TOPIC 9.1

Arrhenius Acids and Bases

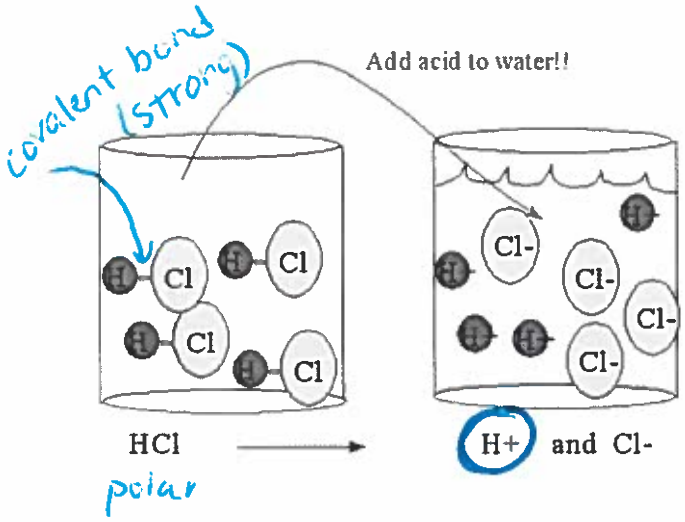
What are the definitions of acids and bases?

Arrhenius Acids

- All the compounds listed on Table K are Arrhenius acids
- What are some similarities you notice between the acids listed on that table?
  - all aqueous
  - all have hydrogen
- Those similarities help define Arrhenius acids:

Arrhenius acid: compound that "gives off" H^+ in water (aq)

(hydronium) $H_3O^+ \rightarrow H^+$



Physical Properties of Acids:

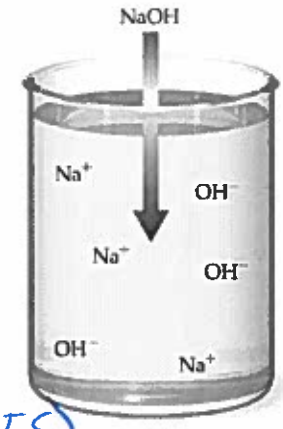
- sour, stinging taste
- burning
- can conduct electricity (ELECTROLYTES)

Arrhenius Bases

- All the compounds listed on Table L are Arrhenius bases
- What are some similarities you notice between the bases listed on that table?
  - all have OH
  - all aqueous
- Those similarities help define Arrhenius bases:

Arrhenius base: compound that "gives off" OH^- in water (aq)

hydroxide ion



Physical Properties of Bases:

- bitter tasting
- corrosive
- can conduct electricity (ELECTROLYTES)

TOPIC 9.2

The pH scale

How can we quantify how acidic or basic a compound is?

Recall the definitions of Arrhenius acids and bases:

Arrhenius acid: compound that gives off H^+ (H_3O^+) ions in water

Arrhenius base: compound that gives off OH^- ions in water

So to determine how acidic or basic a substance is, we have to know how many H^+ or OH^- ions are present.

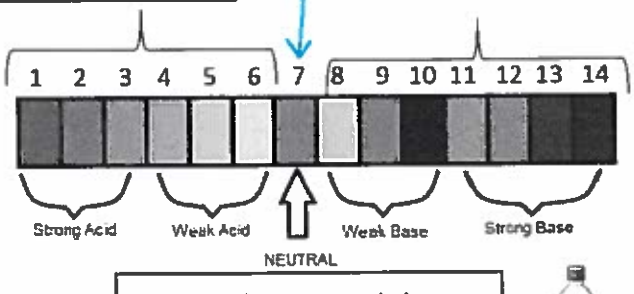
1. **Concentration of H^+ (hydronium, H_3O^+) ions**

acid > 1.0×10^{-7} M H^+ > base

2. **The pH scale**

Acids have more H^+ ions than OH^- ions

Bases have more OH^- ions than H^+ ions



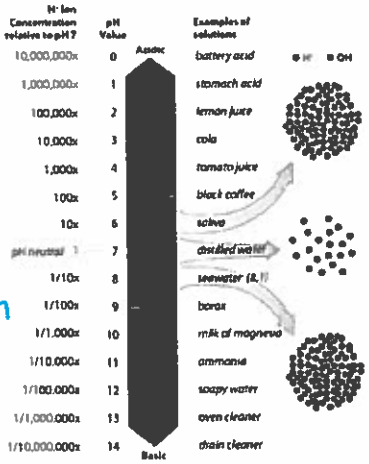
Neutral compounds have equal amounts of OH^- ions and H^+ ions

