06-07 Formulae, Equations and the Mole

Set B **Answer key**

A Multiple choice

9 MARKS

1 **D** $60\ dm^3$ [1]

2 mol $NaHCO_3$ give 1 mol CO_2, so 5.0 mol give 2.5 mol. Volume = 2.5 × 24 = 60 dm^3.

2 **C** RuO_2 [1]

Mass of Ru = 5.79 − 1.39 = 4.40 g. Moles: Ru = $\frac{4.40}{101}$ = 0.0436, O = $\frac{1.39}{16}$ = 0.0869. The ratio is 1 : 2.

3 **C** 1.00 dm^3 of 0.10 mol/dm^3 potassium hydroxide, KOH [1]

A: 0.100 mol × 40 = 4.0 g. B: 0.025 mol × 98 = 2.45 g. C: 0.10 mol × 56 = 5.6 g. D: 0.02 mol × 36.5 = 0.73 g.

4 **C** $45\ cm^3$ [1]

15 cm^3 of N_2 reacts with 45 cm^3 of H_2, so nitrogen is limiting and 15 cm^3 of H_2 is left. 30 cm^3 of NH_3 forms. Total = 15 + 30 = 45 cm^3.

5 **A** 0.5 mole of oxygen unreacted. [1]

3 mol of CO needs only 1.5 mol of O_2, so 0.5 mol of O_2 is left and 3 mol of CO_2 forms.

6 **C** 0.56 mol/dm^3 [1]

$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$. Moles of $Ca(OH)_2$ = 0.2 × 0.0264 = 0.00528 mol, so moles of HCl = 0.01056 mol. Concentration = $\frac{0.01056}{0.0190}$ = 0.56 mol/dm^3.

7 **A** 0.050 mol/dm^3 [1]

Moles of K^+ = 0.100 × 0.0200 = 0.00200 mol, now in 40.0 cm^3 of solution. Concentration = $\frac{0.00200}{0.0400}$ = 0.050 mol/dm^3.

8 **A** 25% [1]

Moles of CO_2 = $\frac{3.0}{24}$ = 0.125 mol = moles of Na_2CO_3. Mass = 0.125 × 106 = 13.25 g. Purity = $\frac{13.25}{53}$ × 100% = 25%.

9 **C** 90.0% [1]

Moles of SO_2 = $\frac{43.2}{24}$ = 1.80 mol = moles of ZnS. Mass of ZnS = 1.80 × 97 = 174.6 g. Purity = $\frac{174.6}{194}$ × 100% = 90.0%.

B Structured questions

20 MARKS

10 **(a)** $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ [2]

(b)

Volume ratio $CH_4 : O_2 = 1 : 2$. [1]

20 cm^3 of CH_4 needs 40 cm^3 of O_2, which is less than the 60 cm^3 of O_2 available. [1]

O_2 is in excess, so CH_4 is the limiting reagent. [1]

(c)

Volume of CO_2 produced = 20.0 cm^3 (ratio $CH_4 : CO_2 = 1 : 1$) [1]

Volume of O_2 remaining = 60 − 40 = 20.0 cm^3, so total = 20 + 20 = 40.0 cm^3 [1]

(d) 0.7 × 20 cm^3 = 14.0 cm^3 [1]

11 $2HNO_3 + Mg \rightarrow Mg(NO_3)_2 + H_2$. Moles of nitric acid = 0.030 × 0.80 = 0.024 mol, moles of Mg = $\frac{10}{24}$ = 0.41667 mol [1]

0.024 mol of nitric acid reacts with only 0.012 mol of Mg, so Mg is in excess and nitric acid is the limiting reagent. [1]

Moles of $Mg(NO_3)_2$ = 0.012 mol, so mass = 0.012 × 148 = 1.78 g [1]

12 **(a)** $NaH + H_2O \rightarrow NaOH + H_2$ [1]

(b)

Moles of NaH = $\frac{0.24}{24}$ = 0.01 mol and moles of H_2O = $\frac{1.8}{18}$ = 0.1 mol [1]

1 mol of NaH reacts with 1 mol of H_2O, so NaH is the limiting reactant. [1]

Moles of NaOH formed = 0.01 mol [1]

13 **(a)(i)** $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$ [1]

(ii)

Moles of HCl = 0.0276 × 0.220 = 0.006072 mol, so moles of $Mg(OH)_2$ = 0.006072 ÷ 2 = 0.003036 mol **[1]**

Concentration = $\frac{0.003036}{0.0250}$ = 0.121 mol/dm^3 **[1]**

(b)

0.12144 × (24 + 2 × 16 + 2 × 1) = 7.04 g **[1]**

(c)

1 dm^3 of water dissolves 7.04 g, so volume = $\frac{10.0}{7.0435}$ = 1.42 dm^3 **[1]**