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— **TUITION** —

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CHEMISTRY

PHYSICAL CHEMISTRY

Level & Board

AQA (A-LEVEL)

TOPIC:

AMOUNT OF SUBSTANCE

PAPER TYPE:

QUESTION PAPER - 3

TOTAL QUESTIONS

10

TOTAL MARKS

/43

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Amount of Substance - 3

1. This question is about a toxic chloroalkane, X, that has a boiling point of 40 °C.

A student carried out an experiment to determine the Mr of X by injecting a sample of X from a hypodermic syringe into a gas syringe in an oven at 97 °C and 100 kPa.

The student's results are set out in Table 1 and Table 2.

Table 1

Mass of hypodermic syringe filled with X before injection / g	10.340
Mass of hypodermic syringe with left over X after injection / g	10.070
Mass of X injected / g	

Table 2

Volume reading on gas syringe before injection of X / cm ³	0.0
Volume of X in gas syringe after injection of X / cm ³	105.0
Volume of X / cm ³	

- (a) Complete Table 1 and Table 2 by calculating the mass and volume of X.

(1)

- (b) X is known to be one of the following chloroalkanes:

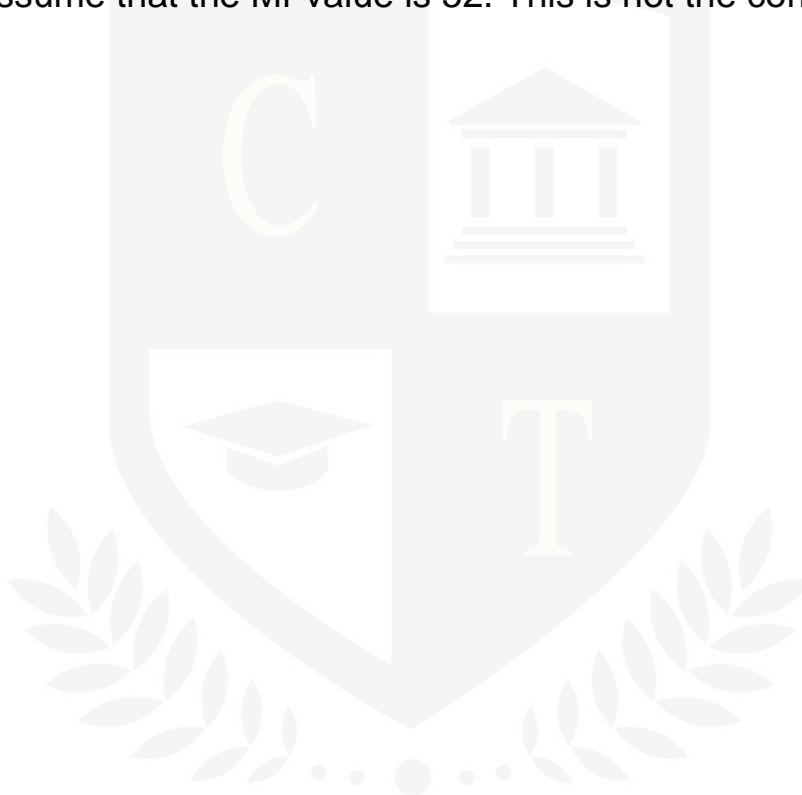
- CCl₄
- CHCl₃
- CH₂Cl₂
- CH₃Cl

Justify this statement by calculating a value for the Mr of X and use your answer to suggest the most likely identity of X from this list.

Give your answer for the Mr of X to an appropriate precision.

(The gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$)

Identity of X (If you have been unable to calculate a value for Mr, you may assume that the Mr value is 52. This is not the correct value).



(5)

(c) Suggest a reason, other than apparatus inaccuracy, why the Mr value determined from the experimental results differs from the actual Mr.

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(2)

(d) Suggest, with a reason, an appropriate safety precaution that the student should take when using the toxic chloroalkane, X, in the experiment.

