H₂O can function as both an ACID and a BASE.

In pure water there can be **AUTOIONIZATION**

\[
K_w = [H_3O^+] [OH^-] = 1.00 \times 10^{-14} \text{ at } 25 \degree C
\]

In a neutral solution \([H_3O^+] = [OH^-]\)

so \(K_w = [H_3O^+]^2 = [OH^-]^2\)

and so \([H_3O^+] = [OH^-] = 1.00 \times 10^{-7} \text{ M}\)

You add 0.0010 mol of NaOH to 1.0 L of pure water. Calculate \([H_3O^+]\) and \([OH^-]\).

**Solution**

\[
2 \text{H}_2\text{O(liq)} \rightarrow \text{H}_3\text{O}^+(aq) + \text{OH}^-(aq)
\]

Initial \(0 \quad 0.0010\)

Change \(+x\) \(+x\)

Equil. \(x\) \(0.0010 + x\)

\(K_w = (x)(0.0010 + x)\)

Because \(x \ll 0.0010\) M, assume \([OH^-] = 0.0010 \text{ M}\)

\([H_3O^+] = K_w / 0.0010 = 1.0 \times 10^{-11} \text{ M}\)

This solution is **BASIC** because \([H_3O^+] < [OH^-]\)

A common way to express acidity and basicity is with \(pH\)

\[
pH = \log \left( \frac{1}{[H_3O^+]} \right) = - \log [H_3O^+]
\]

In a neutral solution, \([H_3O^+] = [OH^-] = 1.00 \times 10^{-7} \text{ at } 25 \degree C\)

\(pH = -\log(1.00 \times 10^{-7}) = -(-7) = 7\)
[H₃O⁺], [OH⁻] and pH

What is the pH of the 0.0010 M NaOH solution?

[H₃O⁺] = 1.0 x 10⁻¹¹ M
pH = -log (1.0 x 10⁻¹¹) = 11.00

General conclusion —
Basic solution pH > 7
Neutral pH = 7
Acidic solution pH < 7

If the pH of Coke is 3.12, it is _________.

Because pH = -log [H₃O⁺] then
log [H₃O⁺] = -pH
Take antilog and get
[H₃O⁺] = 10⁻pH

[H₃O⁺] = 10⁻³.₁₂ = 7.6 x 10⁻⁴ M

Other pX Scales
In general pX = -log X
and so pOH = -log [OH⁻]
K_w = [H₃O⁺][OH⁻] = 1.00 x 10⁻¹⁴ at 25 °C
Take the log of both sides
-log (10⁻¹⁴) = -log [H₃O⁺] + (-log [OH⁻])
14 = pH + pOH