Q1 - 24 June - Shift 1

The cell potential for the following cell

$Pt|H_2(g)|H^+(aq)||Cu^{2+}(0.01M)|Cu(s)$

is 0.576 V at 298 K. The pH of the solution is ___. (Nearest integer)

Space for your notes:

Q2 - 24 June - Shift 2

The resistance of conductivity cell containing 0.01 M KCl solution at 298 K is 1750 Ω. If the conductively of 0.01 M KCl solution at 298 K is 0.152×10^{-3} S cm^{-1}, then the cell constant of the conductivity cell is_______ $\times 10^{-3}$ cm^{-1}.

Space for your notes:

Q3 - 25 June - Shift 1

In a cell, the following reactions take place

$Fe^{2+} \rightarrow Fe^{3+} e^-$ $\quad E^o_{Fe^{3+}/Fe^{2+}} = 0.77$ V

$2I^- \rightarrow I_2 + 2e^-$ $\quad E^o_{I_2/I^-} = 0.54$ V

The standard electrode potential for the spontaneous reaction in the cell is x × 10^{-2}V 298 K. The value of x is __________ (Nearest Integer)

Space for your notes:

Q4 - 25 June - Shift 2

The correct order of reduction potentials of the following pairs is

A. Cl_2/Cl^-

B. I_2/I^-

C. Ag^+/Ag

D. Na^+/Na

E. Li^+/Li

Choose the correct answer from the options given below.

(A) A > C > B > D > E

(B) A > B > C > D > E

(C) A > C > B > E > D

(D) A > B > C > E > D

Space for your notes:

Q5 - 25 June - Shift 2

A solution of $Fe_2(SO_4)_3$ is electrolyzed for 'x' min with a current of 1.5 A to deposit 0.3482 g of Fe. The value of x is______. [nearest integer]

Given : 1 F = 96500 C mol^{-1}

Atomic mass of Fe = 56 g mol^{-1}

Space for your notes:

Q6 - 26 June - Shift 1

The $\left(\frac{\partial E}{\partial T}\right)_P$ of different types of half cells are as follows :

A	B	C	D
1×10^{-4}	2×10^{-4}	0.1×10^{-4}	0.2×10^{-4}

(Where E is the electromotive force)

Which of the above half cells would be preferred to be used as reference electrode ?

(A) A (B) B
(C) C (D) D

Space for your notes:

Q7 - 26 June - Shift 2

$Cu(s) + Sn^{2+}(0.001M) \rightarrow Cu^{2+}(0.01M) + Sn(s)$

The Gibbs free energy change for the above reaction at 298 K is $x \times 10^{-1}$ kJ mol^{-1};

The value of x is______. [nearest integer]

$\left[\text{Given}: E^{\ominus}_{Cu^{2+}/Cu} = 0.34V; E^{\ominus}_{Sn^{2+}/Sn} = -0.14V; F = 96500C\ mol^{-1}\right]$

Space for your notes:

Q8 - 27 June - Shift 1

The limiting molar conductivities of NaI, $NaNO_3$ and $AgNO_3$ are 12.7, 12.0 and 13.3 mS m^2 mol^{-1}, respectively (all at 25°C). The limiting molar conductivity of AgI at this temperature is _____ mS m^2 mol^{-1}

Space for your notes:

Q9 - 27 June - Shift 2

In 3d series, the metal having the highest M^{2+}/M standard electrode potential is

(A) Cr (B) Fe

(C) Cu (D) Zn

Space for your notes:

Q10 - 27 June - Shift 2

For the reaction taking place in the cell:

$Pt(s) | H_2(g) | H^+(aq) || Ag^+(aq) | Ag(s)$

$E^o_{Cell} = +0.5332$ V.

The value of $\Delta_f G^0$ is _________ kJ mol^{-1}. (in nearest integer)

Space for your notes:

Q11 - 28 June - Shift 1

The solubility product of a sparingly soluble salt A_2X_3 is 1.1×10^{-23}. If specific conductance of the solution is 3×10^{-5} S m^{-1}, the limiting molar conductivity of the solution is $x \times 10^{-3}$ S m^2 mol^{-1}. The value of x is ___________.

Space for your notes:

Q12 - 28 June - Shift 1

The quantity of electricity in Faraday needed to reduce 1 mol of $Cr_2O_7^{2-}$ to Cr^{3+} is _________.

