Electro Chemistry 2

Conductance :-

metal

1) Electronic Conductance e^-

2) Electrolytic Conductance ions

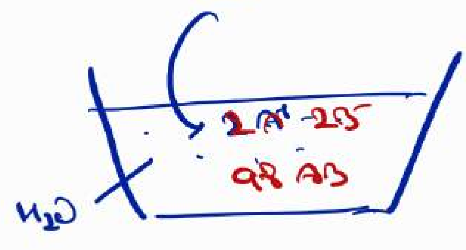
liquids

WE   S.E

%

AB

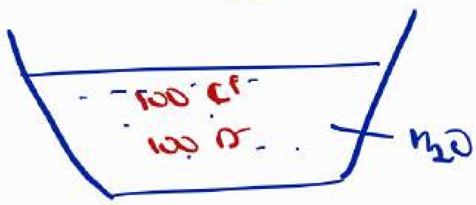
100 WE



100%

100 S.E

CD



SE & WE :-

all Soluble

N - NO_3^-

A - CH_3COO^-

G - grp-1 (Na, K, ...)

S - SO_4^{2-}

A - NH_4^+

G - grp-17 (F, Cl, ...)

Not Soluble

SML

Ag^{+1} Hg^{+1} Pb^{+2}

Hg_2^{+2}

CSB (II)

Ca^{+2} Sr^{+2} Ba^{+2}

Conductance:-

Terms

R — Resistance — ohm

ρ — Resistivity — ohm cm

$$R = \rho \cdot \frac{l}{A}$$

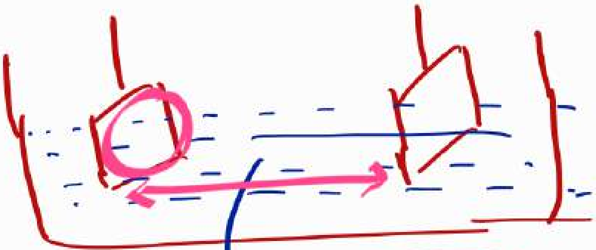
$$R \propto \frac{1}{C} \qquad \rho \propto \frac{1}{K}$$

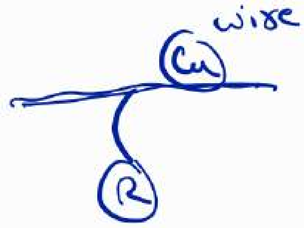
C — Conductance — ohm^{-1} — Siemen

K — Conductivity / Sp. Conductance — $ohm^{-1}\,cm^{-1}$ — Siemen cm^{-1}

$$C = K \cdot \frac{A}{l}$$

Resistance:- R





$$R \propto \frac{l}{A}$$

$$R = \rho \cdot \frac{l}{A}$$

$$R = \rho \cdot \frac{l}{A}$$

$$\boxed{R = \frac{1}{K} \cdot \frac{l}{A}}$$

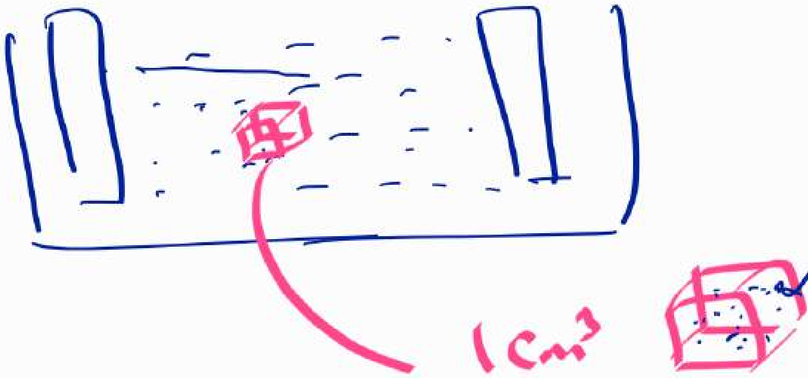
Measuring Conductance :-

1, k (Sp. Conductance) — $ohm^{-1}\ cm^{-1}$

2, Λ (Equivalent Conductance) — CGS: $ohm^{-1}\ cm^{2}\ eq^{-1}$; SI: $ohm^{-1}\ m^{2}\ eq^{-1}$

