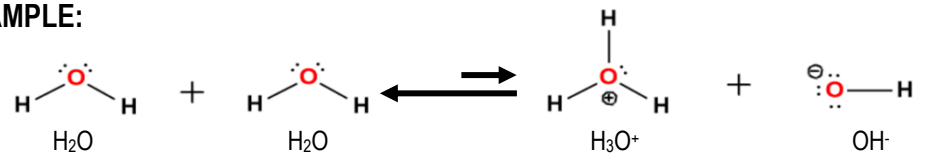
CONCEPT: AUTOIONIZATION OF WATER

1) Water Autoionization

●Water tends to slightly *autoionize*, or react with itself to form ions: _____ cations (H_3O^+) & _____ anions (OH^-).

●The ionization reaction is *reversible* & takes place _____.

EXAMPLE:

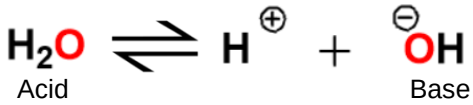


Pure water has a **low** concentration of H_3O^+ & in pure water, the **$[H_3O^+] = [OH^-]$**.

●Free protons, hydrogen ions & H^+ are all essentially synonyms.

●H_3O^+ is commonly simplified to H^+, but free protons are _____ in aqueous systems (they exist as H_3O^+).

EXAMPLE: Alternative depiction of water ionization.



2) Ion Constant of Water (K_w)

●Because H^+ & OH^- participate in many biochemical reactions, their _____ are relevant.

□ The $[H^+]$ & $[OH^-]$ can be determined from the equilibrium constant: $K_{eq} = \frac{[Products]_{eq}}{[Reactants]_{eq}}$

● The ____ _____ of water (K_w) is a simple *rearrangement* of the equilibrium constant & the product of $[H^+][OH^-]$.

EXAMPLE: K_{eq} & K_w for autoionization of water.

Equilibrium Constant of Water (K_{eq})

$$K_{eq} = \frac{[\ ][\ ]}{[H_2O]}$$

Ion Constant of Water (K_w)

$$K_{eq}[H_2O] = K_w = [H^+][OH^-] = 1.0 \times 10^{-14}\ M^2$$

●K_w can differ depending on _____, but in biological systems, K_w is always assumed to be $1.0 \times 10^{-14}\ M^2$.

□ K_w allows us to calculate either $[H^+]$ or $[OH^-]$ when given the concentration of one of the ions.

PRACTICE: Calculate $[H^+]$ in a solution given that $[OH^-]$ is 1.0×10^{-10} M.

a) 1.0×10^{-2} M
b) 1.0×10^{-3} M
c) 1.0×10^{-4} M
d) 1.0×10^{-5} M

PRACTICE: Calculate $[OH^-]$ in a solution given that $[H^+]$ is $1.0 \times 10^{-11.8}$ M.

a) $1.0 \times 10^{-11.8}$ M
b) $1.0 \times 10^{-6.8}$ M
c) $1.0 \times 10^{-4.5}$ M
d) $1.0 \times 10^{-2.2}$ M

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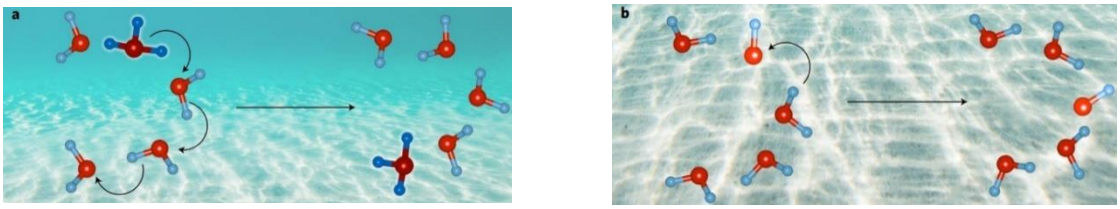
3) Proton Hopping

●*Proton hopping*: _____ and _____ ions can diffuse much more rapidly than other ions in aqueous solutions.

□ Protons from a H_3O^+ or H_2O can continuously "hop" to neighboring water molecules or OH^- ions.

EXAMPLE: Proton hopping.



PRACTICE: Which of the following ions is likely to diffuse the most rapidly in biological systems?

a) Ca^{2+}
b) OH^-
c) Mg^{2+}
d) Cl^-

PRACTICE: The magnitude of K_w indicates that _____.

a) water autoionizes very slowly.
b) water autoionizes very quickly.
c) water autoionizes to a small extent.
d) water ionizes to a large extent (completely).