Problem 8-17 Ampholytes – Amino acids

At what pH will the 0.03 molar solution of methionine contain 1.2 mol. % of Met^+ form and 0.008 mol. % of Met^- form? The dissociation constants of methionine (standard state of infinite dilution, $c^{st} = 1$ mol dm^{-3}) at 25 °C have the following values:

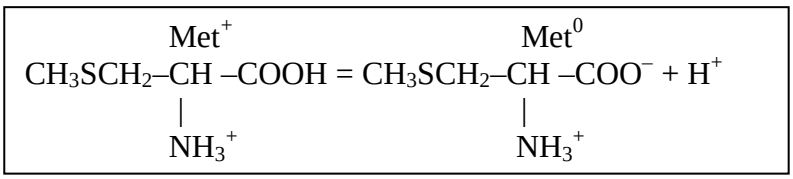
$$pK_1(\text{–COOH}) = 2.28 \quad , \quad pK_2(\text{–}NH_3^+) = 9.21.$$

What pH value corresponds to the isoelectric point of methionine?

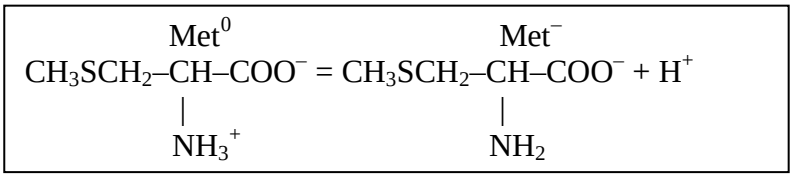
[pH = 4.66 ; pI = 5.745]

Solution:

[Met] ≡ c_{Met}/c^{st}



$$K_1 = \frac{[Met^0]\cdot[H^+]}{[Met^+]} = 10^{-2.28}$$



$$K_2 = \frac{[Met^-]\cdot[H^+]}{[Met^0]} = 10^{-9.21}$$

$\Sigma = [Met^0] + [Met^+] + [Met^-] = 0.03$

1.2 mol. % of Met^+ : $[Met^+] = 0.03 \cdot 0.012$

0.008 mol. % of Met^- : $[Met^-] = 0.03 \cdot 8\cdot10^{-5}$

$$K_1 \cdot K_2 = \frac{[Met^-]}{[Met^+]}\cdot[H^+]^2$$

$$10^{-2.28} \cdot 10^{-9.21} = \frac{0.008}{0.012}\cdot[H^+]^2$$

$$[H^+] = \sqrt{\frac{0.012}{8\cdot10^{-5}}\cdot10^{-11.49}} = 2.203\cdot10^{-5}$$

pH = –log $(2.203\cdot10^{-5})$ = 4.66

Isoelektric point:

$[Met^+] = [Met^-]$

$[H^+]^2 = K_1 \cdot K_2$

pI = ½ $(pK_1 + pK_2)$ = 0.5 · (2.28 + 9.21) = 5.745