(2)

2. What is the volume of $0.200 \text{ mol dm}^{-3} \text{ Ba(OH)}_2 \text{ (aq)}$ required to neutralise exactly 30.0 cm^3 of $0.100 \text{ mol dm}^{-3} \text{ HCl(aq)}$?

- A. 150.0 cm^3
- B. 75.0 cm^3
- C. 15.0 cm^3
- D. 7.50 cm^3

(1)

3. Nickel makes up 25% of the total mass of a fifty pence coin.

A fifty pence coin has mass of 8.0 g.

(a) Calculate how many moles of nickel atoms are in a fifty pence coin.

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(2)

(b) Calculate the number of atoms of nickel in a fifty pence coin.

$$L = 6.02 \times 10^{23} \text{ mol}^{-1}$$

(1)

4. The maximum errors for the pipette and the burette are shown below. These errors take into account multiple measurements.

Pipette $\pm 0.05 \text{ cm}^3$

Burette $\pm 0.15 \text{ cm}^3$

Estimate the maximum percentage error in using each of these pieces of apparatus.

Use an average titre 24.25 cm^3 to calculate the percentage error in using the burette.

(2)

5. PBr_3 can be prepared by heating bromine with phosphorus, P_4 .

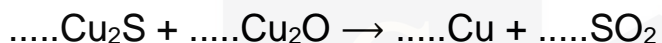
Write a balanced equation for this reaction.

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(1)

6. Copper can be produced from rock that contains CuFeS_2

(a) Balance the equations for the two stages in this process.



(2)

(b) Suggest two reasons why the sulfur dioxide by-product of this process is removed from the exhaust gases.

(2)

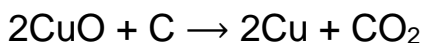
(c) A passenger jet contains 4050 kg of copper wiring. A rock sample contains 1.25% CuFeS_2 by mass.

Calculate the mass, in tonnes, of rock needed to produce enough copper wire for a passenger jet.

(1 tonne = 1000 kg)

(4)

(d) Copper can also be produced by the reaction of carbon with copper(II) oxide according to the equation



Calculate the percentage atom economy for the production of copper by this process.

Give your answer to the appropriate number of significant figures.

(2)

7. A 20.0 cm^3 sample of a $0.400 \text{ mol dm}^{-3}$ aqueous solution of a metal bromide (MBr_n) reacts exactly with 160 cm^3 of $0.100 \text{ mol dm}^{-3}$ aqueous silver nitrate.

What is the formula of the metal bromide?

- A. MBr
 B. MBr_2
 C. MBr_3
 D. MBr_4
8. An experiment was carried out to determine the relative molecular mass (M_r) of a volatile hydrocarbon X that is a liquid at room temperature.

A known mass of X was vaporised at a known temperature and pressure and the volume of the gas produced was measured in a gas syringe.

Data from this experiment are shown in the table.

Mass of X	194 mg
Temperature	373 K
Pressure	102 kPa
Volume	72 cm^3

(a) Calculate the relative molecular mass of X.

Show your working.

Give your answer to the appropriate number of significant figures.

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

(5)

(b) Analysis of a different hydrocarbon Y shows that it contains 83.7% by mass of carbon.

Calculate the empirical formula of Y.

Use this empirical formula and the relative molecular mass of Y ($M_r = 86.0$) to calculate the molecular formula of Y.

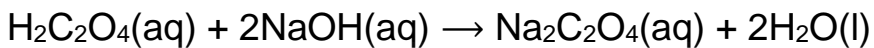
(4)

9. Ethanedioic acid ($\text{H}_2\text{C}_2\text{O}_4$) is a diprotic acid.

Beekeepers use a solution of this acid as a pesticide.

A student carried out a titration with sodium hydroxide solution to determine the mass of the acid in the solution.

The student repeated the titration until concordant titres were obtained.



(a) The student found that 25.0 cm³ of the ethanedioic acid solution reacted completely with 25.30 cm³ of 0.500 mol dm⁻³ sodium hydroxide solution.

