Q1 - 2024 (04 Apr Shift 1)

What pressure (bar) of H_2 would be required to make emf of hydrogen electrode zero in pure water at $25^{\circ}C$?

(1) 10^{-7}

(2) 0.5

(3) 1

(4) 10^{-14}

Q2 - 2024 (04 Apr Shift 1)

One of the commonly used electrode is calomel electrode. Under which of the following categories, calomel electrode comes?

(1) Oxidation - Reduction electrodes

(2) Metal ion - Metal electrodes

(3) Gas - Ion electrodes

(4) Metal - Insoluble Salt - Anion electrodes

Q3 - 2024 (04 Apr Shift 2)

For a strong electrolyte, a plot of molar conductivity against (concentration) $^{1/2}$ is a straight line, with a negative slope, the correct unit for the slope is

(1) $Scm^2\ mol^{-3/2}\ L^{-1/2}$

(2) $Scm^2\ mol^{-3/2}\ L^{1/2}$

(3) $Scm^2\ mol^{-3/2}\ L$

(4) $Scm^2\ mol^{-1}\ L^{1/2}$

Q4 - 2024 (04 Apr Shift 2)

Fuel cell, using hydrogen and oxygen as fuels,

A. has been used in spaceship

B. has as efficiency of 40% to produce electricity

C. uses aluminum as catalysts

D. is eco-friendry

E. is actually a type of Galvanic cell only

Choose the correct answer from the options given below:

(1) A, B, D, E only

(2) A, D, E only

(3) A, B, D only

(4) A, B, C only

Q5 - 2024 (05 Apr Shift 1)

The reaction at cathode in the cells commonly used in clocks involves.

(1) reduction of Mn from +7 to +2

(2) reduction of Mn from +4 to +3

(3) oxidation of Mn from +3 to +4

(4) oxidation of Mn from +2 to +7

Q6 - 2024 (05 Apr Shift 1)

Molar ionic conductivities of divalent cation and anion are 57 S cm^2 mol^{-1} and 73 S cm^2 mol^{-1} respectively.

The molar conductivity of solution of an electrolyte with the above cation and anion will be :

(1) 187 S cm^2 mol^{-1}

(2) 260 S cm^2 mol^{-1}

(3) 130 S cm^2 mol^{-1}

(4) 65 S cm^2 mol^{-1}

Q7 - 2024 (05 Apr Shift 2)

The quantity of silver deposited when one coulomb charge is passed through $AgNO_3$ solution :

(1) 1 g of silver

(2) 1 electrochemical equivalent of silver

(3) 1 chemical equivalent of silver

(4) 0.1 g atom of silver

Q8 - 2024 (05 Apr Shift 2)

For the electro chemical cell

If $E^0_{\left(M^{2+}/M\right)} = 0.46$ V and $E^0_{\left(x/X^{2-}\right)} = 0.34$ V.

Which of the following is correct?

(1) $M + X \rightarrow M^{2+} + X^{2-}$ is a spontaneous reaction

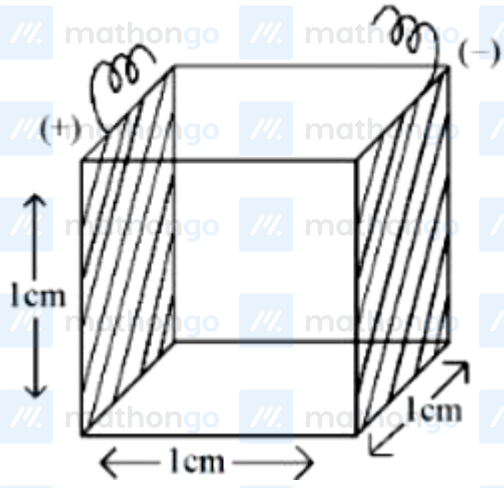
(2) $E_{cell} = 0.80$ V

(3) $E_{cell} = -0.80$ V

(4) $M^{2+} + X^{2-} \rightarrow M + X$ is a spontaneous reaction

Q9 - 2024 (06 Apr Shift 1)

A conductivity cell with two electrodes (dark side) are half filled with infinitely dilute aqueous solution of a weak electrolyte. If volume is doubled by adding more water at constant temperature, the molar conductivity of the cell will -



(1) decrease sharply

(2) increase sharply

(3) remain same or can not be measured accurately

(4) depend upon type of electrolyte

Q10 - 2024 (06 Apr Shift 2)

How can an electrochemical cell be converted into an electrolytic cell?

(1) Applying an external opposite potential lower than E^0 cell.

(2) Reversing the flow of ions in salt bridge.

(3) Applying an external opposite potential greater than E^0 cell-

(4) Exchanging the electrodes at anode and cathode.