3, μ (Molar Conductance) — $ohm^{-1}\ cm^{2}\ mol^{-1}$; $ohm^{-1}\ m^{2}\ mol^{-1}$

k :-

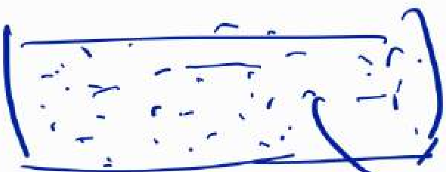


$1\ cm^3$

Conductance shown by the ions present in $1\ cm^3$ vol

Λ : Conductance shown by 1 g eq. ions

Λ_{eq}



Conductance by 1 N soln $\Longrightarrow \Lambda$

Λ_m

μ : Conductance shown by 1 molar ions

1 M soln $\Longrightarrow \mu$

Conductance by

Relationship among κ, Λ & μ :-

$\kappa =$ 1 cm³

$\mu =$ 1 molar ions

$$\boxed{\mu = \kappa \times V}$$

1 cm³

1 molar soln is occupying 'V' vol

CGS/SI

1 M

$$\boxed{\mu = \frac{\kappa}{M}}$$

ohm⁻¹ cm⁻¹

CGS

ohm⁻¹ cm² mol⁻¹

~~molar~~

mol/cm³

$M = \frac{n}{V_{L}}$

$M = \frac{1}{V}$

$V = \frac{1}{M}$

$$\boxed{\mu = \frac{\kappa \times 1000}{M}}$$

molar 3M / 2M / 1M

CGS

ohm⁻¹ cm² mol⁻¹ ; ohm⁻¹ cm⁻¹

$$\boxed{\mu = \frac{\kappa \times 1000}{M}}$$

molar

ohm⁻¹ cm² eq⁻¹ ; ohm⁻¹ cm⁻¹

$$\boxed{\Lambda = \frac{\kappa \times 1000}{N}}$$

normal

SI

ohm⁻¹ m² mol⁻¹ ; ohm⁻¹ m⁻¹

$$\boxed{\mu = \frac{\kappa}{M \times 1000}}$$

molar

ohm⁻¹ m² eq⁻¹ ; ohm⁻¹ m⁻¹

$$\boxed{\Lambda = \frac{\kappa}{N \times 1000}}$$

normal

***

$$\boxed{\mu = n \times \Lambda}$$

effect of dillution :-

Cond | K | μ | Λ

dillution ↑
Conc ↓

$K \downarrow$

$\mu \uparrow$

$\Lambda \uparrow$

$n_{ions} \downarrow$ cond ↓

WE ↑

$\mu \uparrow \Rightarrow$ d.o.d ↑
dissociation

(α very less)

