1. The standard electrode potential of M^+/M in aqueous solution does not depend on

[2023 (06 Apr Shift 1)]

(1) Hydration of a gaseous metal ion

(2) Sublimation of a solid metal

(3) Ionisation of a solid metal atom

(4) Ionisation of a gaseous metal atom

2. The product, which is not obtained during the electrolysis of brine solution is

[2023 (06 Apr Shift 2)]

(1) H_2

(2) HCl

(3) NaOH

(4) Cl_2

3. The standard reduction potentials at 295 K for the following half cells are given below:

$NO_3^- + 4H^+ + 3e^- \rightarrow NO(g) + 2H_2O$	$E^o = 0.97$ V
$V^{2+}(aq) + 2e^- \rightarrow V(s)$	$E^o = -1.19$ V
$Fe^{3+}(aq) + 3e^- \rightarrow Fe(s)$	$E^o = -0.04$ V
$Ag^+(aq) + e^- \rightarrow Ag(s)$	$E^o = 0.80$ V
$Au^{3+}(aq) + 3e^- \rightarrow Au(s)$	$E^o = 1.40$ V

The number of metal(s) which will be oxidised by NO_3^- in aqueous solution is _____.

[2023 (06 Apr Shift 2)]

4. The reaction occurs in which of the given galvanic cell?

$\frac{1}{2}H_2(g) + AgCl(s) \rightleftharpoons H^+(aq) + Cl^-(aq) + Ag(s)$

[2023 (08 Apr Shift 1)]

(1) $Pt\,|H_2(g)|\,HCl(sol^n)\,|\,AgCl(s)|\,Ag$

(2) $Ag\,|\,AgCl(s)|\,KCl(sol^n)\,|\,AgNO_3\,|\,Ag$

(3) $Pt\,|H_2(g)|\,HCl(sol^n)\,|\,AgNO_3(sol^n)\,|\,Ag$

(4) $Pt\,|H_2(g)|\,KCl(sol^n)\,|\,AgCl(s)|\,Ag$

5. The specific conductance of $0.0025M$ acetic acid is 5×10^{-5} S cm^{-1} at a certain temperature. The dissociation constant of acetic acid is _____ $\times 10^{-7}$. (Nearest integer)

Consider limiting molar conductivity of CH_3COOH as 400 S cm^2 mol^{-1}

[2023 (10 Apr Shift 2)]

6. In an electrochemical reaction of lead, at standard temperature, if $E^o_{(Pb^{2+}/Pb)} = m$ Volt and $E^o_{(Pb^{4+}/Pb)} = n$ Volt, then the value of $E^\circ(Pb^{2+}/Pb^{4+})$ is given by $m - xn$. The value of x is _____. (Nearest integer)

[2023 (11 Apr Shift 1)]

7. The number of correct statements from the following is.....

A. E_{cell} is an intensive parameter

B. A negative E^o means that the redox couple is a stronger reducing agent than the H^+/H_2 couple.

C. The amount of electricity required for oxidation or reduction depends on the stoichiometry of the electrode reaction.

D. The amount of chemical reaction which occurs at any electrode during electrolysis by a current is proportional to the quantity of electricity passed through the electrolyte.

[2023 (11 Apr Shift 2)]

8. For lead storage battery pick the correct statements

A. During charging of battery, $PbSO_4$ on anode is converted into PbO_2

B. During charging of battery, $PbSO_4$ on cathode is converted into PbO_2

C. Lead storage battery consists of grid of lead packed with PbO_2 as anode

D. Lead storage battery has ~38% solution of sulphuric acid as an electrolyte

Choose the correct answer from the options given below:

[2023 (12 Apr Shift 1)]

(1) A, B, D only

(2) B, C, D only

(3) B, C only

(4) B, D only

9. A metal surface of 100 cm^2 area has to be coated with nickel layer of thickness 0.001 mm. A current of 2A was passed through a solution of $Ni(NO_3)_2$ for 'x' seconds to coat the desired layer. The value of x is _____. (Nearest integer)
(ρNi (density of Nickel) is 10 g mL^{-1}, Molar mass of Nickel is 60 g mol^{-1} $F = 96500$ $Cmol^{-1}$)
[2023 (13 Apr Shift 1)]

10. At 298 K, the standard reduction potential for Cu^{2+}/Cu electrode is 0.34 V. Given : $K_{sp}\,Cu(OH)_2 = 1 \times 10^{-20}$ Take $\frac{2.303\,RT}{F} = 0.059$ V The reduction potential at pH = 14 for the above couple is $(-)x \times 10^{-2}$ V. The value of x is
[2023 (13 Apr Shift 2)]

11. The number of correct statements from the following is _____
(A) Conductivity always decreases with decrease in concentration for both strong and weak electrolytes.
(B) The number of ions per unit volume that carry current in a solution increases on dilution.
(C) Molar conductivity increases with decrease in concentration.
(D) The variation in molar conductivity is different for strong and weak electrolytes.
(E) For weak electrolytes, the change in molar conductivity with dilution is due to decrease in degree of dissociation.
[2023 (15 Apr Shift 1)]

ANSWER KEYS

1. (3)	**2.** (2)	**3.** (3)	**4.** (1)	**5.** (66)	**6.** (2)	**7.** (4)	**8.** (4)
9. (16)	**10.** (25)	**11.** (3)					

1. (3)

The stability of M^+ ions in aqueous medium depends on three factors: (i) Enthalpy of atomisation (ii) First ionisation enthalpies of isolated gaseous atom (iii) Hydration enthalpy.

