Worksheet

(3) $NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$

26g

4.33 mol/L

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$26\,g\ NaOH \times \frac{1\ mol\ NaOH}{40.00\,g\ NaOH} = 0.65\ mol$

$C = \frac{n}{V} = \frac{0.65\ mol}{0.150\ L} = 4.33\ mol/L$

$pOH = -\log[OH^-_{(aq)}]$

$pOH = -\log[4.33]$

$pOH = -0.637$

$pH + pOH = 14.000$

$pH = 14.000 - (-0.637)$

$pH = 14.637$

Ionization Constants for Acids

Strong acids - ionizes quantitatively in water to form hydronium ions

$HCl_{(aq)} \rightarrow H^+ + Cl^-$

$HCl_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$

Weak acids - ionizes partially in water to form hydronium ions

$CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$

H^+

To describe the equilibrium of acids in water, the equilibrium law is used to calculate the acid ionization constant, K_a.

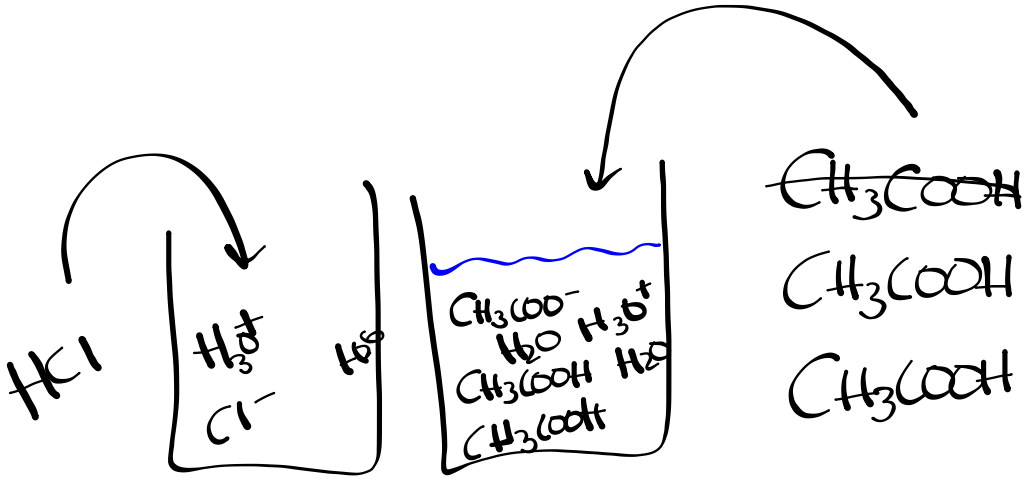
$$CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$$

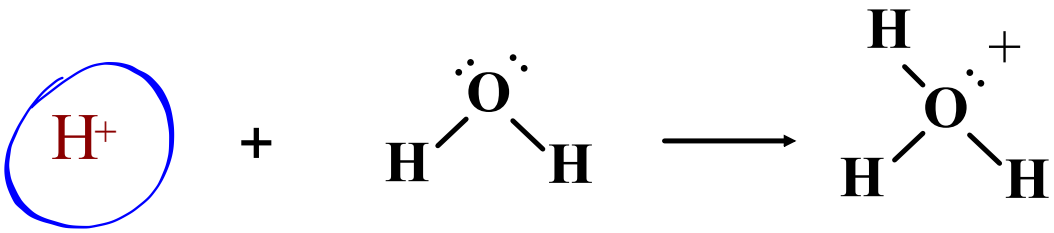
$$K = \frac{[H_3O^+_{(aq)}][CH_3COO^-_{(aq)}]}{[CH_3COOH_{(aq)}][H_2O_{(l)}]}$$

$[H_2O_{(l)}]$ constant

$$K[H_2O_{(l)}] = \frac{[H_3O^+_{(aq)}][CH_3COO^-_{(aq)}]}{[CH_3COOH_{(aq)}]}$$

$$K_a = \frac{[H_3O^+_{(aq)}][CH_3COO^-_{(aq)}]}{[CH_3COOH_{(aq)}]}$$


HCl
H_3O^+
Cl^-
H_2O
CH_3COO^-
H_2O H_3O^+
CH_3COOH H_2O
CH_3COOH
CH_3COOH
CH_3COOH
CH_3COOH



$$pH = -\log [H_3O^+]$$

$$[H_3O^+] = 10^{-pH}$$

$$[H_3O^+][OH^-] = 1.0 \times 10^{-14}$$

Ex. Predict the hydronium ion concentration, and pH of a 1.0 mol/L nitrous acid solution at equilibrium.

WEAK

$HNO_{2(aq)} + H_2O_{(l)} \rightleftharpoons NO_{2(aq)}^- + H_3O_{(aq)}^+$

1.0 mol/L

$K_a = \frac{[NO_{2(aq)}^-][H_3O_{(aq)}^+]}{[HNO_{2(aq)}]}$, $[NO_{2(aq)}^-] = [H_3O_{(aq)}^+]$

$K_a = \frac{[H_3O_{(aq)}^+]^2}{[HNO_{2(aq)}]}$

$[H_3O_{(aq)}^+] = \sqrt{K_a[HNO_{2(aq)}]}$

$[H_3O_{(aq)}^+] = \sqrt{(7.2\times10^{-4})[1.0]}$

$[H_3O_{(aq)}^+] = 2.7\times10^{-2}\ M$

$pH = -\log[H_3O_{(aq)}^+]$

$pH = -\log[2.7\times10^{-2}]$

$pH = 1.57$

Ex. What is the pH of a 0.150 mol/L hypochlorous acid solution at equilibrium?

$$HClO_{(aq)} + H_2O_{(l)} \rightleftharpoons ClO^-_{(aq)} + H_3O^+_{(aq)}$$

0.150 mol/L

$$K_a = \frac{[ClO^-_{(aq)}][H_3O^+_{(aq)}]}{[HClO_{(aq)}]}, \quad [ClO^-_{(aq)}] = [H_3O^+_{(aq)}]$$

$$K_a = \frac{[H_3O^+_{(aq)}]^2}{[HClO_{(aq)}]}$$

$$[H_3O^+_{(aq)}] = \sqrt{K_a[HClO_{(aq)}]}$$

$$[H_3O^+_{(aq)}] = \sqrt{(2.9\times10^{-8})(0.150)}$$

$$[H_3O^+_{(aq)}] = 6.60\times10^{-5}\ M$$

$$pH = -\log[H_3O^+_{(aq)}]$$

$$pH = -\log[6.60\times10^{-5}]$$

$$pH = 4.180$$

$$HA_{(aq)} + H_2O_{(l)} \rightleftharpoons A^-_{(aq)} + H_3O^+_{(aq)}$$