$\alpha \uparrow$

S.E ↑ 100%

$\mu \uparrow$ = mobility ↑

Speed

Conc ↑

measure :-

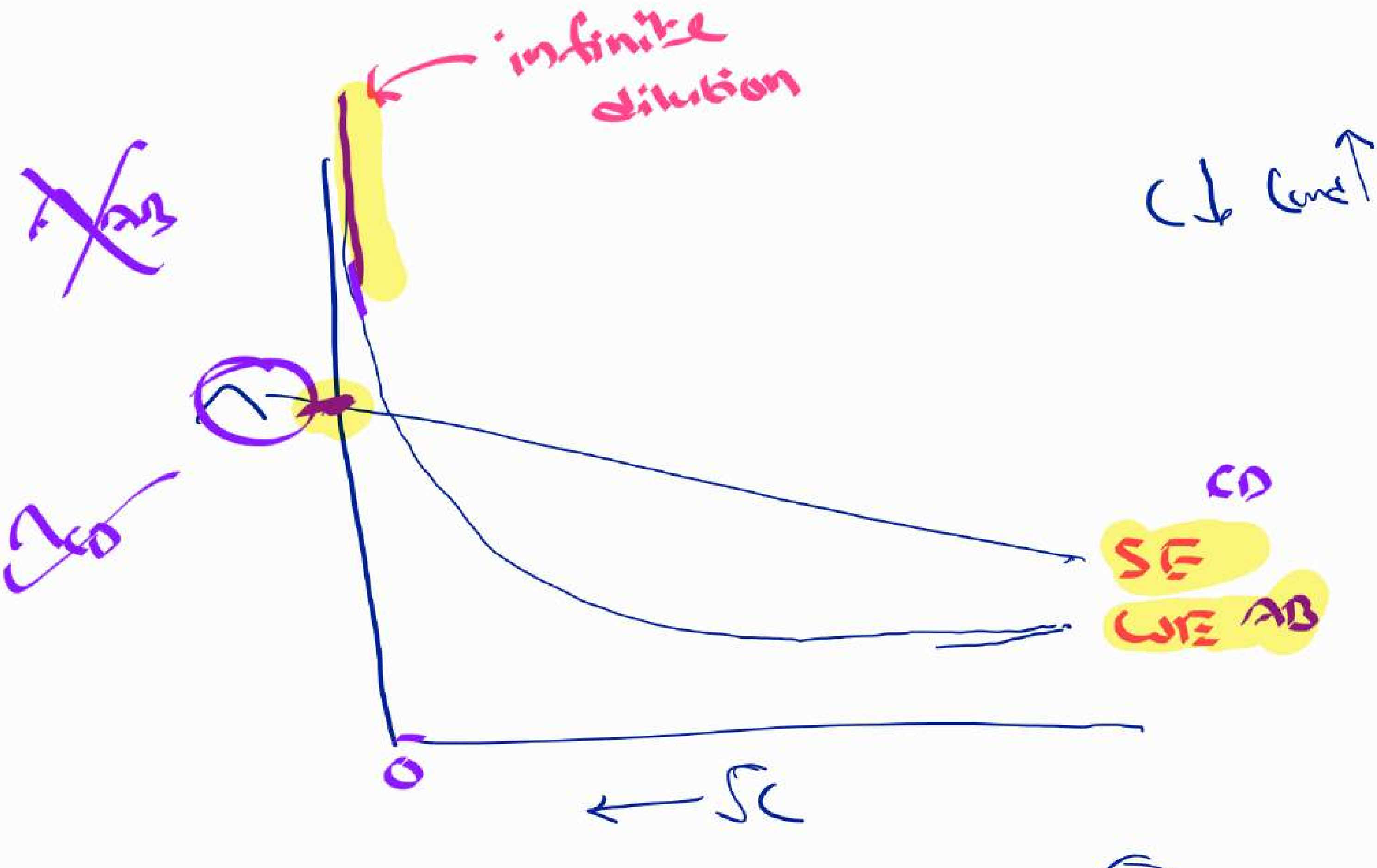
Kohlrausch law :-

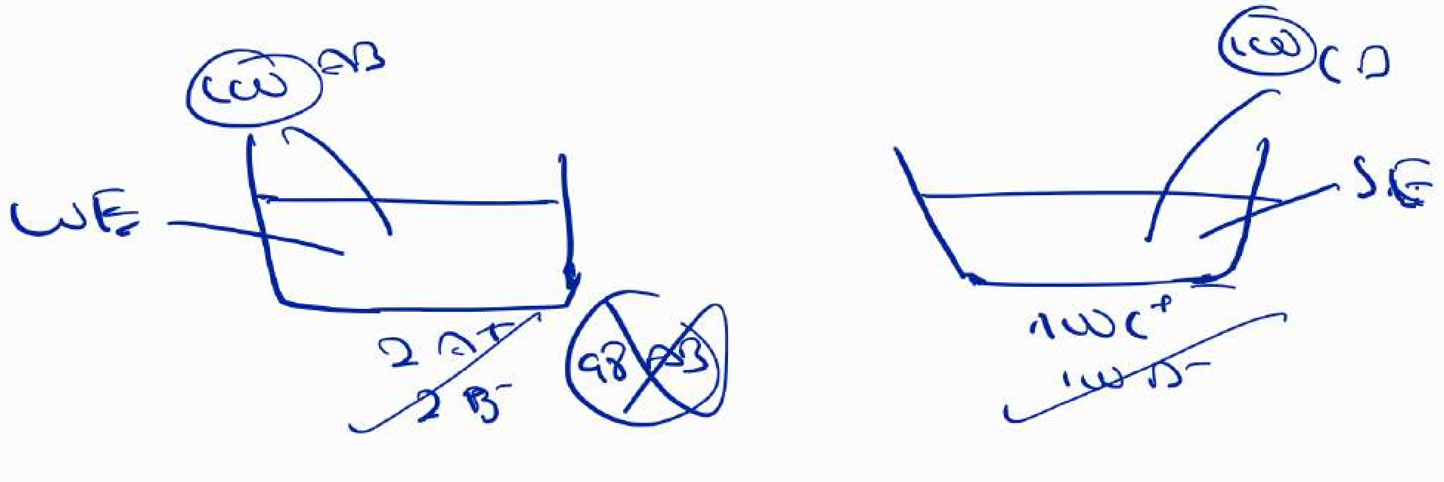
dil^n = Cond $\uparrow$

W.E = $\alpha \downarrow$ = Cond $\downarrow$

S.E $\alpha \uparrow$ = Conductivity = good

dil^n = Cond $\uparrow$





HCl HBr HI

100 H^+ 100 H^+ 100 H^+

Same Same Same

any ion, ionic Conductance doesnot depend on its original Source/ Nature of electrolyte

It is independant

100 CH_3COOH WA/WE → 2 H^+ C↓

100 HCl SA/WE → 100 H^+ C↑

$H^+ \equiv H^+$

Conductance of weak electrolyte :-

CH_3COOH WE → difficult to find Conductance

Kohlrausch law

Conductance of WE with the help of SE

μ_{CH_3COOH}

$$\mu_{CH_3COOH} = \mu_{CH_3COONa} + \mu_{HCl} - \mu_{NaCl}$$

(Salt, SA, Salt)

CH_3COO^- $\cancel{Na^+}$ H^+ $\cancel{Cl^-}$ $\cancel{Na^+}$ $\cancel{Cl^-}$

$:= CH_3COO^- + H^+$

μ

A_2B_3

$$\mu_{A_2B_3} = 2\mu_{A^{+3}} + 3\mu_{B^{-2}}$$

Coefficients

Λ

A_2B_3

$$\Lambda_{A_2B_3} = 1\Lambda_{A^{+3}} + 1\Lambda_{B^{-2}}$$

no coefficients

no stoichiometry

$$\boxed{\mu = n \times \Lambda}$$

molar conductance

equivalent conductance

degree of dissociation :- (α)

