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CHEMISTRY

PHYSICAL CHEMISTRY

LEVEL & BOARD:	OCR (AS - LEVEL)
TOPIC:	AMOUNT OF SUBSTANCE
PAPER TYPE:	QUESTION PAPER 3
TOTAL QUESTIONS	10
TOTAL MARKS	45

Amount of Substance - 3

1. A student reacts 40.0 cm^3 of 2.50 × 10^{-2} mol dm^{-3} HCl(aq) with an excess of Mg. An equation for this reaction is shown.

$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

Calculate the mass, in g, of $MgCl_2$ formed in solution. Give your answer to three significant figures. Show your working. [4]

2. A solution of potassium bromide can be prepared by the redox reaction between potassium metal and bromine gas.

(a) A student reacts 0.0700 mol of potassium completely with bromine gas to form a solution of potassium bromide. The equation for this reaction is shown below.

$2K(s) + Br_2(g) \rightarrow 2KBr(aq)$

Calculate the volume of potassium bromide solution formed, in dm^3, at room temperature and pressure. [2]

(b) Determine the mass of KBr formed. Provide your answer to three significant figures. [2]

(c) Calculate the volume, in cm3, of 1.50 mol dm^{-3} bromine gas needed to react completely with 0.0700 mol of potassium. [2]

3. Magnesium reacts with nitric acid, $HNO_3(aq)$, as shown in the following equation:

$Mg(s) + 2HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + H_2(g)$

A student intends to react 40.0 cm^3 of 0.150 mol dm^{-3} HNO_3 with 0.180 g of magnesium (an excess).

Calculate the volume, in cm^3, of hydrogen that should be produced at RTP. [3]

4. Lithium forms compounds with oxygen, fluorine, and sulfur, resulting in ionic compounds.

(a) Lithium oxide, Li_2O, exhibits a giant ionic lattice structure.

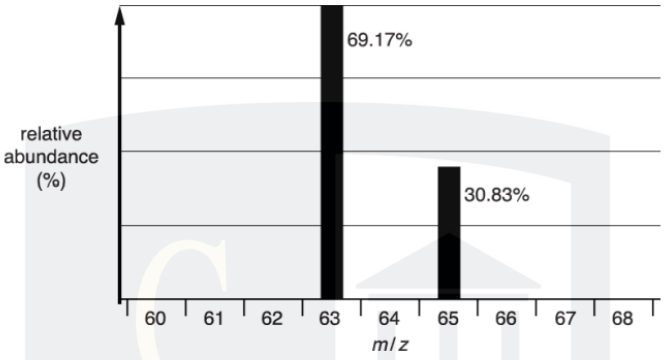
i. Provide a definition for the term 'ionic bond.' [1]

ii. Create a 'dot-and-cross' diagram illustrating the bonding in lithium oxide, representing only the outer electrons. [1]

iii. Calculate the number of lithium ions in 2.25 g of lithium oxide. Express your answer in standard form and round to three significant figures. [1]

(b) Lithium fluoride, LiF, is soluble in water. Compare the electrical conductivities of solid and aqueous lithium fluoride. Explain your answer with regard to the particles involved. [2]

5. A twenty pence coin contains copper and nickel. The copper used to make a batch of coins is analysed by mass spectrometry. The mass spectrum is shown below.



(a) Calculate the relative atomic mass of the copper used to make the coins. Give your answer to two decimal places. relative atomic. [2]

(b) One coin has a mass of 5.00 g and contains 84.0% of copper, by mass. Calculate the number of copper atoms in one coin. Give your answer in standard form and to three significant figures. [2]

6. This question looks at groups in the periodic table. Calcium and strontium are Group 2 metals. They both react with water. A chemist reacts 0.200 g of strontium with 250cm^3 water, leaving a colourless solution containing strontium ions. The volume remains at 250cm^3.

(a) Write an equation for the reaction between strontium and water. Include state symbols. [1]

(b) Calculate the concentration, in mol dm^{-3}, of strontium ions in the resulting solution. [2]

7. A student plans to carry out this experiment using 0.200 g of calcium instead of 0.200 g of strontium. Predict the difference, if any, between the volume of gas produced by calcium and strontium. Explain your reasoning and include a calculation in your answer. [3]

8. Butane, C_4H_{10}, is a highly flammable gas, used as a fuel for camping stoves.

(a) Butane reacts with oxygen as in the equation below:

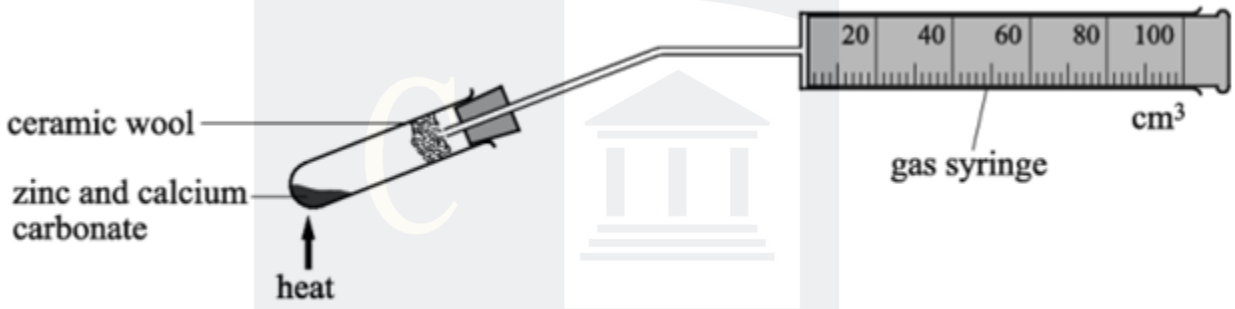
$C_4H_{10}(g) + 6.5O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$

i. The use of portable heaters in enclosed spaces can result in potential dangers if incomplete combustion takes place. Explain the potential danger of incomplete combustion. [1]

ii. A portable heater is lit to heat a room. The heater burns 600 g of butane and consumes 1.50 m^3 of O_2, measured at room temperature and pressure. Determine whether this portable heater is safe to use. Show all your working. [3]

(b) Alkane X can be used as a fuel. Complete combustion of 0.0117 mol of X produces 2.00×10^{-3} m^3 of carbon dioxide gas, measured at 24.0 °C and 101 kPa. Determine the molecular formula of X. Show all your working. [4]

9. A student carried out the reaction of zinc (Zn) and calcium carbonate ($CaCO_3$) in a fume cupboard. The student measured the volume of gas produced.



A mixture containing 0.27 g of powdered zinc and 0.38 g of powdered $CaCO_3$ was heated strongly for two minutes. The volume of gas collected in the 100 cm^3 syringe was then measured. The experiment was then repeated.

(a) Calculate the maximum volume of carbon monoxide, measured at room temperature and pressure, that could be produced by heating this mixture of Zn and $CaCO_3$. Show all your working. [2]

(b) The student did not obtain the volume of gas predicted in **(a)** using this procedure Apart from further repeats, suggest two improvements to the practical procedure that would allow the student to obtain a more accurate result. [2]

10. Europium, atomic number 63, reacts with oxygen at room temperature.

$4Eu + 3O_2 \rightarrow 2Eu_2O_3$

(a) Calculate the volume of oxygen, in cm^3, required to fully react with 9.12 g of europium at room temperature and pressure. [2]

(b) A compound of thulium, atomic number 69, has the following composition by mass:
O 30.7% S 15.4% Tm 53.9%

i. State what is meant by the term empirical formula. [1]

ii. Determine the empirical formula of the compound. Show your working. [2]

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