

## SCH 3U

### ACID & BASE THEORY

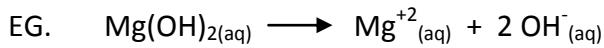
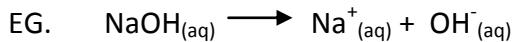
PROPERTY	ACIDS	BASES
Taste	Sour	Bitter
Feel	No characteristic feel	Slippery
Phenolphthalein	Colourless	Pink
Litmus paper	Turns blue litmus red	Turns red litmus blue
Reaction with $Mg_{(s)}$ and other active metals	$H_2$ gas releases	No reaction
Reaction with $NaHCO_3$	$CO_2$ releases	No reaction
Formation	$NM-O_x + H_2O \rightarrow$ acids	$M-O_x + H_2O \rightarrow$ bases
Neutralization	acid + base $\rightarrow$ salt + water	base + acid $\rightarrow$ salt + water

### ARRHENIUS DEFINITION (1887)

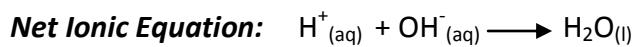
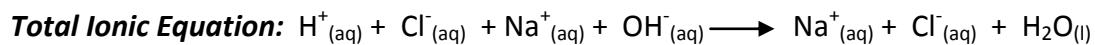
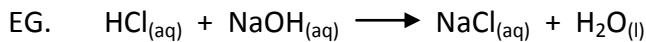
**ACID** -- substance that dissociates in water to form  $H^+$  (hydrogen ions).



**BASE** -- substance that dissociates in water to form  $OH^-$  (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

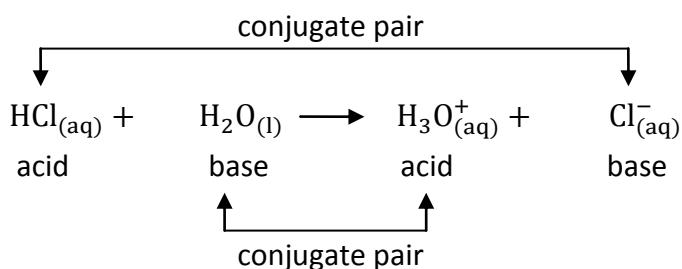
**ACIDS** -- proton ( $H^+$ ) donor

**BASES** -- proton ( $H^+$ ) acceptor

- All Arrhenius acids are Bronsted acids -- both contain H<sup>+</sup> ion
- Any negative ion can be a Bronsted base
- Can use solvents other than H<sub>2</sub>O.
- When H<sub>2</sub>O is the solvent, chemists use Bronsted definitions.
- Acid-base reactions involve proton H<sup>+</sup> 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.

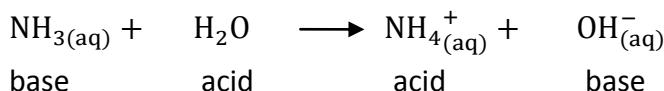
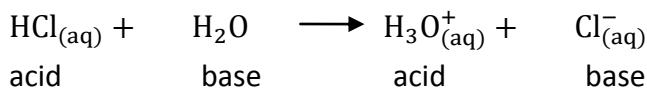


**conjugate acid** = particle formed when the base receives  $H^+$   
**conjugate base** = particle left when  $H^+$  is removed from acid

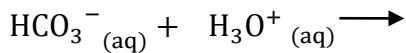
## AMPHOTERIC SUBSTANCES:

- 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.

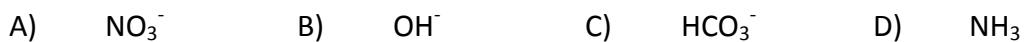


## EXERCISE:

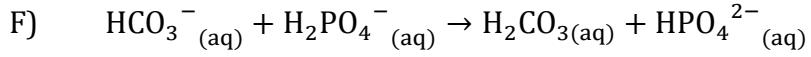
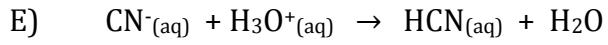
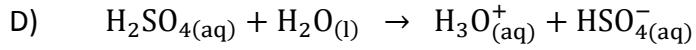
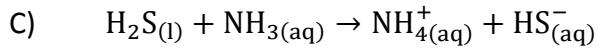
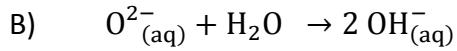
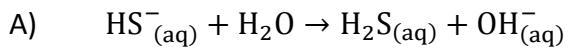
1. If each of the following is an acid, name its conjugate base:



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.