of calcium sulfate until there is no further reaction.

Show that calcium sulfate is the limiting reagent in this reaction.

Calculate the mass, in g, of sulfur dioxide formed.

M_r (CaS) = 72.2
M_r ($CaSO_4$) = 136.2

[5 marks]

Mass of sulfur dioxide _____ g

10. June/2021/Paper_1/No.8

0 8 A student is provided with a 5.60 g sample of ethanoic acid (CH_3COOH) contaminated with sodium ethanoate (CH_3COONa).

The student dissolves the sample in deionised water and makes the volume up to 200 cm^3

The student removes 25.0 cm^3 samples of the solution and titrates them with 0.350 mol dm^{-3} sodium hydroxide solution.

Table 3 shows the results of these titrations.

Table 3

	Rough	**1**	**2**	**3**
Final volume / cm^3	20.85	41.10	20.50	40.80
Initial volume / cm^3	0.00	20.85	0.00	20.50
Titre / cm^3	20.85	20.25	20.50	20.30

0 8 . 1 Use the results in **Table 3** to calculate the mean titre value.

Use the mean titre to calculate the percentage by mass of sodium ethanoate in the original sample.

[6 marks]

Mean titre value _____ cm^3

Percentage by mass _____

0 8 . 2 The student rinses the burette with deionised water before filling with sodium hydroxide solution.

State and explain the effect, if any, that this rinsing will have on the value of the titre.

[2 marks]

_____

_____

_____

_____