Space for your notes:

Q13 - 28 June - Shift 2

For the given reactions

$Sn^{2+} + 2e^{-} \rightarrow Sn$

$Sn^{4+} + 4e^{-} \rightarrow Sn$

The electrode potentials are; $E^{o}_{Sn^{2+}/Sn} = -0.140$ V and $E^{o}_{Sn^{4+}/Sn} = 0.010$ V. The magnitude of standard electrode potential for Sn^{4+}/Sn^{2+} i.e. $E^{o}_{Sn^{4+}/Sn^{2+}}$ is ______ $\times 10^{-2}$ V. (Nearest integer)

Space for your notes:

Q14 - 29 June - Shift 1

A dilute solution of sulphuric acid is electrolysed using a current of 0.10 A for 2 hours to produce hydrogen and oxygen gas. The total volume of gases produced at STP is ________ cm^{3}. (Nearest integer) [Given : Faraday constant F = 96500 C mol^{-1} at STP, molar volume of an ideal gas is 22.7 L mol^{-1}]

Space for your notes:

Q15 - 29 June - Shift 2

The cell potential for the given cell at 298 K

Pt | H_2(g,1 bar) | H^{+}(aq) || Cu^{2+}(aq) | Cu(s)

is 0.31V. The pH of the acidic solution is found to be 3, whereas the concentration of Cu^{2+} is 10^{-x} M. The value of x is _____.

(Given: $E^{\ominus}_{Cu^{2+}/Cu} = 0.34$ V and $\frac{2.303RT}{F} = 0.06$V)

Space for your notes:

Answer Key

Q1 (5)	**Q2** (266)	**Q3** (23)	**Q4** (A)
Q5 (20)	**Q6** (C)	**Q7** (983)	**Q8** (14)
Q9 (C)	**Q10** (51)	**Q11** (3)	**Q12** (6)
Q13 (16)	**Q14** (127)	**Q15** (7)	

Q1 (5)

$$\text{Anode} \ : \ H_2 \rightarrow 2H^+ + 2e^-$$
$$\text{Cathode}: \ Cu^{2+} + 2e^- \rightarrow Cu$$
$$\overline{Cu^{2+} + H_2 \rightarrow 2H^+ + Cu}$$

$$E_{cell} = E^0_{cell} - \frac{0.06}{2}\log\frac{[H^+]^2}{[Cu^{2+}]}$$

$$0.576 = 0.34 - \frac{0.06}{2}\log\left\{\frac{[H^+]^2}{(0.01)}\right\}$$

$$+3.93 - \log(H^+) + \log 0.1 \Rightarrow pH = 4.93 \simeq 5$$

Q2 (266)

$$K = \frac{1}{R} \times \text{cell constant}$$

$$0.152 \times 10^{-3} = \frac{1}{1750} \text{ cell constant}$$

$$\text{cell constant} = 266 \times 10^{-3}$$

Q3 (23)

$$\underset{\text{Cathode}}{Fe^{+3}} + \underset{\text{anode}}{I^-} \longrightarrow I_2 + Fe^{+2}$$

$$E^0_{Cell} = E^0_{cathode} - E^0_{anode}$$

$=0.77-0.54$

$=0.23$

$= 23 \times 10^{-2}\,V$

Q4 (A)

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

$$E^\circ_{I_2/I^-} = +0.54\,V$$

$$E^\circ_{Ag^+/Ag} = +0.80\,V$$

$$E^\circ_{Na^+/Na} = -2.71\,V$$

$$E^\circ_{Li^+/Li} = -3.05\,V$$

Q5 (20)

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

$3F \longrightarrow$ 1 mole Fe is deposited

For 56 g $\longrightarrow 3 \times 96500$ (required charge)

For 1g $\longrightarrow \dfrac{3 \times 96500}{56}$ (required charge)

For 0.3482 g $\longrightarrow \dfrac{3 \times 96500}{56} \times 0.3482$

$= 1800.06$

$Q = it$

$1800.06 = 1.5\ t$

$t = 20$ min

Q6 (C)

A cell with less variation in EMF with temperature is preferred as reference electrode because it can be used for wider range of temperature without much derivation from standard value so a cell with less $\left(\dfrac{\partial E}{\partial T}\right)_P$ is preferred.

