

Problem 8-16 Ampholytes – Amino acids

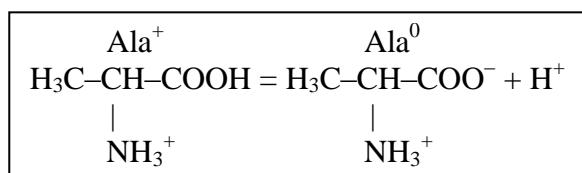
What is the share of single ionic forms in the alanine solution of the concentration 0.02 mol dm^{-3} at $\text{pH} = 5.2$ and temperature 25°C . The dissociation constants have the following values (standard state of infinite dilution, $c^{\text{st}} = 1 \text{ mol dm}^{-3}$)

$$\text{p}K_1(-\text{COOH}) = 2.34 \quad , \quad \text{p}K_2(-\text{NH}_3^+) = 9.69$$

$$[0.0032 \% \text{ Ala}^- ; 0.138 \% \text{ Ala}^+ ; 99.859 \% \text{ Ala}^0]$$

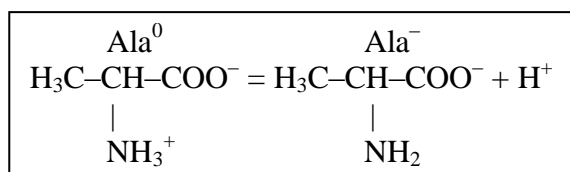
Solution:

$$[\text{Ala}] \equiv c_{\text{Ala}}/c^{\text{st}}$$



$$K_1 = \frac{[\text{Ala}^0] \cdot [\text{H}^+]}{[\text{Ala}^+]} = 10^{-2.34}$$

$$\begin{aligned} [\text{Ala}^+] &= \frac{[\text{H}^+]}{K_1} \cdot [\text{Ala}^0] = \frac{10^{-5.2}}{10^{-2.34}} \cdot [\text{Ala}^0] \\ &= 10^{-2.86} \cdot [\text{Ala}^0] = 1.3804 \cdot 10^{-3} \cdot [\text{Ala}^0] \end{aligned}$$



$$K_2 = \frac{[\text{Ala}^-] \cdot [\text{H}^+]}{[\text{Ala}^0]} = 10^{-9.69}$$

$$\begin{aligned} [\text{Ala}^-] &= \frac{K_2}{[\text{H}^+]} \cdot [\text{Ala}^0] = \frac{10^{-9.69}}{10^{-5.2}} \cdot [\text{Ala}^0] = \\ &= 10^{-4.49} \cdot [\text{Ala}^0] = 3.236 \cdot 10^{-5} \cdot [\text{Ala}^0] \end{aligned}$$

$$[\text{Ala}^0] + [\text{Ala}^+] + [\text{Ala}^-] = 0.02$$

$$[\text{Ala}^0] + 1.38 \cdot 10^{-3} \cdot [\text{Ala}^0] + 3.236 \cdot 10^{-5} \cdot [\text{Ala}^0] = 0.02$$

$$[\text{Ala}^0] = \frac{0.02}{1 + 1.38 \cdot 10^{-3} + 3.236 \cdot 10^{-5}} = 0.01997179 \text{ mol dm}^{-3}$$

$$\dots\dots 100 \cdot \frac{0.01997179}{0.02} = 99.859 \%$$

$$[\text{Ala}^+] = 1.3804 \cdot 10^{-3} \cdot 0.01997179 = 2.7568 \cdot 10^{-5} \text{ mol dm}^{-3}$$

$$\dots\dots 100 \cdot \frac{2.7568 \cdot 10^{-5}}{0.02} = 0.138 \%$$

$$[\text{Ala}^-] = 3.236 \cdot 10^{-5} \cdot 0.01997179 = 6.463 \cdot 10^{-7} \text{ mol dm}^{-3}$$

$$\dots\dots 100 \cdot \frac{6.463 \cdot 10^{-7}}{0.02} = 0.0032 \%$$