S4 Chemistry Practice Paper (Set 2): Redox Reactions, Electrochemical Cells and Electrolysis, Reaction Rates, Chemical Equilibrium, Acid-Base Titration Calculations, Basic Organic Chemistry

S4 | Chemistry | Time: 75 minutes | Total: 100 marks | 24 questions

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Part 1 Redox Reactions

Show all working and state the oxidising and reducing agents.

1. Find the oxidation number of chromium in K2Cr2O7 and of manganese in KMnO4, and state which of the two oxyanions acts as the oxidising agent in acidic solution. [4]

2. In acidic solution MnO4(-) oxidises Fe(2+) to Fe(3+) and is itself reduced to Mn(2+). Write the balanced ionic equation and find how many moles of Fe(2+) are oxidised by 0.0200 mol of MnO4(-). [4]

3. When ClO3(-) is reduced to Cl(-), find the change in oxidation number of chlorine and the number of electrons transferred per ClO3(-) ion. [4]

4. 0.850 mol of hydrogen peroxide decomposes into water and oxygen with a catalyst. Write the equation, find the moles of oxygen formed, and explain why H2O2 is both oxidised and reduced. [4]

Part 2 Electrochemical Cells and Electrolysis

Use standard electrode potentials (Zn: -0.76 V, Cu: +0.34 V, Ag: +0.80 V).

5. A Daniell cell is made from zinc and copper electrodes in their own ion solutions. Find the cell emf, write both electrode reactions, and calculate the standard Gibbs energy change per mole of reaction (F = 96500 C/mol). [5]

6. A current of 2.50 A passes through copper(II) sulphate solution for 30 minutes. Find the charge passed and the mass of copper deposited at the cathode (Cu = 63.5). [4]

7. In a silver plating experiment the cathode gains 1.080 g (Ag = 108.0). Find the moles of electrons, the charge required, and the time in seconds at 1.50 A. [4]

8. Dilute sulphuric acid is electrolysed with platinum electrodes and 0.0200 mol of electrons passes. Write both electrode reactions and find the gas volumes at the anode and cathode (molar volume 24.0 dm3/mol). [4]

Part 3 Reaction Rates

Give all rates in mol/s or mol dm-3 s-1 to three significant figures.

9. A reaction produces 0.500 mol of gas in 40 seconds. Find the average rate of formation and state how the rate usually changes when the temperature is raised by 10 degrees. [4]

10. At 20 degrees a reaction has a rate of 0.0125 mol/s, and the rate doubles for every 10 degree rise. Find the rate at 50 degrees and explain why. [4]

11. A reaction has the rate equation rate = k[A][B]^2 with k = 0.250. When [A] = 0.200 mol dm-3 and [B] = 0.100 mol dm-3, find the initial rate; if only [B] is doubled, by what factor does the rate change? [5]

12. 50 cm3 of 0.200 M hydrochloric acid is added to excess magnesium ribbon and the reaction finishes in 25 seconds. Find the moles of acid, the average rate in mol/s, and how the rate changes with time. [4]

Part 4 Chemical Equilibrium

All volumes are 1.00 dm3 and the temperature is constant.

13. At equilibrium the reaction H2(g) + I2(g) -> 2HI(g) has 0.200 mol H2, 0.200 mol I2 and 1.600 mol HI in the vessel. Find Kc and write its expression. [4]

14. At the same temperature Kc = 64.0. At one moment [H2] = 0.500 M, [I2] = 0.500 M and [HI] = 1.000 M. Find the reaction quotient Qc and state the direction of the net reaction. [5]

15. For PCl5(g) -> PCl3(g) + Cl2(g) the value of Kc is 0.0400. Starting with 2.00 mol PCl5 and no products, find the moles of Cl2 at equilibrium to three significant figures. [4]

16. For 2SO2(g) + O2(g) -> 2SO3(g), Kc is 1600 at 700 K and 40 at 800 K. Deduce whether the forward reaction is exothermic, and state the effect of raising the pressure on the SO3 yield. [4]

Part 5 Acid-Base Titration Calculations

Assume strong acids and bases are fully ionised; give answers to three significant figures.

17. 25 cm3 of 0.100 M sodium hydroxide is neutralised by 0.125 M hydrochloric acid. Find the volume of acid needed in cm3. [4]

18. Find the pH of 0.0100 M hydrochloric acid and 0.0100 M sulphuric acid (treat the acid as fully ionised) and explain the difference. [4]

19. A weak monobasic acid HA of concentration 0.100 M has pH = 2.90. Find [H(+)], Ka and the percentage ionisation, and explain why it cannot be treated as a strong acid. [5]

20. 20 cm3 of 0.050 M oxalic acid (H2C2O4, a dibasic acid) is titrated with 0.100 M sodium hydroxide. Find the volume of alkali needed for complete neutralisation and write the equation. [4]

Part 6 Basic Organic Chemistry

Show all working and give answers to three significant figures.

21. An organic compound contains 40.0% carbon, 6.67% hydrogen and 53.33% oxygen by mass, and has a relative molecular mass of 180. Find its empirical and molecular formulae. [4]

22. 0.050 mol of propene (C3H6) is burned completely. Find the moles of carbon dioxide formed and its volume at room conditions (molar volume 24.0 dm3/mol). [4]

23. 0.050 mol of an alkene decolourises bromine water completely. Find the moles and mass of bromine needed (Br = 80.0) and name the reaction type. [4]

24. 0.150 mol of ethanoic acid is esterified with excess ethanol; the relative molecular mass of ethyl ethanoate is 88.0. The experiment gives 9.68 g. Find the theoretical yield and the percentage yield. [4]
