

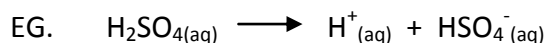
## SCH 3U

### ACID & BASE THEORY

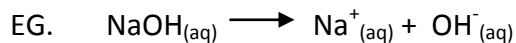
PROPERTY	ACIDS	BASES
Taste	Sour	Bitter
Feel	No characteristic feel	Slippery
Phenolphthalein	Colourless	Pink
Litmus paper	Turns blue litmus red	Turns red litmus blue
Reaction with $\text{Mg}_{(s)}$ and other active metals	$\text{H}_2$ gas releases	No reaction
Reaction with $\text{NaHCO}_3$	$\text{CO}_2$ releases	No reaction
Formation	$\text{NM-O}_x + \text{H}_2\text{O} \rightarrow \text{acids}$	$\text{M-O}_x + \text{H}_2\text{O} \rightarrow \text{bases}$
Neutralization	acid + base $\rightarrow$ salt + water	base + acid $\rightarrow$ salt + water

### ARRHENIUS DEFINITION (1887)

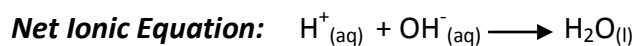
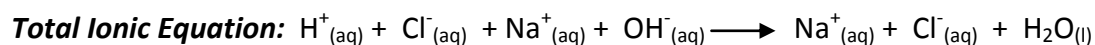
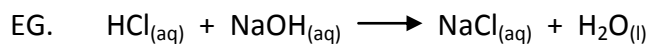
**ACID** -- substance that dissociates in water to form  $\text{H}^+$  (hydrogen ions).



**BASE** -- substance that dissociates in water to form  $\text{OH}^-$  (hydroxide ions).



... Explains **neutralization**:



### PROBLEMS with Arrhenius Theory:

- $\text{H}^+_{(\text{aq})}$  (bare proton) **does not exist**-- instead the hydrogen ion attaches to polar  $\text{H}_2\text{O}$   
$$\text{H}^+_{(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \longrightarrow \text{H}_3\text{O}^+_{(\text{aq})}$$

**hydronium ion**
- ammonia ( $\text{NH}_3$ ) is a base, but does not contain  $\text{OH}^-$  ions.  
$$\text{NH}_{3(\text{g})} + \text{H}_2\text{O}_{(\text{l})} \longrightarrow \text{NH}_4^+_{(\text{aq})} + \text{OH}^-_{(\text{aq})}$$
- many salt solutions are basic -- ones that contain carbonate ion.
- some neutralizations do not produce water --  $\text{NH}_{3(\text{g})} + \text{HCl}_{(\text{g})} \longrightarrow \text{NH}_4\text{Cl}_{(\text{s})}$
- only accounts for water as a solvent.

### BRONSTED-LOWRY THEORY OF ACIDS & BASES

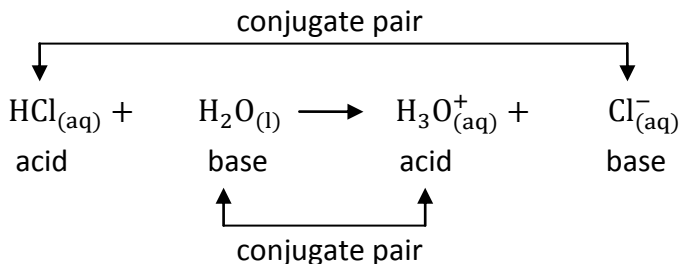
**ACIDS** -- proton ( $\text{H}^+$ ) donor

**BASES** -- proton ( $\text{H}^+$ ) acceptor

- All Arrhenius acids are **Bronsted acids** -- both contain  $\text{H}^+$  ion
- Any **negative ion** can be a **Bronsted base**
- Can use solvents other than  $\text{H}_2\text{O}$ .
- When  $\text{H}_2\text{O}$  is the solvent, chemists use Bronsted definitions.
- Acid-base reactions involve proton  $\text{H}^+$  transfer.

### **CONJUGATE ACID-BASE PAIRS:**

- 2 substances that differ from each other by only **one** proton are referred to as a conjugate acid-base pair.



**conjugate acid** = particle formed when the base receives  $\text{H}^+$

**conjugate base** = particle left when  $\text{H}^+$  is removed from acid

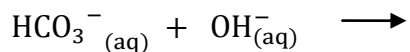
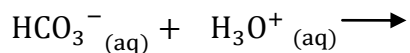
## AMPHOTERIC SUBSTANCES:

- Substances that be either acids or bases depending on the other substance present.

EG.  $\text{H}_2\text{O}$  is a common example of an amphoteric substance, as shown in the following:



EG. Illustrate the amphoteric behaviour of  $\text{HCO}_3^-$  with an acid and with a base.



## EXERCISE:

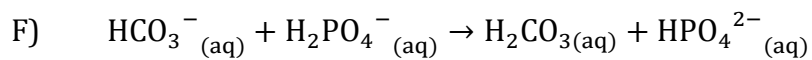
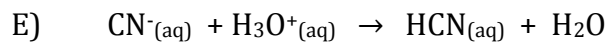
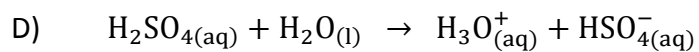
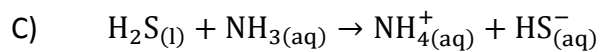
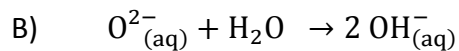
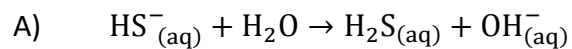
1. If each of the following is an acid, name it conjugate base:



2. If each of the following is a base, name its conjugate acid:



3. Identify the conjugate acid-base pairs in the following reactions:



4. Identify substances in #3 above which are amphiprotic (aka amphoteric). Then illustrate their amphiprotic behaviour.