Calculate the mass, in mg, of the acid in 25.0 cm³ of this solution.

(4)

(b) The student used a wash bottle containing deionised water when approaching the end-point to rinse the inside of the conical flask.

Explain why this improved the accuracy of the titration.

(1)

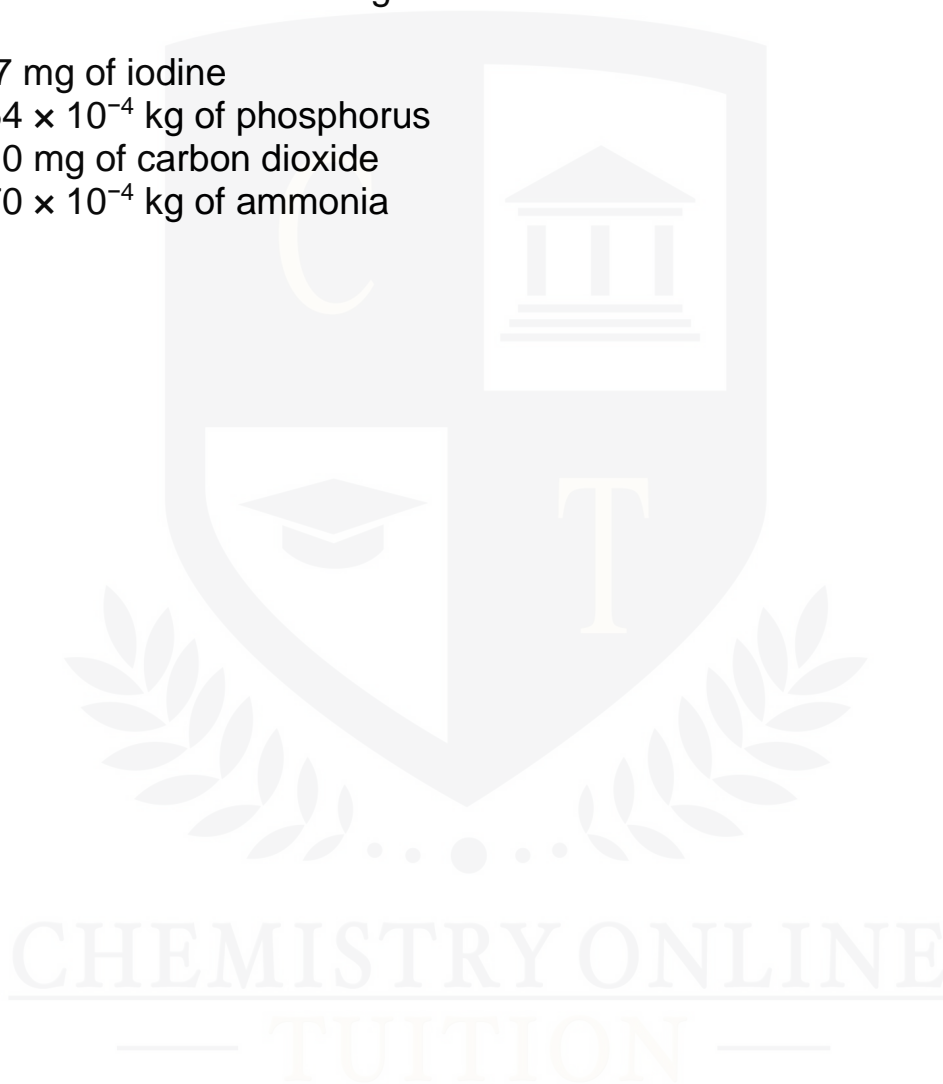
(c) Give the meaning of the term concordant titres.

(1)

10. Which of these contains the greatest number of atoms?

- A. 127 mg of iodine
- B. 1.54×10^{-4} kg of phosphorus
- C. 81.0 mg of carbon dioxide
- D. 1.70×10^{-4} kg of ammonia

(1)



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- Tutoring students in UK and worldwide since 2008
- Chemistry, Physics, and Math's Tutor

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