Q7 (983)

$Cu_{(s)} + Sn^{2+} (0.001\ M) \rightarrow Cu^{2+} (0.01\ M) + Sn_{(s)}$

$E°_{cell} = E°_{cathode} - E°_{anode}$

$= -0.14 - (0.34)$

$= -0.48\ V$

$$E_{cell} = E°_{cell} - \frac{0.059}{2} \log \frac{[Cu^{2+}]}{[Sn^{2+}]}$$

$$= -0.48 - \frac{0.059}{2} \log \frac{0.01}{0.001}$$

$= -0.509$

$\Delta G = -nF\ E_{cell}$

$= -2 \times 96500 \times (-0.5095)$

$= 98333.5\ J/mol$

$= 98.335\ kJ/mol$

$= 983.35 \times 10^{-1}\ kJ/mol$

Nearest Integer : 983

Q8 (14)

Given

(1) λ_m^∞ (NaI) = 12.7 mS m^2 mol^{-1}

(2) λ_m^∞ ($NaNO_3$) = 12.0 mS m^2 mol^{-1}

(3) λ_m^∞ ($AgNO_3$) = 13.3 mS m^2 mol^{-1}

λ_m^∞ (Ag I) = (1) + (3) - (2)

= 12.7 + 13.3 – 12.0

= 26.0 – 12.0

λ_m^∞ (Ag I) = 14.0

Q9 (C)

$Cr^{+2}/Cr \rightarrow -0.90\ V$

$Fe^{+2}/Fe \rightarrow -0.44\ V$

$Cu^{+2}/Cu \rightarrow +0.34\ V$

$Zn^{+2}/Zn \rightarrow -0.76\ V$

So Ans. Cu^{+2}/Cu

Q10 (51)

$$\frac{1}{2}H_2 + Ag^+ \rightarrow H^+ + Ag$$

$\Delta G° = -\,nE°\,F$

$= -1 \times 0.5332 \times 96500\ J$

$= -51.35\ kJ$

$(n = 2 \text{ for } H_2 + 2Ag^+ \rightarrow 2H^+ + 2Ag)$

Q11 (3)

$$A_2X_{3(s)} \rightleftharpoons 2A^{+3}_{(aq)} + 3X^{-2}_{(aq)}$$

solubility = sM 2s 3s

$(2s)^2(3s)^3 = 1.1 \times 10^{-23}$

$108\ s^5 = 1.1 \times 10^{-23}$

$s \simeq 10^{-5} M = 10^{-5}\frac{mol}{L} = 0.01\frac{mol}{m^3}$

Now $\wedge_m \simeq \wedge_m^{\infty} = \frac{k}{m} = \frac{k}{s}$

$\Rightarrow \wedge_m^{\infty} = \frac{3 \times 10^{-5}}{0.01} = 3 \times 10^{-3}\ S\text{-}m^2/mol$

Ans. 3

Q12 (6)

$$Cr_2O_7^{-2} + 6e^- \longrightarrow 2Cr^{+3}$$

1mol 6mol

$\Rightarrow$ number of faradays = moles of electrons
= 6

Q13 (16)

$Sn^{2+} + 2e^- \to Sn \qquad \Delta G_1^0 = +2 \times 0.140 \times F$

$Sn^{+4} + 4e^- \to Sn \qquad \Delta G_2^0 = -4 \times 0.01 \times F$

$Sn^{+4} + 2e^- \to Sn^{+2} \qquad \Delta G_3^0 = -2 \times E^0{}_{Sn^{+4}/Sn^{+2}} \times F$

$\Delta G_3^0 = \Delta G_2^0 - \Delta G_1^0$

$-2 \times E^0 \times F = -(0.04 + 0.28) \times F$

$E^0 = 0.16$ volt $= 16 \times 10^{-2}$ V

Ans 16

Q14 (127)

At anode

$2H_2O \rightarrow O_2(g) + 4H^+ + 4e^-$

At cathode

$2H^+ + 2e^- \rightarrow H_2(g)$

Now number of gm eq. $= \dfrac{i \times t}{96500}$

$= \dfrac{0.1 \times 2 \times 60 \times 60}{96500}$

$= 0.00746$

$V_{O_2} = \dfrac{0.00746}{4} \times 22.7 = 0.0423$

$V_{H_2} = \dfrac{0.00746}{2} \times 22.7 = 0.0846$

$V_{Total} \approx 127$ ml or cc

Q15 (7)

$H_2(g) + Cu^{2+}(aq.) \rightarrow 2H^+(aq.) + Cu(s)$

$0.31 = 0.34 - \dfrac{0.06}{2} \log \dfrac{[H^+]^2}{[Cu^{2+}]}$

$[Cu^{2+}] = 10^{-7}$ M

$x = 7$