WE
100

2 ions

SE

max Cond

$\alpha = 100\%$

$= 1$

dil^n → Cond ↑

infinite dil^n ⇒ max Cond

Cond x%

$$\boxed{\alpha = \frac{\Lambda_c}{\Lambda_\infty}}$$

infinite max Cond 100%

$$\boxed{\alpha = \frac{\mu_c}{\mu_\infty}}$$

42. Aqueous solution of which of the following compounds is the best conductor of electric current ?

(a) Ammonia, NH_3 NE (b) Fructose, $C_6H_{12}O_6$ Non elyte

(c) Acetic acid, CH_3COOH W.E

(d) Hydrochloric acid, HCl **[CBSE AIPMT 2015]**

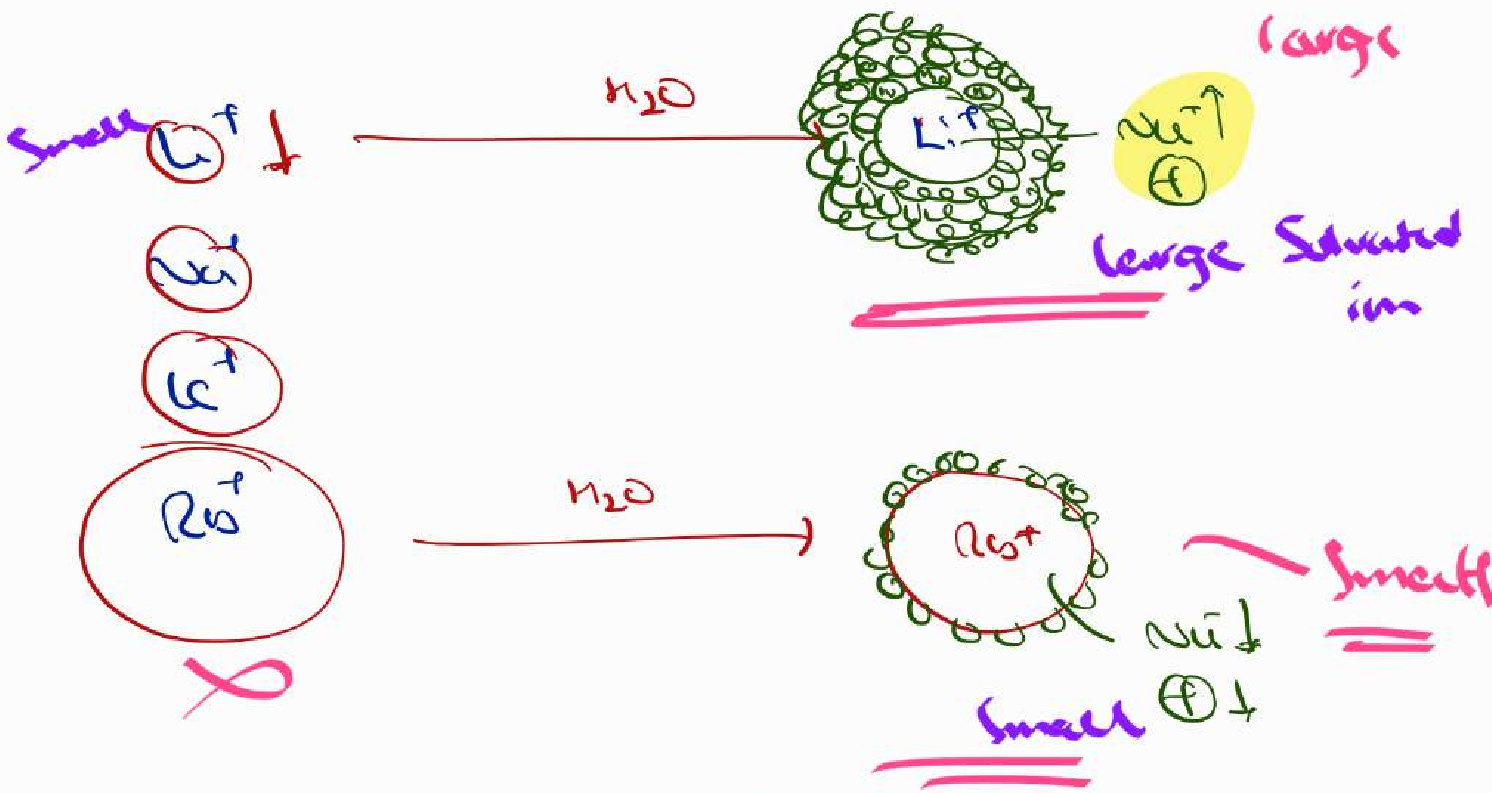
S.E

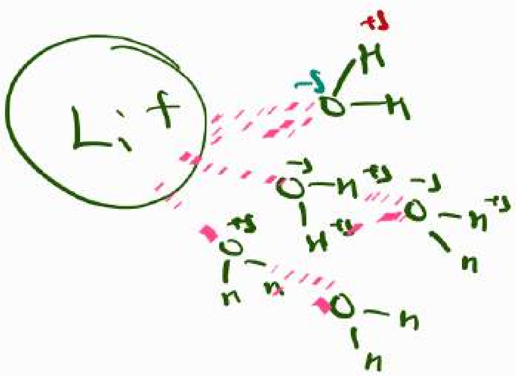
19. The correct order of the mobility of the alkali metal ions in aqueous solution is :

(a) $K^+ > Rb^+ > Na^+ > Li^+$ (b) $Rb^+ > K^+ > Na^+ > Li^+$
(c) $Li^+ > Na^+ > K^+ > Rb^+$ (d) $Na^+ > K^+ > Rb^+ > Li^+$