Q11 - 2024 (08 Apr Shift 2)

The emf of cell $Tl\left|\underset{(0.001M)}{Tl^{+}}\right|\left|\underset{(0.01M)}{Cu^{2+}}\right|Cu$ is 0.83 V at 298 K. It could be increased by :

(1) decreasing concentration of both Tl^{+} and Cu^{2+} ions

(2) increasing concentration of Cu^{2+} ions

(3) increasing concentration of $T1^{+}$ions

(4) increasing concentration of both Tl^{+} and Cu^{2+} ions

Q12 - 2024 (08 Apr Shift 2)

The reaction;

$\frac{1}{2}H_{2(g)}+AgCl_{(s)}\rightarrow H^{+}_{(aq)}+Cl^{-}_{(aq)}+Ag_{(s)}$

occurs in which of the following galvanic cell :

(1) $Ag\left|AgCl_{(s)}\right|KCl_{(soln.)}\left|AgNO_{3\,(aq.)}\right|Ag$

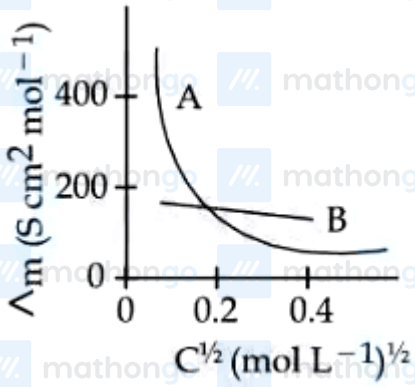
(2) $Pt\left|H_{2(g)}\right|HCl_{(soln.)}\left|AgCl_{(s)}\right|Ag$

(3) $Pt\left|H_{2(g)}\right|KCl_{(soln.)}\left|AgCl_{(s)}\right|Ag$

(4) $Pt\left|H_{2(g)}\right|HCl_{(soln.)}\left|AgNO_{3(aq)}\right|Ag$

Q13 - 2024 (09 Apr Shift 1)

The molar conductivity for electrolytes A and B are plotted against $C^{1/2}$ as shown below. Electrolytes A and B respectively are :



(1) A: strong electrolyte ; B: weak electrolyte

(2) A: weak electrolyte ; B: weak electrolyte

(3) A: weak electrolyte ; B: strong electrolyte

(4) A: strong electrolyte ; B: strong electrolyte

Q14 - 2024 (09 Apr Shift 1)

The standard reduction potentials at 298 K for the following half cells are given below :

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O, E^\circ = 1.33$ V

$Fe^{3+}(aq) + 3e^- \rightarrow Fe \quad E^\circ = -0.04$ V

$Ni^{2+}(aq) + 2e^- \rightarrow Ni \quad E^\circ = -0.25$ V

$Ag^+(aq) + e^- \rightarrow Ag \quad E^\circ = 0.80$ V

$Au^{3+}(aq) + 3e^- \rightarrow Au \quad E^\circ = 1.40$ V

Consider the given electrochemical reactions,

The number of metal(s) which will be oxidized be $Cr_2O_7^{2-}$, in aqueous solution is _____

Q15 - 2024 (09 Apr Shift 2)

Which out of the following is a correct equation to show change in molar conductivity with respect to concentration for a weak electrolyte, if the symbols carry their usual meaning :

(1) $\Lambda_m - \Lambda_m^0 + AC^{\frac{1}{2}} = 0$

(2) $\Lambda_m^2 C - K_a \Lambda_m^{\circ 2} + K_a \Lambda_m \Lambda_m = 0$

(3) $\Lambda^2{}_m C + K_a \Lambda_m^{\circ 2} - K_a \Lambda_m \Lambda_m^{\circ} = 0$

(4) $\Lambda_m - \Lambda_m^{\circ} - AC^{\frac{1}{2}} = 0$

Q16 - 2024 (09 Apr Shift 2)

Match List I with List II

	List - I (Cell)		List - II (Use/Property/Reaction)
A.	Leclanche cell	I.	Converts energy of combustion into electrical energy
B.	Ni – Cd cell	II.	Does not involve any ion in solution and is used in hearing aids
C.	Fuel cell	III.	Rechargeable
D.	Mercury cell	IV.	Reaction at anode $Zn \rightarrow Zn^{2+} + 2e^-$

Choose the correct answer from the options given below:

(1) A-II, B-III, C-IV, D-I

(2) A-I, B-II, C-III, D-IV

(3) A-III, B-I, C-IV, D-II

(4) A-IV, B-III, C-I, D-II

Answer Key

Q1 (4)	**Q2** (4)	**Q3** (2)	**Q4** (2)
Q5 (2)	**Q6** (3)	**Q7** (2)	**Q8** (4)
Q9 (3)	**Q10** (3)	**Q11** (2)	**Q12** (3)
Q13 (3)	**Q14** (3)	**Q15** (2)	**Q16** (4)