An element in M^+ state in aqueous medium is stabler if the electrode potential (M^+/M) value of more negative. Down the group, the tendency to form M^+ ion increases. In this process, ionisation of solid metal is not involved in this process.

2. (2)

The aqueous solution of sodium chloride is known as brine solution. On electrolysis of brine solution, the following reactions are observed.

Oxidation reaction takes place at anode and reduction reaction takes place at cathode. The reaction

Anode: $2\,OH^- \rightarrow \frac{1}{2}O_2 + H_2O + 2e^{\ominus}$

Cathode: $H_2O + e^{\ominus} \rightarrow \frac{1}{2}H_2 + OH^{\ominus}$

Hydrogen and oxygen are electrode products. The remaining solution contain NaOH.

Hence, HCl is not obtained

3. (3)

For feasibility, check , $E^o{}_{cell} = E^o_{cathode(reduction)} - E^o_{anode(oxidation)} > 0$

The E^o values when metal acts as anode and NO_3^- reaction is cathodic reaction.

For Vanadium metal, $E^o_{cell} = 0.97 + 1.19 = 2.16V$

For Iron metal, $E^o_{cell} = 0.97 + 0.04 = 1.01V$

For silver metal, $E^o_{cell} = 0.97 - 0.80 = 0.17V$

For Gold metal, $E^o_{cell} = 0.97 - 1.140 = -0.17V$

For electrodes having oxidation potential greater than -0.97 V, $E^o{}_{cell} > 0$

$\therefore$ Ag, Fe and V can be oxidised

4. (1)

Oxidation is loss of electron and in a galvanic cell it occurs at anode. Reduction is gain of electron and in a galvanic cell it occurs at cathode.

At anode : $\frac{1}{2}H_2\left(g\right) \longrightarrow \underset{(aq)}{H^+} + e^-$

At cathode $\underset{(S)}{AgCl} + \bar{e} \longrightarrow Ag + \underset{(aq)}{Cl^-}$

Overall reaction

$\frac{1}{2}H_2\left(g\right) + AgCl\left(s\right) \longrightarrow H^* + Cl^- + Ag\left(s\right)$

Cell representation :

Anode / Anode electrolyte || Cathodic electrolyte / Cathode.

The cell representation for the above cell will be

$Pt|H_2(g)|HCl(\text{soln}^{n})|AgCl(s)|Ag$

5. (66)

The relation between Molar conductance λ_m and specific conductance κ is

$\lambda_m = \frac{k \times 1000}{M}$

M = molarity

$\lambda_m = \frac{\left(5\times10^{-5}\right)\times\left(10^3\right)}{\left(2.5\times10^{-3}\right)} = 20\ S\ cm^2\ mol^{-1}$

Now, the degree of dissociation, $\alpha = \frac{\lambda_m}{\lambda^\infty}$

$\alpha = \frac{20}{400} = \frac{1}{20}$

The acid dissociation constant, $K_a = \frac{C\alpha^2}{(1-\alpha)} = \frac{\left(2.5\times10^{-3}\right)\left(\frac{1}{20}\times\frac{1}{20}\right)}{\left(\frac{19}{20}\right)}$

$= 65.789 \times 10^{-7}$

$\approx 66 \times 10^{-7}$

6. (2)

The relation between Gibbs Free energy and emf of the cell can be related as follows,

$\Delta G = -nFE_{cell}$

The electrode reactions can be written as follows,

$Pb^{2+} + 2e^- \rightarrow Pb \qquad \Delta G_1 = -2FE^{\circ}_{Pb^{2+}/Pb}$

$Pb^{4+} + 4e^- \rightarrow Pb \qquad \Delta G_2 = -4FE^{\circ}_{Pb^{4+}/Pb}$

$Pb^{4+} + 2e^- \rightarrow Pb^{2+} \qquad \Delta G_3 = -2FE^{\circ}_{Pb^{4+}/Pb^{2+}}$

Now, $\Delta G_3 = \Delta G_2 - \Delta G_1$

$-2FE^{\circ}_{Pb^{4+}/Pb^{2+}} = -4FE^{\circ}_{Pb^{4+}/Pb} + 2FE^{\circ}_{Pb^{2+}/Pb}$

