



DPP –10 [KOHLRAUSCH'S LAW]

Chapter: Electrochemistry

“No one sees the late nights, the doubts, the pressure you carry. But every question you solve today is proof that you are still fighting. Keep going.”

TYPE–1 : Kohlrausch's Law Statement & Expressions

1. Kohlrausch's law states that at:

- (1) Infinite dilution, each ion makes definite contribution to conductance of an electrolyte whatever be the nature of the other ion of the electrolyte.
- (2) Infinite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte whatever be the nature of the other ion of the electrolyte.
- (3) Finite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte whatever be the nature of the other ion of the electrolyte.
- (4) Infinite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte depending on the nature of the other ion of electrolyte.

2. Limiting molar conductivity of NH_4OH (i.e. $\Lambda_{\text{m}[\text{NH}_4\text{OH}]}$) is equal to:

- (1) $\Lambda_{\text{m}[\text{NH}_4\text{OH}]} + \Lambda_{\text{m}[\text{NH}_4\text{Cl}]} - \Lambda_{\text{m}[\text{HCl}]}$
- (2) $\Lambda_{\text{m}[\text{NH}_4\text{Cl}]} + \Lambda_{\text{m}[\text{NaOH}]} - \Lambda_{\text{m}[\text{NaCl}]}$
- (3) $\Lambda_{\text{m}[\text{NH}_4\text{Cl}]} + \Lambda_{\text{m}[\text{NaCl}]} - \Lambda_{\text{m}[\text{NaOH}]}$
- (4) $\Lambda_{\text{m}[\text{NaOH}]} + \Lambda_{\text{m}[\text{NaCl}]} - \Lambda_{\text{m}[\text{NH}_4\text{Cl}]}$

TYPE–2 : Molar Conductivity Calculations

3. At infinite dilution, the equivalent conductances of CH_3COONa , HCl and CH_3COOH are 91, 426 and 391 $\text{mho cm}^2 \text{eq}^{-1}$ respectively at 25 °C. The eq. conductance of NaCl at infinite dilution will be:

- (1) 126
- (2) 209
- (3) 391
- (4) 908

4. The limiting molar conductivities Λ^0 for NaCl , KBr and KCl are 126, 152 and 150 $\text{S cm}^2 \text{mol}^{-1}$ respectively. The Λ^0 for NaBr is:

- (1) 278 $\text{S cm}^2 \text{mol}^{-1}$
- (2) 176 $\text{S cm}^2 \text{mol}^{-1}$
- (3) 128 $\text{S cm}^2 \text{mol}^{-1}$
- (4) 302 $\text{S cm}^2 \text{mol}^{-1}$

5. The molar conductance at infinite dilution of AgNO_3 , AgCl and NaCl are 116.5, 121.6 and 110.3 $\text{S cm}^2 \text{mol}^{-1}$ respectively. The molar conductance of NaNO_3 is:

- (1) 111.4 $\text{S cm}^2 \text{mol}^{-1}$
- (2) 105.2 $\text{S cm}^2 \text{mol}^{-1}$
- (3) 130.6 $\text{S cm}^2 \text{mol}^{-1}$
- (4) 150.2 $\text{S cm}^2 \text{mol}^{-1}$

6. The molar conductivities λ_{NaOAc}^0 and λ_{HCl}^0 at infinite dilution in water at 25°C are 91.0 and 426.2 S cm² mol⁻¹ respectively. To calculate λ_{HOAc}^0 the additional value required is:

- (1) λ_{NaCl}^0 (2) $\lambda_{\text{H}_2\text{O}}^0$
 (3) λ_{KCl}^0 (4) λ_{NaOH}^0

7. Molar conductivities (Λ_m^0) at infinite dilution of NaCl, HCl and CH₃COONa are 126.4, 425.9 and 91.0 S cm² mol⁻¹ respectively. Λ_m^0 for CH₃COOH will be:

- (1) 290.8 S cm² mol⁻¹ (2) 390.5 S cm² mol⁻¹
 (3) 425.5 S cm² mol⁻¹ (4) 180.5 S cm² mol⁻¹

8. If limiting molar conductances of Ca²⁺ and Cl⁻ ions are 119 and 76.3 S cm² mol⁻¹ respectively. The limiting molar conductivity of CaCl₂ is:

- (1) 347 S cm² mol⁻¹ (2) 271.6 S cm² mol⁻¹
 (3) 42.7 S cm² mol⁻¹ (4) 195.3 S cm² mol⁻¹

9.

| Electrolyte | KCl | KNO ₃ | HCl | NaOAc | NaCl |
|--|-------|------------------|-------|-------|-------|
| Λ° (S cm ² mol ⁻¹) | 149.9 | 145.0 | 426.2 | 91.0 | 126.5 |