$H_2O \rightleftharpoons H^+ + OH^-$

What does each "jump" up or down the pH scale represent? → Small drop in pH means big change in acidity

- The pH scale is **not linear, it's logarithmic**
- So, each "jump" down the pH scale represents a 10x increase in H^+ (H_3O^+) concentration
- Each "jump" up the pH scale represents a 10x decrease in H^+ (H_3O^+)

★ the lower the pH, the higher the H^+ concentration



Practice Regents Questions

1. Which change in the H^+ ion concentration of an aqueous solution represents a *decrease* of one unit on the pH scale?
   A) a tenfold increase
   B) a tenfold decrease
   C) a hundredfold increase
   D) a hundredfold decrease

2. When the hydronium ion concentration of an aqueous solution is increased by a factor of 10, the pH value of the solution
   A) decreases by 1
   B) increases by 1
   C) decreases by 10
   D) increases by 10

3. The pH of a solution is 7. When acid is added to the solution, the hydronium ion concentration becomes 100 times greater. What is the pH of the new solution?
   A) 1 B) 5 C) 9 D) 14

   → $100 = 10 \times 10$ (2 jumps down) ∴ $7 - 2 = 5$

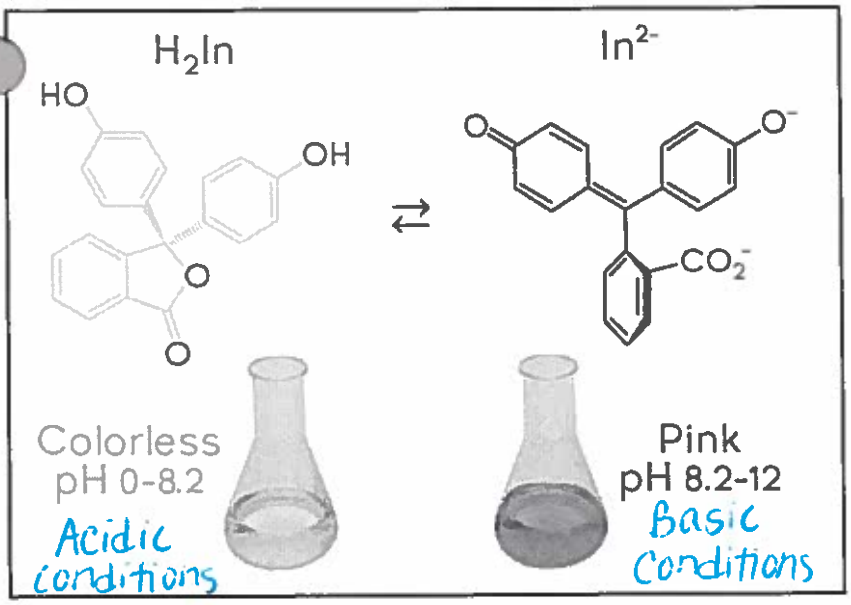
4. When the pH of an aqueous solution is changed from 1 to 2, the concentration of hydronium ions in the solution is
   A) decreased by a factor of 2
   B) decreased by a factor of 10
   C) increased by a factor of 2
   D) increased by a factor of 10

pH ↑ 1 unit
H^+ ↓ 10x

TOPIC 9.3

Chemical Indicators and Table M

How can we determine the pH of a substance?



What is going on in the image to the left?

Certain substances, such as the one shown to the left (phenolphthalein), will change their structure as environmental conditions change (i.e. from acidic to basic).

Recall that STRUCTURE determines PROPERTIES; so a new structure will lead to new properties, such as a new **color**.

These color-changing compounds are known as indicators.

