PROBLEMS OF

ELECTROCHEMISTRY

1. For a cell involving one electron, E°_{cell} = 0.59 V at 298 K, the equilibrium constant for the cell reaction is

[Given that $\frac{2.303\,RT}{F}$ = 0.059 V at T= 298 K]

(a) 1.0×10^{30} (b) 1.0×10^{2}

(c) 1.0×10^{5} (d) 1.0×10^{10}

... NEET 2019

$\Delta G = \Delta G^\circ + RT \ln Q$

$\Delta G^\circ = -RT \ln K$

$\Rightarrow +nFE^\circ_{cell} = +RT \ln K$

$\Rightarrow E^\circ_{cell} = \frac{2.303\,RT}{nF} \log K$

$\Rightarrow 0.59 = \frac{0.059}{1} \log K$

$\log K = 10$

$K = 10^{10}$

2. Following limiting molar conductivities are given as :

$\lambda^{\circ}_{m(H_2SO_4)} = x \; Scm^2 \; mol^{-1}$; $\lambda^{\circ}_{m(K_2SO_4)} = y \; Scm^2 \; mol^{-1}$

$\lambda^{\circ}_{m(CH_3COOK)} = z \; Scm^2 \; mol^{-1}$; λ°_m (in $S \; cm^2 \; mol^{-1}$) for CH_3COOH will be

(a) $x - y + 2z$ (b) $x + y - z$

(c) $x - y + z$

(d) $\dfrac{(x-y)}{2} + z$

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3. During the electrolysis of molten sodium chloride, the time required to produce 0.10 mol of chlorine gas using a current of 3 amperes is

(a) 55 minutes (b) 110 minutes

(c) 220 minutes (d) 330 minutes

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$1F = 96500C$

$NaCl \rightarrow Na^+ + Cl^-$

$(1 mole^- = 1F)$

$2Cl^- \rightarrow Cl_2 + 2e^-$

1 mol

$Q = I \times t$

1 mol → 2 mole$^-$ = 2F

0.10 Cl_2 → 0.2F

$0.2 \times 96500 = 3 \times t$

t = 110 min

4. The pressure of H_2 required to make the potential of H_2 electrode zero in pure water at 298 K is

(a) 10^{-10} atm (b) 10^{-4} atm

(c) 10^{-14} atm (d) 10^{-12} atm

... NEET 2016

$H^+ = 10^{-7}$

$pH = 7$

$-\log H^+ = 7$

$H^+ = 10^{-7}$

$2H^+ + 2e^- \rightarrow H_2$

$$E = E^\circ - \frac{0.0591}{n} \log \frac{P_{H_2}}{[H^+]^2}$$

$$0 = 0 - \frac{0.0591}{2} \log \frac{P_{H_2}}{(10^{-7})^2}$$

$$\log \frac{P_{H_2}}{10^{-14}} = 0$$

$$P_{H_2} = 10^{-14} \text{ atm}$$

5. Calculate emf of the following cell at 25°C if value of E°_{cell} is 4 V

(Given $\frac{RT}{F} \ln 10 = 0.06$) :

$$M \mid M^{2+}_{(0.01)} \parallel M^{2+}_{(0.0001)} \mid M$$

(a) 3.94 V (b) 4.06 V (c) 2.03 V (d) 8.18 V

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6. Cell equation : $A + 2B^{+} \longrightarrow A^{2+} + 2B$

$A^{2+} + 2e^{-} \longrightarrow A$; $E^{\circ} = +0.34\ V$

And $\log_{10} K = 15.6$ at 300 K for all reactions.

Find E° for $B^{+} + e^{-} \longrightarrow B$

[Given that $\dfrac{2.303\ RT}{nF} = 0.059$ at 300K]

(a) 0.80 V (b) 1.26 V (c) -0.54 V (d) +0.94 V

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$E = E^{\circ}_{cell} - \dfrac{0.0591}{n} \log Q$

$E^{\circ}_{cell} = \dfrac{0.0591}{2} \log K$

$E^{\circ}_{cell} = \dfrac{0.0591}{2} \times 15.6$

$E^{\circ}_{cell} = E_{B^{+}/B} - E_{A^{+2}/A}$

7. Time taken to completely decompose 36 g of water by passing 3A current is

(a) 35.8 hr (b) 40 hr (c) 51.8 hr (d) 22.5 hr

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$\frac{4 \text{ mol } e^-}{4F}$

