Problem 10-05 Limiting molar conductivity, transference number

The value of limiting molar conductivity of butyric acid at the temperature of 25 °C is $3.823 \cdot 10^{-2}$ S m^2 mol^{-1} and the limiting molar conductivity of H^+ is 0.03497 S m^2 mol^{-1}. If you can assume that the mean activity coefficient equals to one, determine the limiting molar conductivity of anion $CH_3(CH_2)_2COO^-$ and the transference number of both ions at infinite dilution.

[$\lambda^\infty(C_3H_7COO^-) = 0.00326$ S m^2 mol^{-1}, $t_{H+} = 0.9147$, $t_{A^-} = 0.0853$]

Solution:

$$CH_3(CH_2)_2COOH = \underset{(A^-)}{CH_3(CH_2)_2COO^-} + H^+$$

$$\lambda^\infty = \nu_K \cdot \lambda_K^\infty + \nu_A \cdot \lambda_A^\infty = \lambda^\infty(A^-) + \lambda^\infty(H^+)$$

$\nu_{A^-} = 1$, $\nu_{H+} = 1$

$\lambda^\infty(H^+)$ = is 0.03497 S m^2 mol^{-1}, $\lambda^\infty = 3.823 \cdot 10^{-2}$ S m^2 mol^{-1}

$\lambda^\infty(A^-) = \lambda^\infty(AH) - \lambda^\infty(H^+) = 0.03823 - 0.03497 = 0.0326$ S m^2 mol^{-1}

$$t_i^\infty = \nu_i \cdot \frac{\lambda_i^\infty}{\lambda^\infty}$$

$$t_{A^-}^\infty = \frac{\lambda_{A^-}^\infty}{\lambda^\infty} = \frac{0.00326}{0.03823} = 0.08527$$

$$t_{H^+}^\infty = 1 - t_{A^-}^\infty = 1 - 0.08527 = 0.91473$$