Indicator: compound that can indicate (show) whether a solution is above or below a certain pH range

★ TABLE M ★

pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Methyl orange	RED		trans-ition				YELLOW							
Bromthymol blue	YELLOW					trans-ition	BLUE							
Phenolphthalein	Colorless									PINK				
Litmus	RED							BLUE						
Bromcresol green	YELLOW					BLUE								
Thymol blue	YELLOW									BLUE				

Vinegar has a pH of around 3.0. What color will bromthymol blue be when added to a sample of vinegar? yellow

Identify the pH range in which methyl orange would be yellow AND phenolphthalein would be colorless. 4.4-8.0

↓ pH 4.4 and up

↓ pH 8.0 and below

TOPIC 9.4

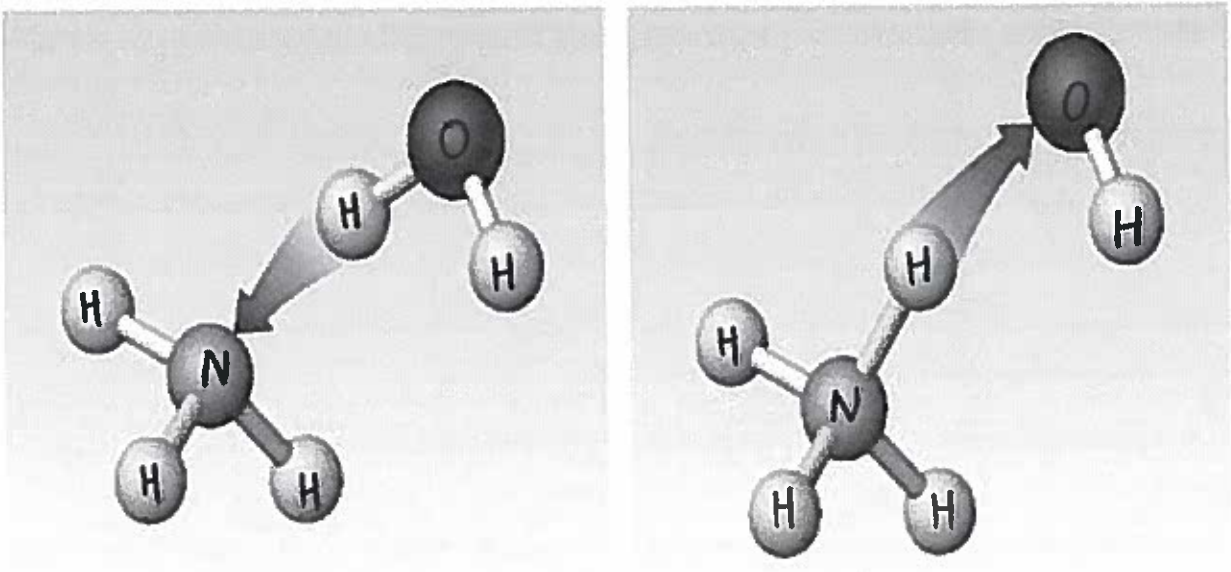
Alternate Acid - Base Theory

Are there other definitions of acids and bases?

Recall when we first defined acids and bases, we used Arrhenius' theory. According to those definitions, acids give off" H^+ (H_3O^+) ions, and bases give of OH^- ions. Take a look at Table L. Notice that ammonia (NH_3) is listed as a base. It doesn't quite fit Arrhenius' theory, does it? Well, it turns out there are other, more comprehensive definitions of acids and bases. The Regents likes to refer to them as "alternative acid – base theories," such as this one:

Acids are H^+ donors.

Bases are H^+ acceptors.



$$\underset{\text{base}}{NH_3} + \underset{\text{"acid"}}{H_2O} \rightleftharpoons NH_4^+ + OH^-$$

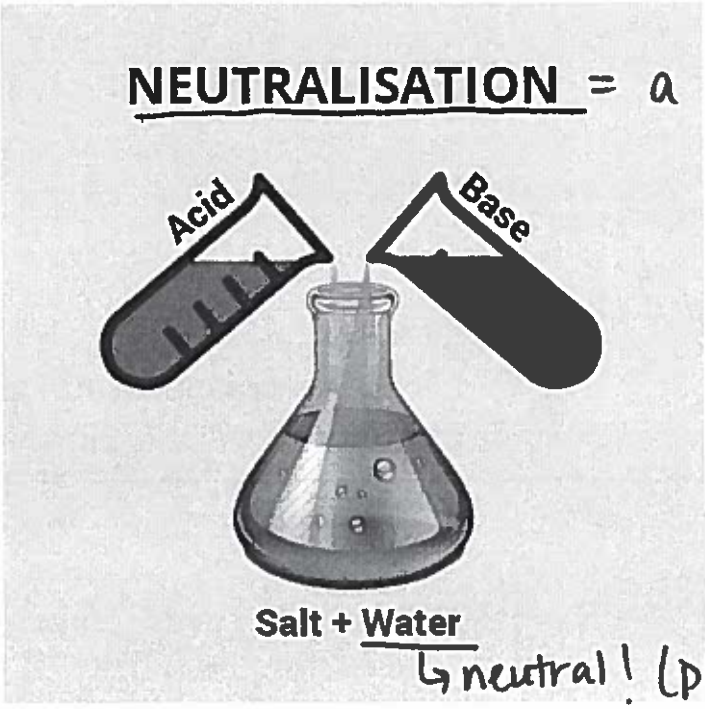
How is the alternative acid – base theory similar to Arrhenius'?

