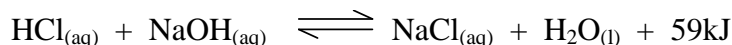


IV.7 - The Equilibrium Constant for the Ionization of Water

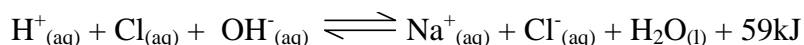
- Acidic Solution: has $[\text{H}_3\text{O}^+] > [\text{OH}^-]$
- Basic Solution: has $[\text{H}_3\text{O}^+] < [\text{OH}^-]$
- Neutral Solution: has $[\text{H}_3\text{O}^+] = [\text{OH}^-]$

Example: A typical acid-base reaction: $\text{HCl} + \text{NaOH}$

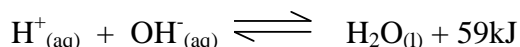
Formula Equation:



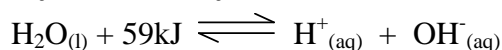
Total Ionic Equation:



Net Ionic Equation:



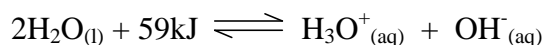
Therefore, the *self-ionization of water* can be written as:



The equilibrium expression (K_w) for this reaction is:

$$K_w = [\text{H}^+][\text{OH}^-] = 1.00 \times 10^{-14} \quad (\text{at } 25^\circ\text{C})$$

- We can also write the self-ionization of water as follows:



so that the equilibrium expression (K_w) is:

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1.00 \times 10^{-14} \quad (\text{at } 25^\circ\text{C})$$

Recall that $[\text{H}_2\text{O}_{(\text{l})}]$ is a constant and not included in the expression.

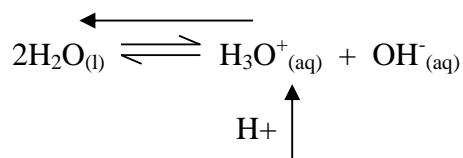
- What happens if the temperature increases?

Increased $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$, increased electrical conductivity

- What happens if temperature is decreased?

Decreased $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$, decreased electrical conductivity

- As $[\text{H}_3\text{O}^+]$ increases $[\text{OH}^-]$ decreases, keeping K_w at a constant 1.00×10^{-14}
- As $[\text{H}_3\text{O}^+]$ decreases $[\text{OH}^-]$ increases, keeping K_w at a constant 1.00×10^{-14}
- If we add an acid, $[\text{H}_3\text{O}^+]$ will increase and the water equilibrium will shift to use up some of the additional H_3O^+ .



- However, the $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$ are very low in neutral water:

$$[\text{H}_3\text{O}^+] = [\text{OH}^-] = 1.0 \times 10^{-7}\text{M}$$

so that very little of this additional H_3O^+ can be neutralized by this small amount of OH^- . The $[\text{H}_3\text{O}^+]$ builds up while the $[\text{OH}^-]$ decreases. BUT even in acidic solution (lots of H_3O^+) a small amount of OH^- will be present.

Unless you are told otherwise, you should always assume the temperature is 25 °C and therefore the value of $K_w = 1.00 \times 10^{-14}$.

Try these...

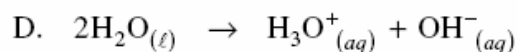
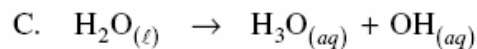
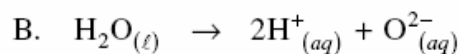
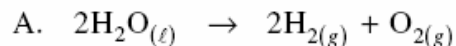
1. What is the $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$ in 0.0010 M $\text{HCl}_{(aq)}$?

2. What is the $[\text{H}_3\text{O}^+]$ of a 0.01 M NaOH at 25°C?

3. Find $[\text{H}_3\text{O}^+]$ at 25°C of 2.0 M $\text{Sr}(\text{OH})_2$?

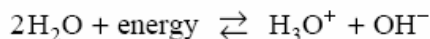
4. January 2002

The ionization of water can be represented by



5. January 1999

Consider the following equilibrium:



In pure water at a temperature of 50°C,

A. $\text{pH} < 7$

B. $\text{pH} + \text{pOH} = 14$

C. $K_w = 1.0 \times 10^{-14}$

D. $[\text{OH}^-] < 1.0 \times 10^{-7}$

*****Do Hebden Questions #28 - 30, pg 127*****