[CBSE AIPMT 2008]

$$\boxed{\text{mobility} \propto \frac{1}{\text{Size of Solvated ion}}}$$





$Rb^+ > K^+ > Na^+ > Li^+$

26. An increase in equivalent conductivity of strong electrolyte with dilution is mainly due to :

(a) increase in ionic mobility of ions

(b) 100% ionisation of electrolyte at normal dilution

(c) increase in both, *i.e.* no. of ions and ionic mobility

(d) increase in no. of ions **[CBSE AIPMT 2010]**

WE

32. Limiting molar conductivity of NH$_4$OH, *i.e.* $\Lambda^\circ_m(NH_4OH)$ is equal to : ↑ Conductance at inf dilⁿ

(a) $\Lambda^\circ_m(NH_4OH) + \Lambda^\circ_m(NH_4Cl) - \Lambda^\circ_m(HCl)$

(b) $\Lambda^\circ_m(NH_4Cl) + \Lambda^\circ_m(NaOH) - \Lambda^\circ_m(NaCl)$ ← SE

(c) $\Lambda^\circ_m(NH_4Cl) + \Lambda^\circ_m(NaCl) - \Lambda^\circ_m(NaOH)$

(d) $\Lambda^\circ_m(NH_4OH) + \Lambda^\circ_m(NaCl) - \Lambda^\circ_m(NH_4Cl)$

[CBSE AIPMT 2012]

33. Molar conductivities $\left(\Lambda^{\circ}_{m}\right)$ at infinite dilution of NaCl, HCl and CH_3COONa are 126.4, 425.9 and 91.0 S cm^2 mol^{-1} respectively. Λ°_{m} for CH_3COOH will be :

(a) 425.5 S cm^2 mol^{-1} (b) 180.5 S cm^2 mol^{-1}

(c) 290.8 S cm^2 mol^{-1} (d) 390.5 S cm^2 mol^{-1}

[CBSE AIPMT 2012]

$CH_3COO \mid H$

$NaCl - HCl + CH_3COONa$

27. Which of the following expressions correctly represents the equivalent conductance at infinite dilution of $Al_2(SO_4)_3$. Given that $\Lambda^{\circ}_{Al^{3+}}$ and $\Lambda^{\circ}_{SO_4^{2-}}$ are the equivalent conductances at infinite dilution of the respective ions ?

1 : 1

(a) $2\Lambda^{\circ}_{Al^{3+}} + 3\Lambda^{\circ}_{SO_4^{2-}}$

(b) $\Lambda^{\circ}_{Al^{3+}} + \Lambda^{\circ}_{SO_4^{2-}}$

(c) $\left(\Lambda^{\circ}_{Al^{3+}} + \Lambda^{\circ}_{SO_4^{2-}}\right) \times 6$

(d) $\frac{1}{3}\Lambda^{\circ}_{Al^{3+}} + \frac{1}{2}\Lambda^{\circ}_{SO_4^{2-}}$

[CBSE AIPMT 2010]

Λ

$\Lambda_{Al_2(SO_4)_3} = 1\,\Lambda_{Al^{+3}} + 1\,\Lambda_{SO_4^{-2}}$

μ

$\mu_{molar}\ Al_2SO_4^{-3}$?

$\Lambda_{eq}\ Al^{+3} = x$

$\Lambda_{eq}\ SO_4^{-2} = y$

$\Downarrow$

$\mu = n\Lambda$

$\Lambda_{Al_2(SO_4)_3} = \Lambda_{Al^{+3}} + \Lambda_{SO_4^{-2}}$

$= n(x+y)$

$= x + y$

n factor

$= 6 \times (x+y)$

$Al_2(SO_4)_3$

$2(+3)$ $\quad$ $3(-2) = -6$

$+6$

$MgCl_2$

Mg^{+2} $\quad$ $2Cl^-$

$+2$ $\quad$ -2

n factor = $\dfrac{\text{total charge of } C^+ \text{ ion}}{\text{total charge of } A^-}$

53. The molar conductance of NaCl, HCl and CH_3COONa at infinite dilution are 126·45, 426·16 and 91 $Scm^2\,mol^{-1}$ respectively. The molar conductance of CH_3COOH at infinite dilution is :