- Acids still "give up" H^+ ions
- Bases still lead to more OH^- in solution

TOPIC 9.5

Neutralization Reactions

What happens when you mix an acid and a base?



HNO_3 + KOH → KNO_3 + HOH

acid base salt water

Which acid and which base, when mixed, will create water and table salt (sodium chloride)?

$HCl + NaOH \longrightarrow NaCl + H_2O$

Wasp stings are slightly basic in nature, while bee stings are slightly acidic. Explain why vinegar can be used as a temporary treatment for a wasp sting, but not a bee sting.

↓ acid

acid + base → salt + H_2O ★ neutralizes it

acid + acid would not be good!

TOPIC 9.6

Titrations

How can we use neutralization reactions to determine molarity of an unknown solution?

Miss Virga found an unlabeled bottle of hydrochloric acid (HCl) in the stockroom. It's pretty important to know the concentration of this acid (there would be a big difference between 0.1 M and 12 M acid!) There is a way to figure this unknown concentration out in the laboratory, and it involves using the acid – base chemistry we learned previously: **neutralization reactions** and **indicators**. The laboratory technique is called **titration**.

Titration: a solution of KNOWN concentration is used to determine the concentration of an UNKNOWN solution. Typically, the known solution is added from a buret to a known volume of the unknown solution until the reaction is complete.

