1. Calculate $\Lambda^0_{HNO_3}$ and Λ^0_{HOAc} using appropriate molar conductances of the electrolytes listed below at infinite dilution in H_2O at $25°C$.

Electrolyte	$\Lambda^0 (S\ cm^2\ mol^{-1})$
KCl	149.9
$NaCl$	126.5
HCl	426.2
KNO_3	145.0
$NaOAc$	91.0

✗ **A.** $\Lambda^0_{HNO_3} = 390.7\ S\ cm^2 \text{mol}^{-1}$
$\Lambda^0_{HOAc} = 517.2\ S\ cm^2 \text{mol}^{-1}$

✗ **B.** $\Lambda^0_{HNO_3} = 517.2\ S\ cm^2 \text{mol}^{-1}$
$\Lambda^0_{HOAc} = 149.8\ S\ cm^2 \text{mol}^{-1}$

✓ **C.** $\Lambda^0_{HNO_3} = 421.3\ S\ cm^2 \text{mol}^{-1}$
$\Lambda^0_{HOAc} = 390.7\ S\ cm^2 \text{mol}^{-1}$

✗ **D.** $\Lambda^0_{HNO_3} = 149.8\ S\ cm^2 \text{mol}^{-1}$
$\Lambda^0_{HOAc} = 444.7\ S\ cm^2 \text{mol}^{-1}$

Kohlrausch law of independent migration of ions:
$\Lambda^0_m = \lambda^0_+ + \lambda^0_-$

$\lambda^0_+ \rightarrow$ Limiting molar conductivities of cation
$\lambda^0_- \rightarrow$ Limiting molar conductivities of anion

Using the given data,
$\Lambda^0_{HNO_3} = \Lambda^0_{KNO_3} + \Lambda^0_{HCl} - \Lambda^0_{KCl}$
$\Lambda^0_{HNO_3} = 145.0 + 426.2 - 149.9$
$\Lambda^0_{HNO_3} = 421.3\ S\ cm^2 \text{mol}^{-1}$

$\Lambda^0_{HOAc} = \Lambda^0_{NaOAC} + \Lambda^0_{HCl} - \Lambda^0_{NaCl}$
$\Lambda^0_{HOAc} = 91.0 + 426.2 - 126.5$
$\Lambda^0_{HOAc} = 390.7\ S\ cm^2 \text{mol}^{-1}$

2. According to Kohlrausch law, the limiting value of molar conductivity of an electrolyte $Fe_2(SO_4)_3$ is given by:

A. $3\lambda_m^0(Fe^{3+}) + 2\lambda_m^0(SO_4^{2-})$

B. $\lambda_m^0(Fe^{3+}) + \lambda_m^0(SO_4^{2-})$

C. $2\lambda_m^0(Fe^{3+}) + 3\lambda_m^0(SO_4^{2-})$ ✔

D. $\frac{2\lambda_m^0(Fe^{3+}) + 3\lambda_m^0(SO_4^{2-})}{6}$

Kohlrausch law:
At infinite dilution, when all the interionic effects disappear and dissociation of electrolyte is complete, each ion makes a definite contribution towards equivalent conductance of the electrolyte irrespective of the nature of the ion with which it is associated.

At infinite dilution, the ion becomes totally independent of other ions. At this point, it contributes maximum towards the conductance of the solution. This value of molar conductance is known as limiting molar conductivity. It is also called as molar conductivity at infinite dilution. It is represented by Λ_m^0

Kohlrausch law of independent migration of ions:
$\Lambda_m^0 = \lambda_+^0 + \lambda_-^0$

$\lambda_+^0 \rightarrow \text{Limiting molar conductivities of cation}$
$\lambda_-^0 \rightarrow \text{Limiting molar conductivities of anion}$

In general,
$\Lambda_m^0 = v_+\lambda_+^0 + v_-\lambda_-^0$

v_+ and v_- are the number of cations and anions after dissociation of an electrolyte.

