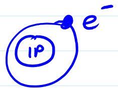
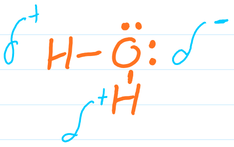
4.3 $H^+_{(aq)}$ & $H_3O^+_{(aq)}$

H atom  $\longrightarrow$ H^+  large concentration of ⊕ charge in a small area

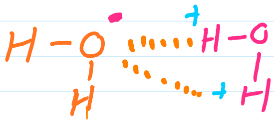
↓ e^- removed

↳ - very strongly attractive to ⊖ charges

Water is polar! (I ♡ Bio. 12)
↳ slight ⊖ charge on "O" & ⊕ on "H".
↓
"Big"; electron "hog"



H bonding



so ... when H+ is in solution with water $H^+_{(aq)}$

$H^+ + H_2O \longrightarrow H_3O^+ \longrightarrow$ "Hydronium Ion"
"protonated water molecule"

(slight ⊖ charge on "O", attracts the ⊕ from H+)

H+ = "the proton"

H_3O^+ = "hydronium ion" or "hydrated proton"

Dissociation of $HCl_{(g)}$ in water $\longrightarrow$ HCl aq was written

$HCl_{(g)} \longrightarrow$

is now written as

$HCl_{(g)} + H_2O \longrightarrow$

Try writing above eqn with

$HNO_{3\,(aq)}$

4.4 Bronsted-Lowry Theory (of Acids & Bases)

- more general than Arrhenius Theory
- allows for existence of equilibrium rxns ⇌

Acid - donates a proton to another substance — "proton donor"
- Proton Donor → give away an H+

Base - accepts a proton from another substance — "proton acceptor"
- Proton Acceptor → take an H+

eg) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

NH_3: Base
H_2O: Acid (acting as
NH_4^+: Conjugate acid
OH^-: conjugate Base

H^+ donor here!)

To identify the "acid", in a conjugate pair, look for the species that gained an H^+

eg) NH_3 / NH_4^+ = conjugate pair

↑ x-tra H ; Acid.

Label acid & base in the following

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

Acid, Base, conjugate base, conjugate acid

gained H^+. it is "acid" on product side

In every Brønsted-Lowry rxn there is an acid & a base on both sides of the reaction. (conjugate Acid-Base pairs)

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

A, B, B, A — xtra "H"

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

B, A, A, B

Practice : Follow these steps to write the products & Label the Acid & base on each side

1. on Reactant side : Identify the "acid"
   "which way does the H go?"
2. Write products : Remove H^+ & add ⊖ to acid
   : Add H & ⊕ to base
3. Label A, B ; CA, CB - to find "conjugate "acid on product side
   Look to see who "gained an H".

Examples:

1. $H_2CO_3 + SO_4^{2-} \rightleftharpoons$
2. $NH_4^+ + H_2O \rightleftharpoons$
3. $CO_3^{2-} + HSO_4^- \rightleftharpoons$
4. $CO_3^{-2} + H_2O \rightleftharpoons$
5. $H_2CO_3 + H_2O \rightleftharpoons$

Part 1 Video Ends Here
Please, keep reminder of this note package for Part 2 video

Amphiprotic Substances

- can act as acid or a base → becomes OH^-

Amphiprotic Substances

- can act as acid or a base
- H_2O in above reactions ... donate H → acting as acid (becomes OH^-)
  .... take H → acting as base (↳ becomes H_3O^+)

- Polyprotic acids
  - more than 1 H
  - when ionized form an ion that is "amphiprotic"

$H_2SO_4 \rightarrow H^+ + HSO_4^-$

$H_2CO_3 \rightarrow H^+ + HCO_3^-$

$H_3PO_4 \rightarrow H^+ + H_2PO_4^-$

↳ $H^+ + HPO_4^{2-}$

all 3 ions are amphiprotic
they all have H AND ⊖

→ only 1 "H" ionizes at a time

To identify an amphiprotic ion : Look for Both H to give away ; acts as an acid And − charge ... to accept an H^+ acting as a base

H_2O is amphiprotic b/c $H_2O \rightleftharpoons H^+ + OH^-$

Quick Check: Which of these are amphiprotic?

Se^{2-}, HSe^-, H_2Se, H_3PO_4, $H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-}, H_2SO_3, HSO_3^-

Which of these could form an ion that is amphiprotic?
- & write the ion .... (remove an H^+)

$HCl \rightarrow$

$HNO_3 \rightarrow$

$H_2SO_4 \rightarrow$

$H_3PO_4 \rightarrow$

$H_2PO_4^- \rightarrow$

Practice :

Write the conjugate base for ...

HSO_4^-

H_2CO_3

CH_3COOH

NH_4^+

H_3PO_4

$H_2PO_4^-$

HPO_4^{2-}

Write the conjugate acids for ...

HSO_4^-

SO_4^{2-}

NH_2^-

NH_3

HPO_4^{2-}

$H_2PO_4^-$