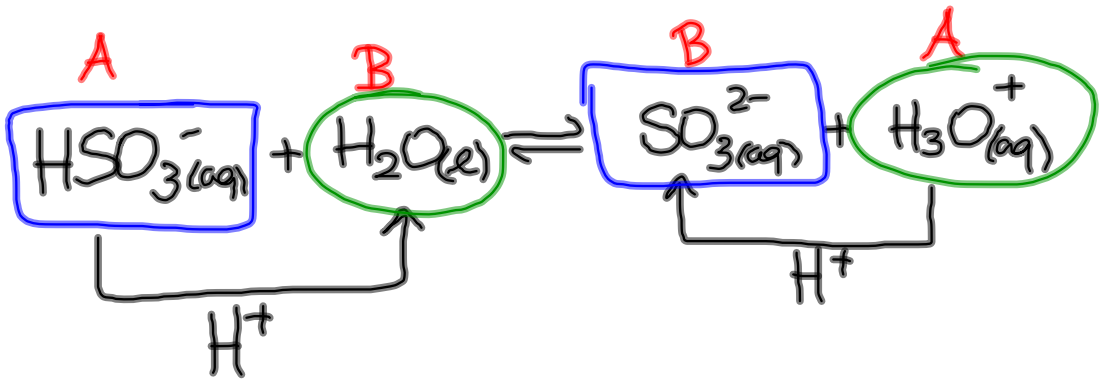
Homework - Worksheet

4. a)



Water Equilibrium

Conductivity is due to the presence of ions. For water:

$$H_2O_{(l)} <==> H^+_{(aq)} + OH^-_{(aq)}$$

- therefore $K = \frac{[H^+]\,[OH^-]}{[H_2O]}$ is very small
- slight conductivity shows that equilibrium greatly favors water molecules (less than 2 H^+ per billion water)

- therefore the concentration of water in pure water and in dilute aqueous solutions is essentially constant and can be combined with the equilibrium constant to produce a new constant called the *Ion Product Constant*

Ionization Constant for water (ion product constant)

$K_w = [H^+]\,[OH^-] = 1.0 \times 10^{-14}$ at SATP

Since $[H^+]$ and $[OH^-]$ are found in 1:1 ratio
($H_2O_{(l)} <==> H^+_{(aq)} + OH^-_{(aq)}$)

$[H^+_{(aq)}] = [OH^-_{(aq)}] = 1.0 \times 10^{-7}$ mol/L in **neutral** solutions.

Arrhenius's Theory - acid is a substance that ionizes water produce H^+ ions.
- additional ions produced by the acid increases the H^+ concentration in the water. (more acid, more H^+)

Therefore acids always have a $[H^+] > 10^{-7}$ mol/L

Basic solutions produce a $[OH^-]$ greater than 10^{-7} mol/L

K_w can be used to calculate either $[H^+]$ or $[OH^-]$

since **$K_w = [H^+]\,[OH^-]$** then $[H^+] = K_w / [OH^-]$

and $[OH^-] = K_w / [H^+]$

pH and pOH

$pH + pOH = 14.00$

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

$[H^+_{(aq)}] = 10^{-pH}$ $\quad$ $[OH^-_{(aq)}] = 10^{-pOH}$

Ex. Calculate the pH of a solution where $[H^+_{(aq)}] = 3.24 \times 10^{-4}M$.

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

$pH = -\log[3.24 \times 10^{-4}]$

$pH = 3.489$

Ex. Calculate the concentration of hydroxide ions in a solution with a pOH of 10.14.

$[OH^-_{(aq)}] = 10^{-pOH}$

$[OH^-_{(aq)}] = 10^{-10.14}$

$[OH^-_{(aq)}] = 7.2 \times 10^{-11} M$

10^x

$10^{\wedge}(-10.14)$

Strong Acids

Calculate the concentration of the hydroxide ions, pH and pOH of a 0.15 mol/L solution of hydrochloric acid at 25°C.

Strong acids will always completely ionize

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

0.15 mol/L → 0.15 mol/L

$[OH^-_{(aq)}] = ?$

~~pH~~ = ?

pOH = ?

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

$pH = -\log[0.15]$

$pH = 0.82$

$K_w = [H^+_{(aq)}][OH^-_{(aq)}]$

$[OH^-_{(aq)}] = \frac{K_w}{[H^+_{(aq)}]}$

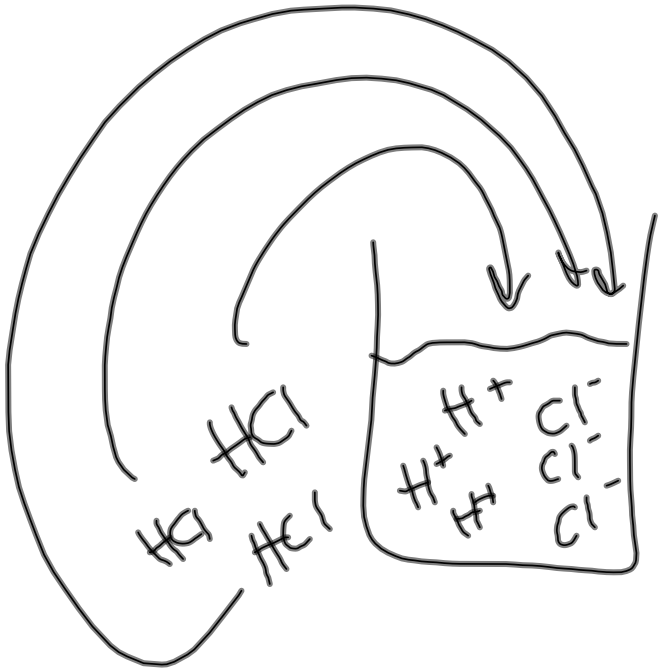
$[OH^-_{(aq)}] = \frac{1.0 \times 10^{-14}}{0.15}$

$[OH^-_{(aq)}] = 6.7 \times 10^{-14} M$

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

$pOH = -\log[6.7 \times 10^{-14}]$

$pOH = 13.18$


HCl
HCl
HCl
H+
H+
H+
Cl-
Cl-
Cl-