For $Fe_2(SO_4)_3$

$Fe_2(SO_4)_3 \rightarrow 2Fe^{3+} + 3SO_4^{2-}$

$\therefore$
$\Lambda_m^0(Fe_2SO_4) = 2\lambda_+^0(Fe^{3+}) + 3\lambda_-^0(SO_4^{2-})$

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

- A. $128\ S\,cm^2mol^{-1}$ ✔
- B. $176\ S\,cm^2mol^{-1}$ ✘
- C. $278\ S\,cm^2mol^{-1}$ ✘
- D. $302\ S\,cm^2mol^{-1}$ ✘

For a strong electrolyte $NaBr$, the limiting molar conductivity is the sum of the individual ionic conductivities.

$$\Lambda^0_{NaBr} = \lambda^0_{Na^+} + \lambda^0_{Br^-}$$

$$\Lambda^0_{NaBr} = \Lambda^0_{NaCl} + \Lambda^0_{KBr} - \Lambda^0_{KCl} \ldots.eqn(1)$$

$$\Lambda^0_{NaBr} = \lambda^0_{Na^+} + \lambda^0_{Cl^-} + \lambda^0_{K^+} + \lambda^0_{Br^-} - \lambda^0_{Na^+} - \lambda^0_{Br^-}$$

$$\Lambda^0_{NaBr} = \lambda^0_{Na^+} + \lambda^0_{Br^-}$$

Hence,
Substituting the values in equation (1), we get-

$$\Lambda^0_{NaBr} = \Lambda^0_{NaC1} + \Lambda^0_{KBr} - \Lambda^0_{KC1}$$

$$\Lambda^0_{NaBr} = 126 + 152 - 150$$
$$\Lambda^0_{NaBr} = 128\ S\,cm^2mol^{-1}$$

Hence, option A is correct.

4. The molar conductances at infinite dilution for electrolytes BA and CA are 140 and 120 $ohm^{-1}cm^2mol^{-1}$ respectively. If the molar conductance at infinite dilution of BX is 198 $ohm^{-1}cm^2mol^{-1}$, then at infinite dilution, the molar conductance of CX is:

- ✔ **A.** $178\ ohm^{-1}cm^2mol^{-1}$
- ✖ **B.** $198\ ohm^{-1}cm^2mol^{-1}$
- ✖ **C.** $218\ ohm^{-1}cm^2mol^{-1}$
- ✖ **D.** $130\ ohm^{-1}cm^2mol^{-1}$

Let the limiting molar conductivity of ions $A,\ B,\ C$ and X be $\lambda^0_A, \lambda^0_B,\ \lambda^0_C \text{ and } \lambda^0_X$ respectively.

$\Lambda^0_{BA} = 140\ ohm^{-1}cm^2mol^{-1}$

$\lambda^0_A + \lambda^0_B = 140......eqn.1$

$\Lambda^0_{CA} = 120\ ohm^{-1}cm^2mol^{-1}$

$\lambda^0_A + \lambda^0_C = 120......eqn.2$

$\Lambda^0_{BX} = 198\ ohm^{-1}cm^2mol^{-1}$

$\lambda^0_B + \lambda^0_X = 198......eqn.3$

Equation $(2) - (1) + (3)$, we get
$\lambda^0_A + \lambda^0_C - \lambda^0_A - \lambda^0_B + \lambda^0_B + \lambda^0_X = 120 - 140 + 198$
$\lambda^0_C + \lambda^0_X = 178$
$\therefore$
Molar conductance at infinite dilution of CX is,
$\Lambda^0_{CX} = 178\ ohm^{-1}cm^2mol^{-1}$

5. At 300 K molar conductivity of solution A is 350 units. and at infinite dilution the molar conductivity of the same sample is 480 unit. Predict the percentage dissociation of the electrolyte.

- ✔ **A.** 73.0 %
- ✖ **B.** 37.0 %
- ✖ **C.** 63.0 %
- ✖ **D.** 137.0 %

Given, $\Lambda_m^0 = 480$

$\Lambda_m = 350$

$$\alpha = \frac{\text{molar conductivity of solution at given concentration}}{\text{molar conductivity of solution at infinte dilution}}$$

$$\alpha = \frac{\Lambda_m}{\Lambda_m^0}$$

$$= \frac{350}{480}$$

$= 0.73$ or 73%