$2H_2O \rightarrow 2H_2 + O_2$

H_2O

O^{-2}

$2O^{-2} \rightarrow O_2 + 4e^-$

$2 \times 2 = 4$

$4H^+ \rightarrow 2H_2$

$H^+ \rightarrow H^0$ $4e^-$

2 mol H_2O ⟶ 4F

36 g ⟶ 4F

$4 \times 96500\ C$

$Q = I \times t$

$4 \times 96500 = 3 \times t$

8. A conductivity cell has a cell constant of 0.5 cm^{-1} . This cell when filled with 0.01 M NaCl solution has a resistance of 384 ohms at 25∘C. Calculate the equivalent conductance of the given solution.

(a) 130.2 Ω^{-1} cm^2 $(g\ eq)^{-1}$ (b) 137.4 Ω^{-1} cm^2 $(g\ eq)^{-1}$

(c) 154.6Ω^{-1} cm^2 $(g\ eq)^{-1}$ (d) 169.2Ω^{-1} cm^2 $(g\ eq)^{-1}$

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9. Calculate the standard cell potential (in V) of the cell in which following reaction takes place.

$Fe^{2+}_{(aq)} + Ag^{+}_{(aq)} \longrightarrow Fe^{3+}_{(aq)} + Ag_{(s)}$

Given that

$E^{\circ}_{Ag^{+}/Ag} = x$ V; $E^{\circ}_{Fe^{2+}/Fe} = y$ V ; $E^{\circ}_{Fe^{3+}/Fe} = z$ V

(a) x-z (b) x-y (c) x+2y -3z (d) x+y –z

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$$\Delta G^\circ_3 = \Delta G^\circ_2 - \Delta G^\circ_1$$

$$-1F E^\circ = -3FZ - (-2Fy)$$

$$E^\circ = 3Z - 2y$$

10. The standard Gibbs energy for the given cell reaction in kJ mol^{-1} at 298 K is

$Zn_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$,

E° =2V at 298 K

(Faraday's constant, F = 96000 C mol^{-1})

(a) -192 (b) 192 (c) -384 (d) 384

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$\Delta G^\circ = -nFE^\circ_{cell}$

$= -2 \times 96000 \times 2$

$= -384$ KJ/mol

11. Consider the statements S1 and S2:

S1 : Conductivity always increases with decrease in the concentration of electrolyte.

S2 : Molar conductivity always increases with decrease in the concentration of electrolyte.

The correct option among the following is

(a) Both S1 and S2 are wrong

(b) Both S1 and S2 are correct

(c) S1 is wrong and S2 is correct

(d) S1 is correct and S2 is wrong

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limiting molar conductivity

NaCl

$$\lambda_m^{\circ}(NaCl) = \lambda^{\circ}_{Na^+} + \lambda^{\circ}_{Cl^-}$$

$$\lambda^{\circ}_m CaCl_2 = \lambda^{\circ}_m Ca^{2+} + 2\lambda^{\circ}_m Cl^-$$

$$\lambda^{\circ}_m CH_3COOH = \lambda^{\circ}_m CH_3COO^- + \lambda^{\circ}_m H^+$$

$1+2-3$

(1) $\lambda^{\circ}_m CH_3COONa = \lambda^{\circ}_m CH_3COO^- + \lambda^{\circ} Na^+$

(2) $\lambda^{\circ}_m HCl = \lambda^{\circ}_m H^+ + \lambda^{\circ} Cl^-$

$$\lambda^{\circ}_m NaCl = \lambda^{\circ}_{Na^+} + \lambda^{\circ}_{Cl^-}$$

12.