(a) $201{\cdot}28\ S\,cm^2\,mol^{-1}$ (b) $390{\cdot}71\ S\,cm^2\,mol^{-1}$

(c) $698{\cdot}28\ S\,cm^2\,mol^{-1}$ (d) $540{\cdot}48\ S\,cm^2\,mol^{-1}$ [NEET 2021]

47. The molar conductivity of a 0.5 mol/dm^3 solution of $AgNO_3$ with electrolytic conductivity of 5.76×10^{-3} S cm^{-1} at 298 K is

(a) 2.88 S cm^2/mol (b) 11.52 S cm^2/mol

(c) 0.086 S cm^2/mol (d) 28.8 S cm^2/mol

[NEET 2016]

$\mu = ?$

$C = 0.5$ M

$K = 5.76 \times 10^{-3}$ S cm^{-1}

cgs

$$\mu = \frac{K \times 1000}{M}$$

23. The equivalent conductance of $\frac{M}{32}$ solution of a weak monobasic acid is 8.0 mho cm^2 and at infinite dilution is 400 mho cm^2. The dissociation constant of this acid is

(a) 1.25×10^{-5} (b) 1.25×10^{-6}

(c) 6.25×10^{-4} (d) 1.25×10^{-4}

$K_a =$

[CBSE AIPMT 2009]

$$CH_3COOH \xrightarrow{H_2O} CH_3COO^- + H^+$$

initial: C 0 0

$t =$: $C - C\alpha$ $C\alpha$ $C\alpha$

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$$

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

$$\boxed{K_a = C\alpha^2}$$

$$K_a = C\alpha^2 \quad (C = 1/32)$$

$$\alpha = \frac{\Lambda_c}{\Lambda_\infty} = \frac{8}{400} = 0.02$$

$\Lambda_c = 8.0$ S cm^2

$\Lambda_\infty = 400$ mho cm^2

$$= \frac{1}{32} \times (0.02)^2$$

$$= \frac{1}{\cancel{32}_{8}} \times \cancel{4}^{\,} \times 10^{-4}$$

$$= \frac{1}{8} \times 10^{-4}$$

$$= 0.125 \times 10^{-4}$$

54. The molar conductivity of 0·007 in acetic acid is 20 S $cm^2 mol^{-1}$. What is the dissociation constant of acetic acid ? Choose the correct option :

$$\Lambda^{\circ}_{H^+} = 350 \text{ S cm}^2 \text{ mol}^{-1};\ \Lambda^{\circ}_{CH_3COO^-} = 50 \text{ S cm}^2 \text{ mol}^{-1}$$

(a) $1 \cdot 75 \times 10^{-4} \text{mol L}^{-1}$ (b) $2 \cdot 50 \times 10^{-4} \text{mol L}^{-1}$

(c) $1 \cdot 75 \times 10^{-5} \text{mol L}^{-1}$ (d) $2 \cdot 50 \times 10^{-5} \text{mol L}^{-1}$ [NEET 2021]

$C = 0.007\ M$

$\Lambda_c = 20\ S\,cm^2\,mol^{-1}$

$K_a = ?$

$K_a = C\alpha^2$

$\alpha = \dfrac{\Lambda_c}{\Lambda_\infty}$

20

Λ^∞

35. The limiting molar conductivities of HCl, CH_3COONa and NaCl are respectively 425, 90 and 125 mho cm^2 mol^{-1} at 25°C. The molar conductivity of 0·1M CH_3COOH solution is 7·8 mho cm^2 mol^{-1} at the same temperature. The degree of dissociation of 0·1 M acetic acid solution at the same temperature is

(a) 0.10 (b) 0.02

(c) 0.15 (d) 0.03 **[CBSE AIPMT 2012]**

$$K_a = C\alpha^2$$

Acid dissociation Constant

degree of dissociation

37. At 25° C molar conductance of 0.1 molar aqueous solution of ammonium hydroxide is 9.54 $ohm^{-1}\ cm^2\ mol^{-1}$ and at infinite dilution its molar conductance is 238 $ohm^{-1}\ cm^2\ mol^{-1}$. The degree of ionisation at the same temperature is:

