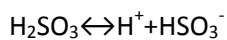


What are the equilibrium concentrations of H<sub>2</sub>SO<sub>3</sub>, H<sup>+</sup>, HSO<sub>3</sub><sup>-</sup>, and SO<sub>3</sub><sup>2-</sup> in a 0.050 M solution of sulfurous acid H<sub>2</sub>SO<sub>3</sub> at 25 °C? For H<sub>2</sub>SO<sub>3</sub> at 25 °C, K<sub>a1</sub> = 1.5 × 10<sup>-2</sup> and K<sub>a2</sub> = 1.0 × 10<sup>-7</sup>.

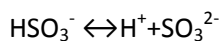
**Solution:**



$$K_{a1} = \frac{[\text{H}^+][\text{HSO}_3^-]}{[\text{H}_2\text{SO}_3]}$$

$$\text{From this equation } [\text{H}^+][\text{HSO}_3^-] = K_{a1} \cdot [\text{H}_2\text{SO}_3] = 1.5 \cdot 10^{-2} \cdot 0.050 = 7.5 \cdot 10^{-4}.$$

$$\text{The concentration of } \text{H}^+ = \text{HSO}_3^- = \sqrt{7.5 \cdot 10^{-4}} = 2.738 \cdot 10^{-2} \text{ M.}$$



$$K_{a2} = \frac{[\text{H}^+][\text{SO}_3^{2-}]}{[\text{HSO}_3^-]}$$

$$\text{So, } [\text{H}^+][\text{SO}_3^{2-}] = K_{a2} \cdot [\text{HSO}_3^-] = 1.0 \cdot 10^{-7} \cdot 2.738 \cdot 10^{-2} = 2.738 \cdot 10^{-9}$$

$$\text{The concentration of } \text{H}^+ = \text{SO}_3^{2-} = \sqrt{2.738 \cdot 10^{-9}} = 5.23 \cdot 10^{-5} \text{ M.}$$

**Answer:**

The equilibrium concentrations in 0.050 M solution are:

$$[\text{H}_2\text{SO}_3] = 5 \cdot 10^{-2} - 2.738 \cdot 10^{-2} = \mathbf{2.262 \cdot 10^{-2} \text{ M}};$$

$$[\text{H}^+] = 2.738 \cdot 10^{-2} + 5.23 \cdot 10^{-5} = \mathbf{2.743 \cdot 10^{-2} \text{ M}},$$

$$[\text{HSO}_3^-] = 2.738 \cdot 10^{-2} - 5.23 \cdot 10^{-5} = \mathbf{2.733 \cdot 10^{-2} \text{ M}}, \text{ and}$$

$$[\text{SO}_3^{2-}] = \mathbf{5.23 \cdot 10^{-5} \text{ M}}.$$