IGCSE · Cambridge (CIE) · Chemistry

16 mins 16 questions

Multiple Choice Questions

# The Mole & the Avogadro Constant

The Mole / Linking Moles, Mass & Mr / Reacting Masses / Calculating Concentration / Titration Calculations / Empirical & Molecular Formula / Percentage Yield & Purity

| | |
|---|---|
| Easy (5 questions) | /5 |
| Medium (6 questions) | /6 |
| Hard (5 questions) | /5 |
| **Total Marks** | **/16** |

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# Easy Questions

## 1 Extended Only

Which row correctly describes the mole and the value of Avogadro's constant?

| | one mole of a substance is equal to | one mole of a substance contains |
|---|---|---|
| **A** | the substances relative atomic or molecular mass in grams | $6.02 \times 10^{23}$ atoms, molecules or formula units |
| **B** | the substances atomic number in grams | $6.02 \times 10^{23}$ atoms, molecules or formula units |
| **C** | the substances relative atomic or molecular mass in grams | $12.04 \times 10^{23}$ atoms, molecules or formula units |
| **D** | the substances atomic number in grams | $12.04 \times 10^{23}$ atoms, molecules or formula units |

**(1 mark)**

## 2 Extended Only

The complete combustion of methane produces carbon dioxide and steam.

$$CH_4(g) + 2\ O_2(g) \rightarrow 2\ H_2O(g) + CO_2(g)$$

Which statements are about the reaction correct?

| | |
|---|---|
| **1** | The empirical formula of methane is $CH_4$ |
| **2** | The number of atoms in 1 mole of methane is 4 x Avogadro's constant |
| **3** | 1 mole of methane produces 72 $dm^3$ of gaseous products at r.t.p |
| **4** | 1 mole of methane occupies a volume of 12 $dm^3$ at r.t.p |

**A.** 1, 2 and 3

**B.** 1 and 2

**C.** 1 and 3

**D.** 2 and 4

**(1 mark)**

## 3 Extended Only

Magnesium carbonate and hydrochloric acid react to produce salt, water and carbon dioxide.

$$MgCO_3\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2O\ (l) + CO_2\ (g)$$

What is the volume of $CO_2$ produced when 21 g of magnesium carbonate ($M_r$ = 84) reacts completely with excess hydrochloric acid?

One mole of gas occupies 24.0 $dm^3$ at room temperature and pressure.

**A.** 4 $dm^3$

**B.** 8 $dm^3$

**C.** 6 $dm^3$

**D.** 2 $dm^3$

**(1 mark)**

## 4 Extended Only

Calcium carbonate undergoes thermal decomposition at high temperatures to form calcium oxide and carbon dioxide.

$$CaCO_3 \rightarrow CaO + CO_2$$

What mass of calcium oxide ($M_r$ = 56) is formed when 60 g of calcium carbonate ($M_r$ = 100) is completely decomposed?

**A.** 28 g

**B.** 18.5 g

**C.** 60 g

**D.** 33.6 g

**(1 mark)**

## 5 Separate: Chemistry and Extended Only

Substance **X** was analysed and found to contain 40.00% carbon, 6.67% hydrogen and 53.33% oxygen by mass.

What is the empirical formula of **X**?

**A.** $C_4H_8O_4$

**B.** $C_6H_{12}O_8$

**C.** $C_2H_4O_2$

**D.** $CH_2O$

**(1 mark)**

# Medium Questions

## 1 Separate: Chemistry and Extended Only

What is the concentration in mol $dm^{-3}$ of a solution of sodium hydroxide that contains 16 g of NaOH in 200 $cm^3$ of distilled water?

**A.** 2 mol $dm^{-3}$

**B.** 2.5 mol $cm^{-3}$

**C.** 0.2 mol $dm^{-3}$

**D.** 1 mol $cm^{-3}$

**(1 mark)**

## 2 Separate: Chemistry and Extended Only

A student was given a sample of hydrochloric acid and asked to find its concentration in mol / $dm^3$. She titrated 25 $cm^3$ of the acid against a standard solution of sodium hydroxide of 0.1 mol $dm^{-3}$. The average titre of sodium hydroxide was 30 $cm^3$.

What is the concentration of the acid?