$\Rightarrow 4E^{\circ}_{Pb^{+4}/Pb} = 2E^{\circ}_{Pb^{+2}/Pb} + 2E^{\circ}_{Pb^{+4}/Pb^{+2}}$

$\Rightarrow 4n = 2m + 2E^{\circ}_{Pb^{+4}/Pb^{+2}}$

$\Rightarrow E^{\circ}_{Pb^{+4}/Pb^{+2}} = 2n - m$

$\Rightarrow E^{\circ}_{Pb^{+2}/Pb^{+4}} = m - 2n$

Hence, the value of $x = 2$

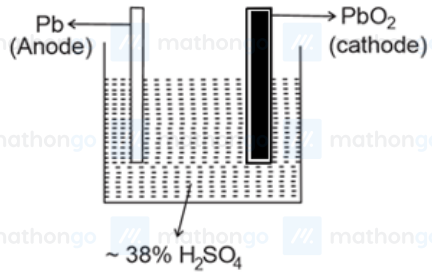
7. (4)

An intensive property is a bulk property, meaning that it is a physical property of a system that does not depend on the system size or the amount of material in the system.

$\Delta G = -nFE_{cell}$

The ΔG in the above equation is an extensive property, E_{cell} is an intensive property. A negative E^{o}means that the redox couple is a stronger reducing agent than the H^+/H_2couple. The amount of electricity required for oxidation or reduction depends on the stoichiometry of the electrode reaction. The amount of chemical reaction which occurs at any electrode during electrolysis by a current is proportional to the quantity of electricity passed through the electrolyte.

8. (4)



The lead storage battery is as shown in diagram. Lead storage battery consists of lead anode and a grid of lead packed with lead oxide(PbO_2) as cathode, a 38% solution of H_2SO_4 is used as an electrolyte. During charging of battery $PbSO_4$ deposited on cathode is converted in PbO_2 and $PbSO_4$ deposited on anode is converted into Pb. The electrolyte used in battery is H_2SO_4 which is about 38% by mass.

9. (16)

One equivalent of substance deposited for 96500C(one Faraday).

$i \times t$ Columbus of charge can be utilised to get w g of substance.

Millimoles of Ni coated

$= \frac{(2x)100}{96500 \times 2}$

$= \frac{10x}{965}$

Mass of Ni $= \left(\frac{x}{965}\right)600$

$= \frac{600x}{965}mg$

Volume$= \frac{60x}{965} \times 10^{-3}\ cm^3$

$= 100 \times 10^{-4}$

$\Rightarrow x = 0.1608 \times 10^3$

≈ 161

10. **(25)** For the reaction:

$Cu^{2+}(aq)+2e^- \rightarrow Cu(s)$

The reduction potential is

$$E = E^o - \frac{RT}{2F}\ln\frac{1}{\left[Cu^{2+}\right]}$$

From the given data $pH = 14$ and

$K_{sp} = \left(Cu(OH)_2\right) = 1.0 \times 10^{-20}$, we get

$$[H^+] = 10^{-14}M, [OH^-] = \frac{K_W}{[H^+]} = \frac{10^{-14}M^2}{10^{-14}M} = 1M$$

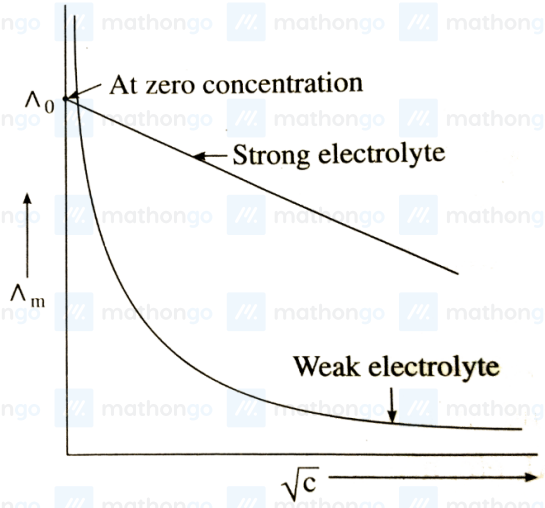
$$\left[Cu^{2+}\right] = \frac{K_{sp}}{[OH^-]^2} = \frac{1.0\times10^{-20}M^2}{1M} = 1.0 \times 10^{-20}M$$

$$E = 0.34\ V - \left(\frac{0.059V}{2}\right)\log\frac{1}{1.0\times10^{-20}} = 0.34\ V - \frac{0.059\times20V}{2}$$

$$E = 0.34 - 0.59 = -0.25\ V$$

11. **(3)**

Conductivity always decreases with the decrease in concentration both, for weak and strong electrolytes.



This can be explained by the fact that the number of ions per unit volume that carry the current in a solution decreases on dilution.

Molar conductivity of a strong and weak electrolyte increases with dilution. On dilution as volume of solution increases. Thus, on dilution, ions get more apart and mobility of ions increases which leads to increase in molar conductivity of the solution.

Except (B) and (E), all statements are correct.