Calculate Λ_{HOAc}^0 using appropriate molar conductances of the electrolytes listed above at infinite dilution in H₂O at 25 °C

- (1) 390.7 (2) 217.5 (3) 517.2 (4) 552.7

10. The molar conductivity of an infinitely diluted solution of NH₄Cl is 150 S cm² mol⁻¹ and the ionic conductances of OH⁻ and Cl⁻ ions are 198 S cm² mol⁻¹ and 76 S cm² mol⁻¹ respectively. The molar conductivity (S cm² mol⁻¹) of the solution of NH₄OH at infinite dilution is [NCERT Pg. 83]

- (1) 272 (2) 424
 (3) 124 (4) 226

11. For strong electrolytes the values of molar conductivities at infinite dilution are given below

| Electrolyte | λ_m^0 (S m ² mol ⁻¹) |
|-------------------|---|
| BaCl ₂ | 280×10^{-4} |
| NaCl | 126.5×10^{-4} |
| NaOH | 248×10^{-4} |

The molar conductance at infinite dilution for Ba(OH)₂ is

- (1) 523×10^{-4} S m² mol⁻¹
 (2) 52.3×10^{-4} S m² mol⁻¹
 (3) 5.23×10^{-4} S m² mol⁻¹
 (4) 523×10^{-2} S m² mol⁻¹

12. Following limiting molar conductivities are given as

$$\lambda_m^\circ(\text{H}_2\text{SO}_4) = x \text{ S cm}^2 \text{ mol}^{-1}$$

$$\lambda_m^\circ(\text{K}_2\text{SO}_4) = y \text{ S cm}^2 \text{ mol}^{-1}$$

$$\lambda_m^\circ(\text{CH}_3\text{COOK}) = z \text{ S cm}^2 \text{ mol}^{-1}$$

λ_m° (in S cm² mol⁻¹) for CH₃COOH will be

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- (1) $\frac{(x - y)}{2} + z$ (2) $x - y + 2z$
 (3) $x + y + z$ (4) $x - y + z$

13. The molar conductances of NaCl, HCl and CH₃COONa at infinite dilution are 126.45,

426.16 and $91 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$ respectively. The molar conductance of CH_3COOH at infinite dilution is

- (1) $698.28 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$
- (2) $540.48 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$
- (3) $201.28 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$
- (4) $390.71 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$

14. From the following molar conductivities at infinite dilution,

$$\Lambda_m^0 \text{ for } \text{Al}_2(\text{SO}_4)_3 = 858 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\Lambda_m^0 \text{ for } \text{NH}_4\text{OH} = 238.3 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\Lambda_m^0 \text{ for } (\text{NH}_4)_2\text{SO}_4 = 238.4 \text{ S cm}^2 \text{ mol}^{-1}$$

Calculate Λ_m^0 for $\text{Al}(\text{OH})_3$

- (1) $715.2 \text{ S cm}^2 \text{ mol}^{-1}$
- (2) $1575.6 \text{ S cm}^2 \text{ mol}^{-1}$
- (3) $786.3 \text{ S cm}^2 \text{ mol}^{-1}$
- (4) $157.56 \text{ S cm}^2 \text{ mol}^{-1}$

TYPE-3 : Equivalent Conductance Problems

15. Ionic conductance of H^+ and SO_4^{2-} are x and $y \text{ S cm}^2 \text{ mol}^{-1}$. Hence, equivalent conductivity of H_2SO_4 is

- (1) $2x + \frac{y}{2}$
- (2) $x + \frac{y}{2}$
- (3) $\frac{x}{2} + y$
- (4) $\frac{x}{2} + \frac{y}{2}$

16. Which of the following expressions correctly represents the equivalent conductance at infinite dilution of $\text{Al}_2(\text{SO}_4)_3$. Given that $\Lambda_{\text{Al}^{3+}}^0$ and $\Lambda_{\text{SO}_4^{2-}}^0$ are the equivalent conductances at infinite dilution of the respective ions:

- (1) $\Lambda_{\text{Al}^{3+}}^0 + \Lambda_{\text{SO}_4^{2-}}^0$
- (2) $(\Lambda_{\text{Al}^{3+}}^0 + \Lambda_{\text{SO}_4^{2-}}^0) \times 6$
- (3) $\frac{1}{3}\Lambda_{\text{Al}^{3+}}^0 + \frac{1}{2}\Lambda_{\text{SO}_4^{2-}}^0$
- (4) $2\Lambda_{\text{Al}^{3+}}^0 + 3\Lambda_{\text{SO}_4^{2-}}^0$

17. Molar conductances of BaCl_2 , H_2SO_4 and HCl at infinite dilutions are x_1 , x_2 and x_3 respectively. Equivalent conductance of BaSO_4 at infinite dilution will be:

- (1) $\frac{[x_1 + x_2 - x_3]}{2}$
- (2) $\frac{[x_1 - x_2 - x_3]}{2}$
- (3) $2(x_1 + x_2 - 2x_3)$
- (4) $\frac{[x_1 + x_2 - 2x_3]}{2}$

18. Equivalent conductances of Ba^{2+} and Cl^- ions are 127 and $76 \text{ ohm}^{-1} \text{ cm}^2 \text{ eq}^{-1}$ respectively. Equivalent conductance of BaCl_2 at infinite dilution is (in the unit $\text{ohm}^{-1} \text{ cm}^2 \text{ eq}^{-1}$)

- (1) 139.5
- (2) 101.5
- (3) 203
- (4) 279

19. The value of λ_{eq}^0 ($\text{cm}^2 \Omega^{-1} \text{ eq}^{-1}$) of Al^{3+} is x and Cl^- is y then, the value of λ_m^0 ($\text{cm}^2 \Omega^{-1} \text{ mole}^{-1}$) of AlCl_3 will be

- (1) $\frac{x}{3} + y$
- (2) $3x + 3y$
- (3) $\frac{x}{3} + \frac{y}{3}$
- (4) $3x + \frac{y}{3}$

TYPE-4 : Advanced Calculations with Degree of Dissociation

20. The equivalent conductivity of 0.1 N CH_3COOH at 25 °C is 80 and at infinite dilution it is 400. The degree of dissociation of CH_3COOH is:
- (1) 1 (2) 0.2
(3) 0.1 (4) 0.5
21. The conductivities at infinite dilution of NH_4Cl , NaOH and NaCl are 130, 218, 120 $\text{ohm}^{-1}\text{cm}^2 \text{eq}^{-1}$. If equivalent conductance of $\frac{\text{N}}{100}$ solution of NH_4OH is 10, then degree of dissociation of NH_4OH at this dilution is
- (1) 0.005 (2) 0.044
(3) 0.01 (4) 0.02
22. At 25 °C molar conductance of 0.1 molar aqueous solution of ammonium hydroxide is 9.54 $\text{ohm}^{-1} \text{cm}^2 \text{mol}^{-1}$ and at infinite dilution its molar conductance is 238 $\text{ohm}^{-1} \text{cm}^2 \text{mol}^{-1}$. The degree of ionisation of ammonium hydroxide at the same concentration and temperature is:
- (1) 40.800 % (2) 2.080 %
(3) 20.800 % (4) 4.008 %
23. If equivalent conductance of 1M benzoic acid is 12.8 $\text{ohm}^{-1} \text{cm}^2 \text{eq}^{-1}$ and if the equivalent conductances of benzoate ion and H^+ ion at infinite dilution are 42 and 288.42 $\text{ohm}^{-1} \text{cm}^2 \text{eq}^{-1}$ respectively, then its degree of dissociation is
- (1) 39%
(2) 3.9%
(3) 0.35%
(4) 0.039%
24. For HCl solution at 25 °C, equivalent conductance at infinite dilution, is 425 $\text{ohm}^{-1} \text{cm}^2 \text{eq}^{-1}$. The specific conductance of a solution of HCl is 3.825 $\text{ohm}^{-1} \text{cm}^{-1}$. If the degree of dissociation is 90%. The normality of the solution is:
- (1) 0.90 N (2) 1.0 N
(3) 10 N (4) 1.2 N
25. Limiting molar conductance of H^+ and CH_3COO^- ions are 344 $\text{ohm}^{-1} \text{cm}^2 \text{mol}^{-1}$ and 40 $\text{ohm}^{-1} \text{cm}^2 \text{mol}^{-1}$ respectively. Molar conductance of 0.008 M CH_3COOH is 48. What will be the value of K_a for CH_3COOH :
- (1) 1.4×10^{-5} (2) 1.2×10^{-5}
(3) 1.4×10^{-4} (4) 1×10^{-5}
26. The ionization constant of a weak electrolyte is 25×10^{-6} while the equivalent conductance of its 0.01 M solution is 19.6 $\text{S cm}^2 \text{eq}^{-1}$. The equivalent conductance of the electrolyte at infinite dilution (in $\text{S cm}^2 \text{eq}^{-1}$) will be
- (1) 39.2 (2) 78.4 (3) 392 (4) 196
27. The conductivity of a saturated solution of BaSO_4 is $3.06 \times 10^{-6} \text{ohm}^{-1} \text{cm}^{-1}$ and its molar conductance is 1.53 $\text{ohm}^{-1} \text{cm}^{-1} \text{mol}^{-1}$. The K_{sp} of BaSO_4 will be
- (1) 4×10^{-12} (2) 2.5×10^{-9}
(3) 2.5×10^{-13} (4) 4×10^{-6}