(a) 20.800% (b) 4.0008%

(c) 40.800% (d) 2.080% **[CBSE AIPMT 2013]**

$$\alpha = \frac{\mu_c}{\mu_\infty}$$

39. When 0.1 mol MnO_4^{2-} is oxidised, the quantity of electricity required to completely oxidise MnO_4^{2-} to MnO_4^- is

(a) 96500 C (b) 2×96500 C

(c) 9650 C (d) 96.50 C **[CBSE AIPMT 2014]**

46. 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 [NEET 2016]

22. Al_2O_3 is reduced by electrolysis at low potentials and high currents. If 4.0×10^4 amperes of current is passed through molten Al_2O_3 for 6 hours, what mass of aluminium is produced ?

(Assume 100% current efficiency. At mass of Al = 27 g mol^{-1})

(a) 1.3×10^4 g

(b) 9.0×10^3 g

(c) 8.05×10^4 g

(d) 2.4×10^5 g

[CBSE AIPMT 2009]

40. The weight of silver (At. Wt =108) displaced by a quantity of electricity which displaces 5600 mL of O_2 at STP will be

(a) 5.4 g
(b) 10.8 g
(c) 54.0 g
(d) 108.0 g [CBSE AIPMT 2014]

12. 4.5 g of Al (atomic mass 27 amu) is deposited at cathode from Al^{3+} solution by a certain quantity of charge. The volume of H_2 produced at STP from H^+ ions in solution by the same quantity of charge will be :

(a) 11.2 L
(b) 44.8 L
(c) 5.6 L
(d) 22.4 L. [CBSE AIPMT 2005]

10. An electric current is passed through silver nitrate solution using silver electrodes. 10.79 g of silver was found to be deposited on the cathode. If the same amount of electricity is passed through copper sulphate solution using copper electrodes, the weight of copper deposited on the cathode is

(a) 6.4 g (b) 2.3 g

(c) 12.8 g (d) 3.2 g [CBSE AIPMT 2004]

52. On electrolysis of dilute sulphuric acid using (Pt) platinum electrode, the product obtained at anode will be :

(a) SO_2 gas (b) hydrogen gas

(c) Oxygen gas (d) H_2S gas [NEET 2020]

43. Zinc can be coated on iron to produce galvanised iron but the reverse is not possible. It is because

(a) zinc is lighter than iron

(b) zinc has lower melting point than iron

(c) zinc has lower negative electrode potential than iron

(d) zinc has higher negative electrode potential than iron

[NEET 2016]

18. Standard free energies of formation (in kJ/mol) at 298 K are –237.2, –394.4 and –8.2 for $H_2O(l)$, $CO_2(g)$ and pentane(g), respectively. The value of E°_{cell} for the pentane-oxygen fuel cell is :

(a) 2.0968 V (b) 1.0968 V

(c) 0.0968 V (d) 1.968 V [CBSE AIPMT 2008]

6. On the basis of the information available from the reaction

$$\frac{4}{3}\text{Al} + \text{O}_2 \rightarrow \frac{2}{3}\text{Al}_2\text{O}_3,\ \Delta G = -827\ \text{kJ mol}^{-1}\ \text{of}\ \text{O}_2$$

the minimum *emf* required to carry out an electrolysis of Al_2O_3 is ($F = 96500\ \text{C mol}^{-1}$)

(a) 8.56 V (b) 2.14 V

(c) 4.28 V (d) 6.42 V [CBSE AIPMT 2003]

4. In electrolysis of NaCl when Pt electrode is taken then H_2 is liberated at cathode while with Hg cathode it forms sodium amalgam because

(a) Hg is more inert than Pt

(b) more voltage is required to reduce H^+ at Hg than at Pt

(c) Na is dissolved in Hg while it does not dissolve in Pt.

(d) Concentration of H^+ ions is larger when Pt electrode is taken. [CBSE AIPMT 2002]

2. The most convenient method to protect the bottom of the ship made of iron is

(a) white tin plating

(b) coating it with red lead oxide

(c) connecting it with Mg block

(d) connecting it with Pb block [CBSE AIPMT 2001]