CHEMISTRY STUDY MATERIALS FOR CLASS 12
(NCERT Based Questions - Answers)
GANESH KUMAR DATE:- 29/12/2020

Electrochemistry

Question 78.

(a) Define the term degree of dissociation. Write an expression that relates the molar conductivity of a weak electrolyte to its degree of dissociation.

(b) For the cell reaction; $Ni_{(s)}$ | $Ni^{2+}_{(aq)}$ || $Ag^{+}_{(aq)}$ | $Ag_{(s)}$

Calculate the equilibrium constant at 25 °C. How much maximum work would be obtained by operation of this cell?

$E^{o}Ni2/Ni = 0.25$ V and $E^{o}Ag+/Ag = 0.80$ V

Answer:

(a) Degree of dissociation: It is the measure of the extent to which an electrolyte gets dissociated into its constitutent ions.

Thus higher the degree of dissociation, higher will be its molar conductance.

Mathematically it can be expressed as:

$$\alpha = \frac{\text{Molar conductance at given conentration}}{\text{Molar conductance at infinite dilution}}$$

$$\Rightarrow \alpha = \frac{\Lambda_m}{\Lambda_m^o}$$

(*b*) $Ni_{(s)}$ | $Ni^{2+}(aq)$ || $Ag^{+}(aq)$ | $Ag_{(s)}$

Given : $E^o_{Ni^{2+}/Ni} = 0.25\,V$, $E^o_{Ag^{+}/Ag} = 0.80\,V$

$$Ni + 2Ag^{+} \longrightarrow Ni^{2+} + 2Ag$$

$$E^o_{Cell} = E^o_{Cathode} - E^o_{Anode} = 0.80\ V - 0.25\ V$$

$$\therefore \quad E^o_{Cell} = 0.55\ V$$

Using formula,

$$\log K_C = \frac{nE^o_{Cell}}{0.0591} \Rightarrow \log K_C = \frac{2 \times 0.55}{0.059}$$

$$\Rightarrow \log K_C = 18.644 \text{ or } K_C = 4.406 \times 10^{18}$$

Maximum work done can be calculated as,

$$\Delta G^o = -nF\ E^o_{Cell}$$
$$= -2 \times 96500\ C\ mol^{-1} \times 0.55\ V$$
$$= -106{,}150\ J\ mol^{-1}$$

Maximum work = 106.150 KJ mol^{-1}

Question 79.

(a) Define conductivity and molar conductivity for the solution of an electrolyte. Discuss their variation with concentration.

(b) Calculate the standard cell potential of the galvanic cell in which the following reaction takes place : Fe^{2+} (aq) + Ag^{+} (aq) → Fe^{3+} (aq) + Ag (s)

Calculate the $\Delta_r G°$ and equilibrium constant of the reaction also.

(E^0Ag+/Ag = 0.80 V; E^0Fe3+/Fe2+ = 0.77 V)

Answer:

(a) Conductivity : The conductance of the solution of an electrolyte enclosed in a cell between two electrodes of unit area of cross section separated by 1 cm. It is represented as K with unit ohm^{-1} cm^{-1}

Molar conductivity: It is the conductance of the volume V of solution containing one mole of electrolyte kept between two electrodes with area of cross section A and distance of unit length.

Molar conductivity increases with decrease in concentration of solute for both weak and strong electrolytes.

(b) **Given :** $E^0_{Ag^+/Ag} = 0.80\,V$, $E^0_{Fe^{3+}/Fe^{2+}} = 0.77\,V$

$\Delta_r G° = ?$ $K_C = ?$

∵ Cell Reaction

Fe^{2+} (aq) + Ag^+ (aq) ⟶ Fe^{3+} (aq) + Ag (s)

$$E^0_{Cell} = E^0_{Cathode} - E^0_{Anode} = 0.80\text{ V} - (0.77\text{ V}) = 0.03\text{ V}$$

$$\Delta_r G° = -nFE^o_{Cell}$$
$$= -1 \times 96500\text{ C mol}^{-1} \times 0.03\text{ V}$$

∴ $\Delta_r G° = -2895\text{ J mol}^{-1}$

$$\log K_C = \frac{nE^o_{Cell}}{0.0591}, \quad \log K_C = \frac{1 \times 0.03\text{ V}}{0.0591},$$

$\log K_C = 0.5076$

$\log K_C = 0.508$

∴ K_C = antilog 0.508 ∴ K_C = **3.221**

Question 80.

(a) Calculate E^0_{cell} for the following reaction at 298 K:

$2Al(s) + 3Cu^{2+}$ (0.01M) → $2Al^{2+}$ (0.01M) + 3Cu(s)

Given: E_{cell} = 1.98 V

(b) Using the E^0 values of A and B, predict which is better for coating the surface of iron [$E^0(Fe^{2+}/Fe)$ = -0.44 V] to prevent corrosion and why?

Given: $E^0(A^{2+}/A)$ = -2.37 V; $E^0(B^{2+}/B)$ = -0.14 V

Answer:

(a) For the reaction

$$2Al(s) + 3Cu^{2+}\ (0.01M) \rightarrow 2Al^{3+}\ (0.01M) + 3Cu(s)$$

Given: E_{cell} = 1.98 V E^0_{cell} = ?

Using Nernst equation

$$E_{cell} = E^0_{cell} - \frac{0.0591}{n} \log \frac{[Al^{3+}]^2}{[Cu^{2+}]^3}$$

or $$1.98\ V = E^0_{cell} - \frac{0.0591}{6} \log \frac{(0.01)^2}{(0.01)^3}$$

$$\left[\begin{array}{l} \because \log 100 = 2 \log 10 \\ \log 10 = 1 \end{array}\right]$$

or $$1.98\ V = E^0_{cell} - 0.00985 \log 100$$

or $$1.98\ V = E^0_{cell} - 0.00985 \times 2$$

$$1.98\ V = E^0_{cell} - 0.0197$$

$$\therefore\ E^\circ_{cell} = 1.98\ V + 0.0197$$

$$\therefore\ E^\circ_{cell} = \mathbf{1.9997\ V}$$

(b) Element A will be better for coating the surface of iron than element B because its E° value is more negative.

Question 81.

(a) Define the following terms :

(i) Primary batteries

(ii) Corrosion

(b) The resistance of a conductivity cell containing 0.001 M KCl solution at 298 K is 1500 Ω. What is the cell constant if conductivity of 0.001 M KCl solution at 298 K is 0.146×10^{-3} S cm^{-1}?

Answer:

(a) (i) Primary batteries : Batteries which can't be rechared/reused.

(ii) Corrosion : Loss of useful metals due to oxidation on exposure to atmospheric gases and moisture.

(b) k = 1R(lA)

lA = k × R = 0.146×10^{-3} S cm^{-1} × 1500 Ω lA = 0.219 cm^{-1}

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