**A.** 0.50 mol $dm^{-3}$

**B.** 0.12 mol $dm^{-3}$

**C.** 1.25 mol $dm^{-3}$

**D.** 1.0 mol $dm^{-3}$

**(1 mark)**

## 3 Separate: Chemistry and Extended Only

A substance was analysed and found to contain 26.57 % potassium, 35.36 % chromium, and 38.07 % oxygen by mass.

What is the empirical formula of the substance?

**A.** $KCr_2O_7$

**B.** $K_2CrO_7$

**C.** $K_2Cr_2O_5$

**D.** $K_2Cr_2O_7$

**(1 mark)**

## 4 Separate: Chemistry and Extended Only

Substance X was analysed and found to contain 40.00 % carbon, 6.67 % hydrogen and 53.33 % oxygen by mass. The compound has a relative molecular mass of 60.0 g $mol^{-1}$.

What is the molecular formula of X?

**A.** $C_4H_8O_4$

**B.** $C_6H_{12}O_8$

**C.** $C_2H_4O_2$

**D.** $CH_2O$

**(1 mark)**

## 5 Separate: Chemistry and Extended Only

A student thermally decomposes 24.8 g of copper carbonate and obtains 11.2 g of copper(II) oxide and carbon dioxide gas which is released.

$$CuCO_3 \rightarrow CuO + CO_2$$

What is the percentage yield of CuO?

**A.** 55 %

**B.** 70 %

**C.** 82 %

**D.** 90 %

**(1 mark)**

## 6 Separate: Chemistry and Extended Only

A sample of chalk (limestone) with a mass of 1.70 g was reacted with excess HCl and the amount of carbon dioxide given off was measured using a gas syringe. 0.36 $dm^3$ of $CO_2$ gas was collected at r.t.p.

$$CaCO_3 + 2\ HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

What is the percentage purity of the chalk?

**A.** 75 %

**B.** 88 %

**C.** 90 %

**D.** 98 %

**(1 mark)**

# Hard Questions

## 1 Extended Only

Calcium carbide and water react to produce ethyne and calcium hydroxide.

$$CaC_2\,(s) + 2H_2O\,(l) \rightarrow C_2H_2\,(g) + Ca(OH)_2\,(s)$$

What is the volume of $C_2H_2$ produced, at standard temperature and pressure, when 45 g of water reacts completely with calcium carbide?

**A.** 72 $dm^3$

**B.** 30 $dm^3$

**C.** 24 $dm^3$

**D.** 6 $dm^3$

**(1 mark)**

## 2 Extended Only

Aluminium and oxygen react to produce aluminium oxide.

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

How many kilograms of aluminium oxide are formed when 5.4 kg of aluminium react with excess oxygen?

**A.** 5.4 kg

**B.** 88 kg

**C.** 10.2 kg

**D.** 33.6 kg

**(1 mark)**

## 3 Extended Only

Magnesium nitride and water react to produce a precipitate of magnesium hydroxide and ammonia gas.

$$Mg_3N_2 + 6\ H_2O \rightarrow 3\ Mg(OH)_2 + 2\ NH_3$$

How much magnesium nitride is needed to produce 87 g of the precipitate in excess water?

**A.** 24 g

**B.** 50 g

**C.** 30 g

**D.** 12 g

**(1 mark)**

## 4 Separate: Chemistry and Extended Only

A student was asked to find the concentration in g / $dm^3$ of a solution of sulfuric acid. She transferred 25 $cm^3$ of the acid to a 250 $cm^3$ volumetric flask and made it up to the mark. She titrated 25 $cm^3$ of the diluted acid against a standard solution of sodium hydroxide of 0.1 mol $dm^{-3}$. The average titre of sodium hydroxide was 18 $cm^3$.

What is the concentration of the original acid in grams per decimetre?

**A.** 9.85 g $dm^{-3}$

**B.** 12.25 g $dm^{-3}$

**C.** 98 g $dm^{-3}$

**D.** 35.28 g $dm^{-3}$

**(1 mark)**

## 5 Extended Only

A chemist reacted 0.6 g of magnesium with 0.6 $dm^3$ of oxygen in a sealed container to produce magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

Which row correctly describes the limiting reactant?

| | **limiting reactant** | **reason** |
|---|---|---|
| **A** | Mg | in excess |
| **B** | Mg | is used up first |
| **C** | $O_2$ | is used up first |
| **D** | $O_2$ | in excess |

**(1 mark)**