How long (approximate) should water be electrolysed by passing through 100 amperes current so that the oxygen released can completely burn 27.66 g of diborane? (Atomic weight of B = 10.8 u)

(a) 6.4 hours (b) 0.8 hours (c) 3.2 hours (d) 1.6 hours

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$B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$

$(10.8 \times 2) + 6 = 27.6\ g \rightarrow 1\ mol$

3 mol O_2

$2H_2O \xrightarrow{4F} 2H_2 + O_2$ (1 mol)

12F

$12 \times 96500 = 100 \times t$

$$2H_2O \longrightarrow 2H_2 + O_2^{0}$$

H_2O

$$2O^{-2} \longrightarrow O_2^{0} + 4e^-$$

4 mole e^-

4e

4F

13. Given :

$E^\circ_{Cl_2/Cl^-} = 1.36\ V$, $E^\circ_{Cr^{3+}/Cr} = -0.74\ V$

$E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\ V$, $E^\circ_{MnO_4^-/Mn^{2+}} = 1.51\ V$

Among the following, the strongest reducing agent is

(a) Cr^{3+} (b) Cl^- (c) Cr (d) Mn^{2+}

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14. What is the standard reduction potential (E°) for $Fe^{3+} \longrightarrow Fe$?

Given that :

$Fe^{2+} + 2e^- \longrightarrow Fe$; $E^\circ_{Fe^{2+}/Fe} = -0.47$ V — (2)

$Fe^{3+} + e^- \longrightarrow Fe^{2+}$; $E^\circ_{Fe^{3+}/Fe^{2+}} = +0.77$ V — (3)

(a) + 0.057 V (b) + 0.30 V (c) -0.30 V (d) -0.057 V

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$\Delta G^\circ_2 + \Delta G^\circ_3 = \Delta G^\circ_1$

$-2F(-0.47)$

$+ (-1F(+0.77))$

$= -3FE^\circ$

$Fe^{+3} + 3e \longrightarrow Fe$ — (1)

(2) + (3) = 1

$Fe^{+3} + 3e^- \longrightarrow Fe$

$\frac{-0.17}{3} = 0.057$ V

15. To find the standard potential of M^{3+}/M electrode, the following cell is constituted:

$Pt|M|M^{3+}\ (0.001\ mol\ L^{-1})||\ Ag^{+}(0.01\ mol\ L^{-1})\ |\ Ag$

The emf of the cell is found to be 0.421 volt at 298 K. The standard potential of half reaction $M^{3+} + 3e^{-} \rightarrow M$ at 298 K will be

(Given $E^{\circ}_{Ag^{+}/Ag}$ at 298 K = 0.80 Volt)

(a) 0.32 Volt (b) 0.66 Volt (c) 0.38 Volt (d) 1.28 Volt

... JEE Main 2017

16.

What will occur if a block of copper metal is dropped into a beaker containing a solution of 1 M $ZnSO_4$?

(a) The copper metal will dissolve with evolution of oxygen gas.

(b) The copper metal will dissolve with evolution of hydrogen gas.

(c) No reaction will occur.

(d) The copper metal will dissolve and zinc metal will be deposited.

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17. Oxidation of succinate ion produces ethylene and carbon dioxide gases. On passing 0.2 Faraday electricity through an aqueous solution of potassium succinate, the total volume of gases (at both cathode and anode) at STP (1 atm and 273 K) is

(a) 8.96 L (b) 4.48 (c)6.72 L (d) 2.24 L

... JEE Main 2016

18.

Two Faradays of electricity are passed through a solution of $CuSO_4$. The mass of copper deposited at the cathode is (at. Mass of Cu=63.5 amu) :

(a) 2 g (b) 127 g (c) 0 g (d) 63.5 g

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19. A variable, opposite external potential (E_{ext}) is applied to the cell :

$Zn|Zn^{2+}$ (1M)||Cu^{2+} (1 M)|Cu, of potential 1.1 V .

When $E_{ext} < 1.1$ V and $E_{ext} > 1.1$ V, respectively electron flow from

(a) anode to cathode and cathode to anode

(b) cathode to anode and anode to cathode

(c) cathode to anode in both cases

(d) anode to cathode in both cases.

... JEE Main 2015

20. At 298 K, the standard reduction potentials are 1.51 V for MnO_4^- | Mn^{2+}, 1.36 V for Cl_2 | Cl^-, 1.07 V for Br_2 | Br^- and0 .54 V for I_2 | I^-.

At pH =3, permanganate is expected to oxidize

$$\left[\frac{RT}{F} = 0.059V\right]$$

(a) Cl^-, Br^- and I^- (b) Cl^- and Br^- (c) Br^- and I^- (d) I^- only

... JEE Main 2015