S4 Chemistry Practice Paper: Mole Concept and Stoichiometry, Solution Concentration and Dilution, Acid-Base Titration, Redox and Electron Transfer, Electrolysis and Faraday Law, Reaction Rate

Level: S4 | Subject: Chemistry | 75 minutes | 100 marks | 24 questions | question paper

Section A: Mole Concept and Stoichiometry (18 marks)

Show all working. Relative atomic masses: Mg 24.0, Ca 40.0, C 12.0, O 16.0, H 1.0, S 32.1, Zn 65.4, Cu 63.5, Ag 108.0; molar volume at room conditions = 24.0 dm3/mol.

#	Question	Marks
1	4.8 g of magnesium reacts with excess dilute hydrochloric acid: Mg + 2HCl -> MgCl2 + H2. Find (a) the number of moles of magnesium, (b) the volume of hydrogen at room conditions, (c) the mass of magnesium chloride formed (Mr = 95.0).	5
2	25.0 g of calcium carbonate is completely decomposed by heating: CaCO3 -> CaO + CO2. Find the number of moles of calcium carbonate and the volume of carbon dioxide released at room conditions.	4
3	A compound contains 40.0% carbon, 6.70% hydrogen and 53.3% oxygen by mass, and has a relative molecular mass of 60. Find its empirical and molecular formulae.	4
4	0.50 mol of zinc is heated with 0.40 mol of sulphur: Zn + S -> ZnS. Find (a) the limiting reagent, (b) the mass of zinc sulphide formed (Mr = 97.5), (c) the mass of the reactant left over.	5

Section B: Solution Concentration and Dilution (17 marks)

Concentrations are in mol/dm3; 1 dm3 = 1000 cm3; the number of moles of solute is unchanged on dilution.

#	Question	Marks
5	5.85 g of sodium chloride (Mr = 58.5) is dissolved in water and made up to 250 cm3 of solution. Find the concentration.	4
6	25.0 cm3 of 2.0 mol/dm3 sulphuric acid is diluted to a total volume of 500 cm3. Find the new concentration and state what happens to the number of moles of solute.	5
7	How many grams of anhydrous sodium carbonate (Mr = 106) are needed to prepare 0.250 dm3 of 0.20 mol/dm3 solution?	4
8	200 cm3 of 0.50 mol/dm3 solution is mixed with 300 cm3 of 0.20 mol/dm3 of the same solute (assume volumes are additive). Find the final concentration.	4

Section C: Acid-Base Neutralisation and Titration (17 marks)

Acid-base reactions follow the stoichiometric ratio; pH + pOH = 14 at 25 C; take the specific heat capacity of water as 4.2 J g-1 K-1 and its density as 1.0 g/cm3.

#	Question	Marks
9	25.0 cm3 of sodium hydroxide solution needs 20.0 cm3 of 0.10 mol/dm3 hydrochloric acid to reach the end point. Find the concentration of the sodium hydroxide solution.	5

10	Find (a) the pH of 0.010 mol/dm3 hydrochloric acid; (b) the pH of 0.0010 mol/dm3 sodium hydroxide solution at 25 C.	4
11	25.0 cm3 of sulphuric acid needs 30.0 cm3 of 0.20 mol/dm3 sodium hydroxide for neutralisation: H2SO4 + 2NaOH -> Na2SO4 + 2H2O. Find the acid concentration.	4
12	50 cm3 of 1.0 mol/dm3 hydrochloric acid is mixed with 50 cm3 of 1.0 mol/dm3 sodium hydroxide and the temperature rises by 6.7 C. Find the enthalpy change of neutralisation in kJ/mol and state the sign of dH.	4

Section D: Redox and Electron Transfer (16 marks)

Use changes in oxidation number to identify redox; the reduction half-equation of permanganate in acid is MnO4- + 8H+ + 5e- -> Mn2+ + 4H2O.

#	Question	Marks
13	In acidic solution MnO4- is reduced to Mn2+. Find (a) the number of electrons gained per MnO4- ion, (b) the number of moles of Fe2+ oxidised by 1 mol of MnO4-.	4
14	25.0 cm3 of iron(II) sulphate solution needs 20.0 cm3 of 0.020 mol/dm3 potassium permanganate to reach the end point. Find the concentration of Fe2+.	4
15	Find the oxidation number of the stated element: (a) Cr in K2Cr2O7, (b) Mn in MnO2, (c) N in NO3-.	4
16	1.3 g of zinc is placed in copper(II) sulphate solution: Zn + Cu2+ -> Zn2+ + Cu. Find (a) the oxidising and reducing agents, (b) the moles of electrons transferred, (c) the mass of copper deposited.	4

Section E: Electrolysis and Faraday Law (16 marks)

Charge Q = It with the Faraday constant taken as 96500 C/mol; electrolysis of copper(II) sulphate deposits copper at the cathode and gives oxygen at the anode.

#	Question	Marks
17	A current of 2.0 A passes through copper(II) sulphate solution for 30 minutes. Find the charge passed and the mass of copper deposited at the cathode (Ar Cu = 63.5).	5
18	On electrolysing water, hydrogen forms at the cathode and oxygen at the anode: 2H2O -> 2H2 + O2. If 0.50 mol of hydrogen is collected at the cathode, find the moles of oxygen and the volume ratio.	4
19	In a zinc-copper cell, state (a) the metal at the negative electrode, (b) the direction of electron flow, (c) the type of reaction at the cathode.	3
20	Silver is electroplated with a current of 1.0 A. Find the charge and the time in minutes needed to deposit 1.08 g of silver (Ar Ag = 108).	4

Section F: Reaction Rate (16 marks)

Rate is expressed as the amount of reactant used or product formed per unit time; change only one variable in a comparison experiment.

#	Question	Marks
21	Zinc reacts with dilute sulphuric acid and the volume of hydrogen is read every 30 s by water displacement; 48 cm3 is collected in the first 60 s. Find the average rate over the first 60 s in cm3/s.	4

22	A reaction has the rate equation rate = k[A]. At constant temperature [A] is doubled. State the change in rate and whether the rate constant k changes.	4
23	A catalyst lowers the activation energy of a reaction from 80 kJ/mol to 60 kJ/mol. Explain why the rate increases and state whether dH changes.	4
24	The temperature of a reaction is raised from 20 C to 50 C. If the rate roughly doubles for every 10 C rise, find the approximate rate factor and explain why.	4