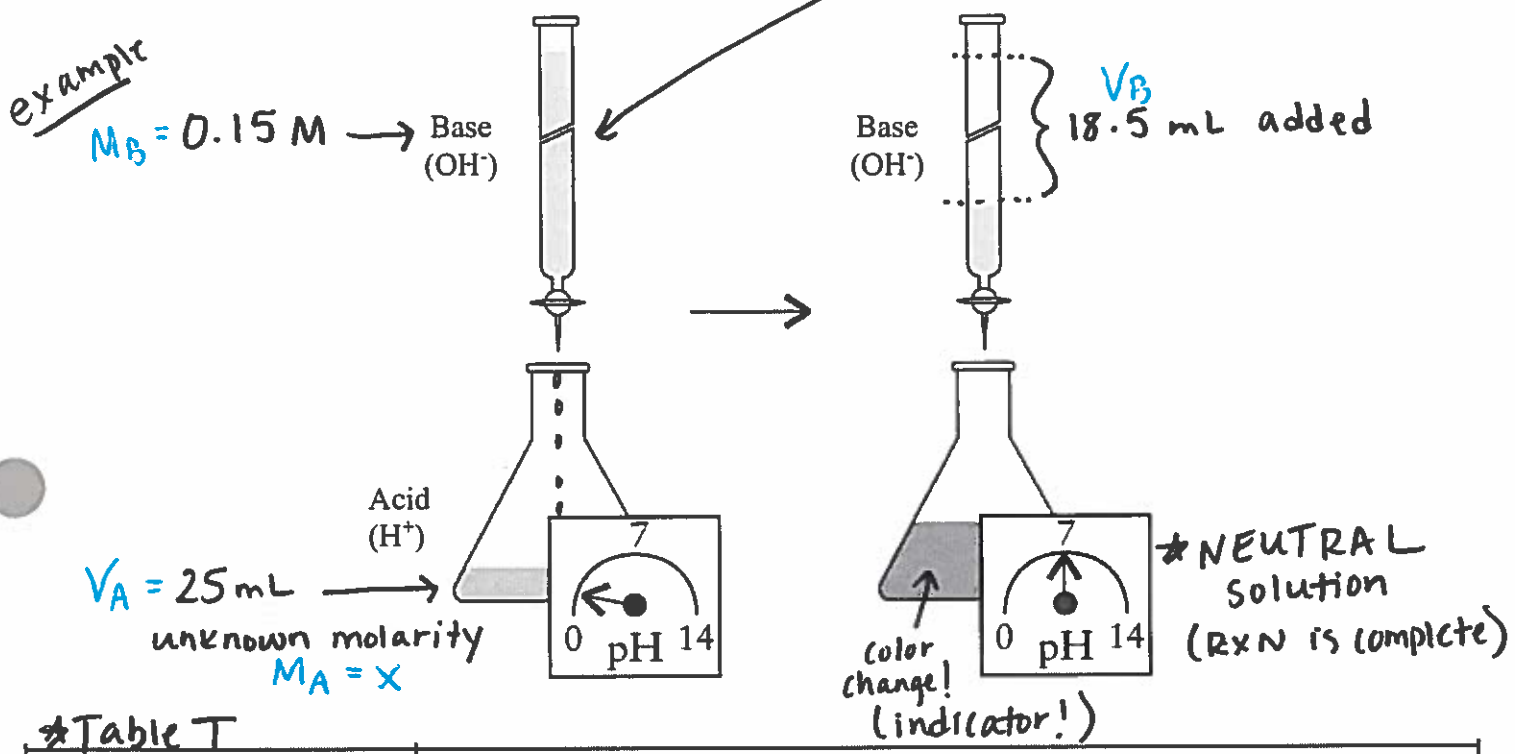


*Table T

Titration	$M_AV_A = M_BV_B$	M_A = molarity of H^+	M_B = molarity of OH^-
		V_A = volume of acid	V_B = volume of base

$\frac{mol}{L} \times L$

$$M_AV_A = M_BV_B$$

$$x(25) = (0.15)(18.5)$$

$$\frac{x(25)}{25} = \frac{2.775}{25}$$

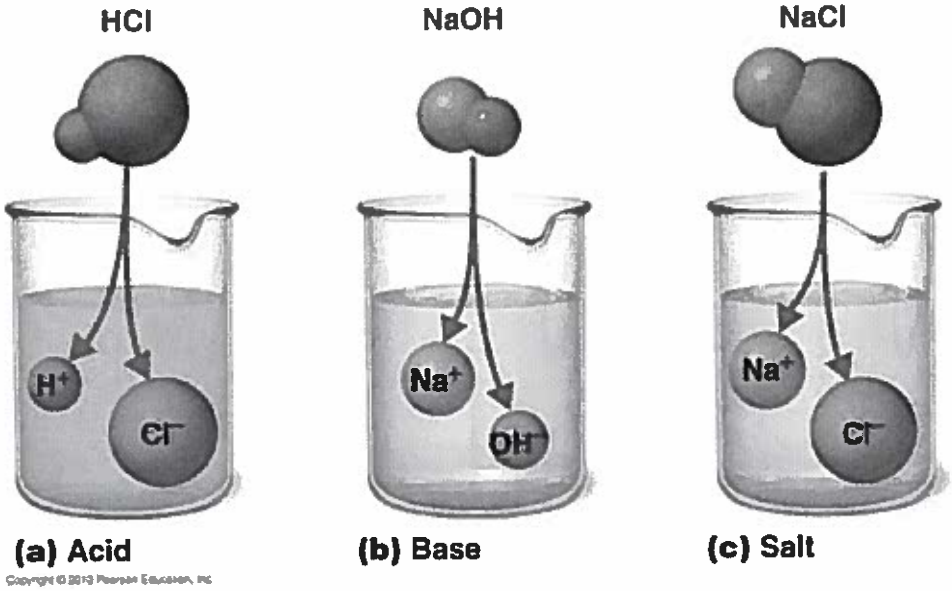
$$x = 0.11\ M$$

TOPIC 9.7

Classifying Electrolytes

How can we identify and differentiate between electrolytes?

Electrolyte: a substance that can conduct electricity when dissolved in H_2O b/c of MOBILE IONS



Electrolyte	Description/Where to Find Them	Example
Acid	covalent Table K	$H_3PO_4 \xrightarrow{H_2O} 3H^+ + PO_4^{3-}$
Base	ionic Table L	$KOH \xrightarrow{H_2O} K^+ + OH^-$
Salt	Table F soluble	$NaNO_3 \xrightarrow{H_2O} Na^+ + NO_3^-$

Don't forget: *the* higher *concentration of* mobile *ions, the* stronger *the electrolyte (greater conductivity of electricity)*

i.e. which would have greatest conductivity?

a) 0.1 M KCl ~~b)~~ 1.0M KCl c) 0.1 M K_3PO_4 d) 1.0 M K_3PO_4