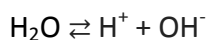


Question: what is the pH of a solution that has an equal concentration of H⁺ and OH⁻ ions?

Explanation:

Water is a weak electrolyte:



Dissociation constant of water is very small.

$$\text{Concentration of water molecules in water: } [\text{H}_2\text{O}] = \frac{n}{V} = \frac{m}{M \cdot V} = \frac{1000\text{g}}{18 \frac{\text{g}}{\text{mol}} \cdot 1\text{L}} = \frac{55,56\text{ mol}}{1\text{L}};$$

At 25°C dissociation constant of water is $1,8 \times 10^{-16}$ mol/L;

$$K_{\text{H}_2\text{O}} = \frac{[\text{H}^+][\text{OH}^-]}{[\text{H}_2\text{O}]} = 1,8 \times 10^{-16};$$

$$[\text{H}^+][\text{OH}^-] = K_{\text{H}_2\text{O}} \cdot [\text{H}_2\text{O}];$$

$$[\text{H}^+][\text{OH}^-] = 1,8 \times 10^{-16} \text{ mol/L} \cdot 55,6 \text{ mol/L} = 10^{-14} \text{ mol}^2/\text{L}^2;$$

So in any dilute water solution at 25°C $[\text{H}^+][\text{OH}^-] = 10^{-14} \text{ mol}^2/\text{L}^2$ – the ion-product constant for water;

$$[\text{H}^+] = [\text{OH}^-];$$

$$[\text{H}^+]^2 = 10^{-14} \text{ mol}^2/\text{L}^2;$$

$$[\text{H}^+] = \sqrt{10^{-14}} = 10^{-7} \text{ mol/L};$$

$$\text{pH} = -\lg [\text{H}^+] = 7.$$

Answer: pH=7.