Q1

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

$$E=E^{\circ}-\frac{0.059}{n} \log \frac{P_{H_2}}{\left[H^{+}\right]^2}$$

$$0=0-\frac{0.059}{2} \log \frac{P_{H_2}}{\left(10^{-7}\right)^2}$$

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

$$\frac{P_{H_2}}{10^{-14}}=1$$

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

Q2

Theory based

Q3

$$\Lambda_m=\Lambda_m^{\circ}-A \sqrt{C}$$

$$\text{Units of } A \sqrt{C}=\text{Scm}^2 \text{ mole}^{-1}$$

$$\text{Uits of } A=\text{Scm}^2 \text{ mole}^{-3/2} \text{ L}^{1/2}$$

Q4

Fuel cell is used in spaceship and it is type of galvanic cell.

Q5

In the cathode reaction manganese (Mn) is reduced from the +4 oxidation state to the +3 state.

Q6

$$\Lambda_C^{+2}=57 \text{Scm}^2 \text{ mol}^{-1}$$

$$\Lambda_A^{+2}=73 \text{Scm}^2 \text{ mol}^{-1}$$

$$\Lambda_{\text{Solution }}=\lambda_C^{+2}+\Lambda_A^{-2}$$

$$=57+73=130$$

Q7

$$W = ZIt$$
$$W = ZQ$$
$$Q = \frac{W}{Z}$$
$$W = ZQ = \text{ (electrochemical equivalent)}$$

Q8

$$M \mid M^{+2} \| X / X^{2-}$$
$$E^{o}_{cell} = E^{o}_{M/M^{+2}} + E^{o}_{X/X^{-2}}$$
$$= -0.46 + 0.34 = -0.12 \text{ V}$$

As E^{o}_{cell} is negative so anode becomes cathode and cathode become anode. Spontaneous reaction will be

$$M^{+2} + X^{2-} \longrightarrow M + X$$

Q9

Solution is already infinitely dilute, hence no change in molar conductivity upon addition of water

Q10

Applied external potential should be greater than E^{0}_{cell} in opposite direction.

Q11

$$\begin{array}{ll} \text{Anodic Reaction} & \left[T\ell_{(s)} \rightarrow T^{+}{}_{(aq)} + e^{-}\right] 2 \\ \text{Cathodic Reaction} & Cu^{+2}{}_{(aq)} + 2e^{-} \rightarrow Cu_{(s)} \\ \hline \text{Overall Redox Reaction} & 2\ T\ell_{(s)} + Cu^{+2}{}_{(aq)} \rightarrow 2\ T\ell^{+}_{(aq)} + Cu_{(s)} \end{array}$$

$$E_{cell} = E^{o}_{cell} - \frac{0.0591}{2} \log \frac{\left[T\ell^{+}\right]^{2}}{\left[Cu^{+2}\right]}$$

E_{cell} increases by increasing concentration of $\left[Cu^{+2}\right]$ ions.

Q12

Anodic half cell

Gas - gas ion electrode

$$\frac{1}{2} H_{2(g)} \rightarrow H^{+}_{(aq)} + e^{-}$$

Cathodic Reaction

Metal-metal insoluble salt anion electrode

$Ag^{+}_{(aq)} + e^{-} \rightarrow Ag_{(s)}$

$AgCl_{(s)} \rightleftharpoons Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$

$AgCl_{(s)} + e^{-} \rightarrow Ag_{(s)} + Cl^{-}_{(aq)}$

Overall redox reaction

$\frac{1}{2}H_{2(g)} + AgCl_{(s)} \rightarrow H^{+}_{(aq)} + Cl^{-}_{(aq)} + Ag_{(s)}$

Cell Representation

$Pt\left|H_{2(g)}\right|kCl_{(sol)}\left|AgCl_{(s)}\right|Ag$

Q13

$A \rightarrow$ Weak electrolyte

$B \rightarrow$ Strong electrolyte

Q14

Fe, Ni, Ag will be oxidized due to lower S.R.P.

Q15

$HA(aq) \rightleftharpoons H^{+}(aq) + A^{-}(aq)$

$K_a = \frac{\alpha^2 C}{1-\alpha}$

$\alpha^2 C + K_a\alpha - K_a = 0$

$\left(\frac{\lambda_m}{\lambda_m^{\infty}}\right)^2 C + K_a\frac{\lambda_m}{\lambda_m^{\infty}} - K_a = 0$

$\lambda_m^2 C + K_a\lambda_m\lambda_m^{\infty} - K_a(\lambda_m^{\infty})^2 = 0$

Q16

A-IV, B-III, C-I, D-II