O Level Combined Chemistry Structured

The Mole Concept and Stoichiometry Test 1.0

Q1

Chromium, Cr, is extracted from a mineral called chromite, $FeCr_2O_4$.

(a) (i) Calculate the relative molecular mass of chromite.

[1]

(ii) Calculate the percentage by mass of chromium in chromite.

[1]

(b) In industry, chromite is changed into chromium(III) oxide, Cr_2O_3. Metallic chromium is formed by heating this oxide in hydrogen gas. The balanced chemical equation for this reaction is

$$Cr_2O_3 + 3H_2 \rightarrow 2Cr + 3H_2O$$

Calculate the mass of chromium that could be formed from 76 g of chromium(III) oxide.

[2]

Q2

The equation below shows the salts formed from the reaction between lead(II) nitrate and zinc sulfate.

$$Pb(NO_3)_2 + ZnSO_4 \rightarrow PbSO_4 + Zn(NO_3)_2$$

A student wanted to prepare one of the two products in the above reaction in the laboratory. He was told that only the following reagents are available for use.

dilute nitric acid	lead(II) hydroxide powder	aqueous lead(II) nitrate
dilute sulfuric acid	aqueous zinc chloride	zinc carbonate powder

(a) What volume (in cm^3) of 0.100 mol/dm^3 of lead(II) nitrate solution is required to react completely with a solution containing 0.0250 mol of zinc sulfate to produce the salts above?

volume of lead(II) nitrate ..... cm^3
[2]

Q3

(a) A solution of potassium hydroxide, KOH, has a concentration of 0.35 mol/dm^3. 25 cm^3 of KOH was reacted with excess ammonium sulfate as shown in the equation below.

$$2KOH + (NH_4)_2SO_4 \longrightarrow K_2SO_4 + 2NH_3 + 2H_2O$$

Calculate the mass of potassium sulfate formed.

[2]

(b) Another solution of potassium hydroxide was prepared by dissolving 29.5 g of potassium hydroxide in 5 dm^3 of distilled water.

Determine the concentration of the solution in mol/dm^3.

[2]

Q4

Magnesium chloride, $MgCl_2$, is present in seawater at a concentration of 1.26 g/dm^3.

(i) Write the formulae for the ions present in magnesium chloride.

.....[1]

(b) (ii) Calculate the number of moles of chloride ions arising from the magnesium chloride in 1 dm^3 of seawater.

number of moles of Cl^- ions = ... mol [2]

(c) The concentration of sulfate ions in seawater is 1.24 g/dm^3. Excess aqueous barium chloride is added to a 1 dm^3 sample of seawater.

Calculate the mass of barium sulfate precipitated in this reaction.

mass = ... g [2]

Q5

The equation shows the decomposition of ammonium nitrite, NH_4NO_2, when heated gently.

$$NH_4NO_2(aq) \rightarrow N_2(g) + 2H_2O(g)$$

(a) A sample of 25.0 cm^3 of 0.500 mol/dm^3 aqueous ammonium nitrite is heated.

Calculate the volume of nitrogen formed in dm^3 at room temperature and pressure.

volume of nitrogen = ...dm^3 [2]

(b) Name the apparatus that is used to measure the volume of the gas produced.

.....[1]

Answers

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Q1

4ai	M_r of $FeCr_2O_4$ = 56 + 2(52) + 4(16) = 224
ii	Percentage of Cr in $FeCr_2O_4$ = 2(52) □224 x 100 = 46.4 %
b	No of moles of Cr_2O_3 = 76 □[2(52) + 3(16)] = 0.5 mol From eqn, 1 mole Cr_2O_3 produces 2 moles Cr 0.5 mole Cr_2O_3 produces 1 mole Cr Mass of chromium produced = 1 x 52g =52g

Q2

(a) Mole ratio $Pb(NO_3)_2$: $ZnSO_4$ is 1:1 Hence, the number of moles of $Pb(NO_3)_2$ is <u>0.0250 mol</u>. [1] Volume of $Pb(NO_3)_2$. = 0.0250 / 0.1 = 0.25 dm^3 = <u>250 cm^3</u> [1]	1m: 0.0250 mol of $Pb(NO_3)_2$; can be embedded within calculation 1m: Vol. of $Pb(NO_3)_2$ = 250 cm^3

Q3

(a)	No. of moles of KOH = 0.35 x (25/1000) = 0.00875 mol Mole ratio of KOH : K_2SO_4 = 2 : 1 Thus, no. of mole of K_2SO_4 = 0.004375 mol Mass of K_2SO_4 = 0.004375 x (2(39) + 32 + 4(16)) = 0.76125 g	[1] [1]
(b)	No. of moles of KOH = 29.5 / (39+16+1) = 0.5267857143 mol (leave to 5 d.p.) Concentration = 0.52679 / 5 = 0.1053571429 mol/dm^3 ≈ 0.105 mol / dm^3	[1] [1]

Q4

(b)(i)	Mg^{2+} and Cl^-	[1]
(b)(ii)	Number of moles of magnesium ions = 1.26 ÷ (24 + 71) = 0.013263 mol Number of moles of chloride ions = 0.013263 x 2 = 0.0265 mol (3s.f)	[1] [1]
2(c)	Number of moles of SO_4^{2-} =1.24 ÷ 96 = 0.012917 mol Mass of $BaSO_4$ precipitated = 0.012917 × 233 = 3.01 g (3s.f)	[1] [1]

Q5

(a)	Moles of NH_4NO_2 = 0.025 × 0.500 = 0.0125 mol Volume of N_2 = 0.0125 x 24 dm^3 = 0.3 dm^3	[1] [1]
(b)	Gas syringe	[1]