

CBSE EXAMINATION PAPER-2022

CHEMISTRY

(Solved)

Time allowed : 3 hours

Maximum Marks : 12

General Instructions :

Read the following instructions carefully and follow them :

- i. This question paper contains **5 questions**. All questions are **compulsory**.
- ii. This question paper is divided into **2 sections**.
- iii. **Section A** – questions number **1 to 4** are short answer Each question carries **3 marks**.
- iv. **Section B** – questions number **5 to 5** are case based questions
- v. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.
- vi. Use of calculator is NOT allowed.

Section A

Question 1.

Calculate $\Delta_r G^\circ$ and $\log K_e$ for the following cell:



Given that $E^\circ_{\text{cell}} = 1.05\text{V}$, $F = 96,500 \text{ C mol}^{-1}$

[3 Marks]

Answer: The cell reaction is: $\text{Ni(s)} + 2\text{Ag}^+(\text{aq}) \rightarrow \text{Ni}^{2+}(\text{aq}) + 2\text{Ag(s)}$. Given data: Standard cell potential, $E^\circ_{\text{cell}} = 1.05 \text{ V}$; Faraday's constant, $F = 96,500 \text{ C mol}^{-1}$; Number of electrons transferred, $n = 2$ (because Ni goes from 0 to +2 and 2Ag^+ gain 2 electrons).

(a) Calculate $\Delta_r G^\circ$:

Use the formula $\Delta rG^\circ = -n F E^\circ_{\text{cell}}$

$$\Delta rG^\circ = -2 * 96,500 * 1.05 = -202,650 \text{ J mol}^{-1} = -202.65 \text{ kJ mol}^{-1}$$

(b) Calculate $\log K_e$:

Use the relation $\Delta rG^\circ = -R T \ln K_e$, where $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$, $T = 298 \text{ K}$.

$$\ln K_e = -\Delta rG^\circ / (R T) = 202,650 / (8.314 * 298) = 202,650 / 2477.572 \approx 81.74$$

$$\text{Therefore, } \log K_e = \ln K_e / 2.303 = 81.74 / 2.303 \approx 35.5$$

Final answers:

$$\Delta rG^\circ = -202.65 \text{ kJ mol}^{-1}, \log K_e = 35.5.$$

This shows the reaction is spontaneous and favors product formation at standard conditions.

Question 2.

Calculate the e.m.f. of the following cell at 298K:



Given that $E^\circ_{\text{cell}} = +0.44 \text{ V}$

$$[\log 2=0.3010 \log 3 =0.4771 \log 10=1]$$

[3 Marks]

Answer: To calculate the e.m.f. of the given cell, we can use the Nernst equation, which is: $E = E^\circ - (RT/nF) \ln Q$. Here, $E^\circ = 0.44 \text{ V}$ and $T = 298 \text{ K}$. The standard conditions give us $R = 8.314 \text{ J}/(\text{mol}\cdot\text{K})$ and $F = 96500 \text{ C/mol}$. For the cell reaction: $\text{Fe(s)} \rightarrow \text{Fe}^{2+}(0.001 \text{ M}) + 2e^-$, $n = 2$. First, calculate $Q = [\text{Fe}^{2+}]/[\text{H}^+]^2 = 0.001/(0.01)^2 = 0.01$. Substituting E° , Q , R , T , and n into the Nernst equation: $E = 0.44 - (8.314 \times 298)/(2 \times 96500) \ln(0.01)$. Calculating: $E = 0.44 - 0.00412 \times 4.605 = 0.44 - 0.01896 \approx 0.421 \text{ V}$. Thus, the e.m.f. of the cell at 298 K is approximately 0.421 V.

Question 3.

Define transition metals. Why Zn, Cd and Hg are not called transition metals? How is the variability in oxidation states of transition metals different from that of p-block elements?

[3 Marks]

Answer: Transition metals are defined by IUPAC as metallic elements with an incomplete d subshell in either their neutral state or in their ions. These metals exhibit multiple oxidation states, paramagnetism, and the ability to form colored ions. Examples of transition metals include iron, copper, and nickel. However, zinc (Zn), cadmium (Cd), and mercury (Hg) possess a d^{10} electron configuration in their ground and common oxidation states, meaning they have fully filled d orbitals. Thus, they do not exhibit the variability in oxidation states typically associated with transition metals. Instead, their oxidation states are more stable and generally lower than that of transition metals. Moreover, the oxidation state

variability of transition metals differs from that of p-block elements where oxidation states typically change by increments of two, due to the differing electron configurations; transition metals change by one unit owing to their partially filled d orbitals allowing for the loss of electrons from both s and d orbitals.

Question 4.

Write the main product in the following reactions :

[3 Marks]

Answer: In the reactions involving the generation of free radicals, the primary product formed typically stems from the propagation steps that occur after the initial chain initiation. For instance, when chlorine reacts with methyl radicals under UV light, the major product formed is chloromethane (CH_3Cl) as free radicals interact with one another to create stable compounds. The chain process involves methyl and chlorine radicals engaging through multiple steps, eventually leading to the formation of various products. However, chloromethane is the principal product due to its stability and lower energy compared to other possible products. This reaction exemplifies the process of halogenation where the free radical mechanism plays a crucial role in determining the major product. It is also important to note that besides the main product, minor side reactions can yield additional products, but these are often negligible in organic reaction results due to their lower yields. The presence of free radicals and subsequent termination steps contribute to the overall outcome of the reactions as radicals can further react or combine to produce other species.

Section B

Question 5. Read the following passage and answer the questions that follow. The rate of reaction is concerned with the decrease in concentration of reactants or increase in the concentration of products per unit time. It can be expressed as instantaneous rate at a particular instant of time and average rate over a large interval of time. A number of factors such as temperature, concentration of reactants, catalyst affect the rate of reaction. Mathematical representation of rate of a reaction is given by rate law: $\text{Rate} = k[\text{A}]^m[\text{B}]^n$, where m and n indicate how sensitive the rate is to the change in concentration of A and B. Sum of $m + n$ gives the overall order of the reaction. When a sequence of elementary reactions gives us the products, the reactions are called complex reactions. Molecularity and order of an elementary reaction are the same. Zero order reactions are relatively uncommon but they occur under special conditions. All natural and artificial radioactive decay of unstable nuclei take place by first order kinetics.
