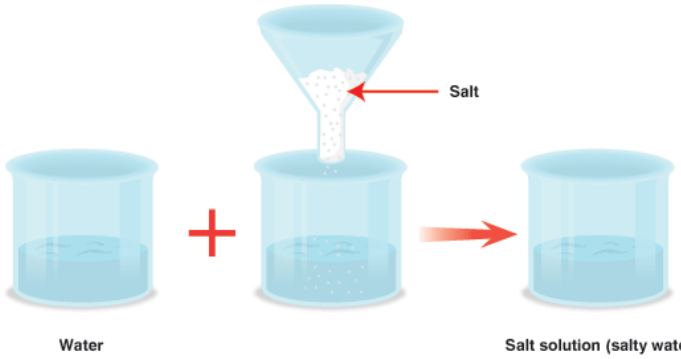
Solution:

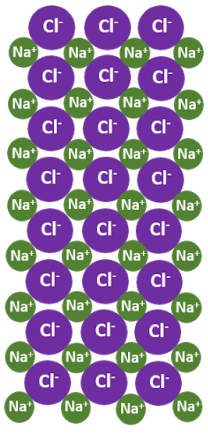


What is the difference between the **solute** and the **solvent**?

What is the **dissolution process** for an ionic compound?

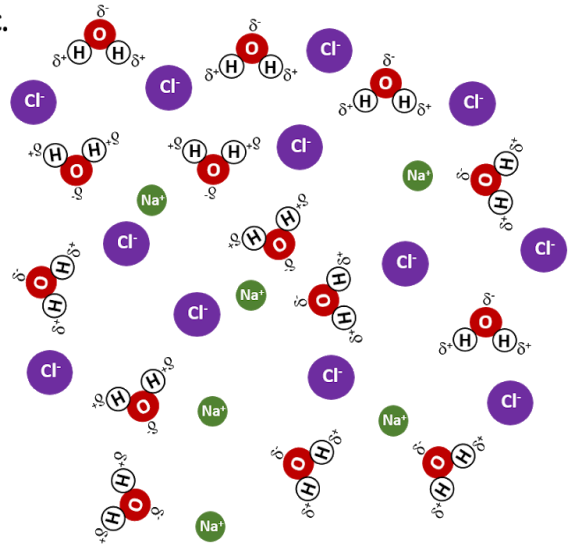
A.

B.



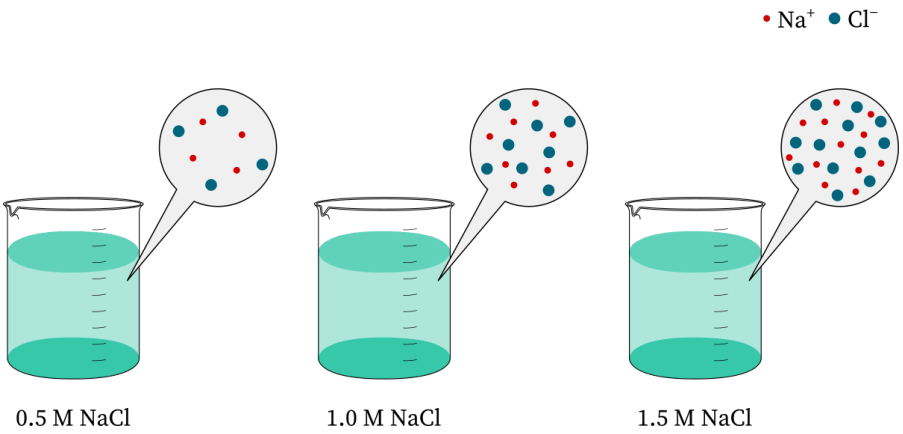
Sodium Chloride Crystal

C.



Sodium Chloride Dissolved in Water

Concentration:



Molarity:

$$M = \frac{n}{V}$$

n: mol (solute)

V: L (solution)

M: $\frac{mol}{L}$ or M

Example: What would be the molarity of a solution of NaCl if 0.150 moles of NaCl are dissolved to make 2.00 L of solution?

Example: What would be the concentration of $Pb(NO_3)_2$ if 10.0 g are dissolved to make 200. mL of solution?

Practice:

1) What would be the molarity of 50.0 mL solution made by dissolving 0.256 g of potassium iodide (KI)?

2) With how many mL of solution would 0.500 g of KOH need to be diluted to create a solution with a concentration of 0.100 M?

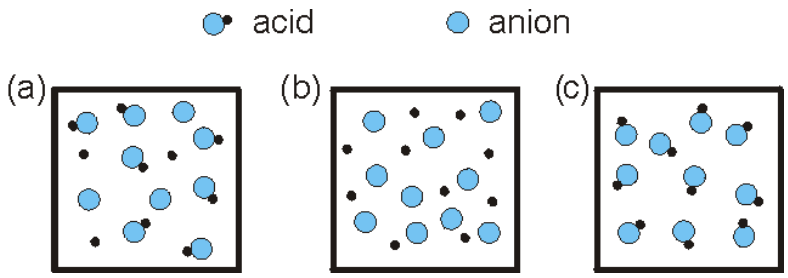
Concept Check: What is the concentration of nitrate ions in a 0.150 M solution of aluminum nitrate?

How does the **Arrhenius definition** for an **acid** and a **base** differ?

	Acids	**Bases**
What ion does it produce in solution?		
How does it taste?		
What types of substances is it good at corroding?		
What types of pH values does it have?		

What makes a **strong acid/base** different from a **weak acid/base**?

Concept Check: Identify the strong acid and the weak acid in the following diagram.



List of Strong Acids and Bases

Strong Acids	Strong Bases
1) Hydrochloric acid, HCl	1) Hydroxides of all group 1 metals (ex., NaOH)
2) Hydrobromic acid, HBr	2) Calcium hydroxide, $Ca(OH)_2$
3) Hydroiodic acid, HI	3) Strontium hydroxide, $Sr(OH)_2$
4) Chloric acid, $HClO_3$	4) Barium hydroxide, $Ba(OH)_2$
5) Perchloric acid, $HClO_4$	
6) Nitric acid, HNO_3	
7) Sulfuric acid, H_2SO_4	

How does **Bronsted-Lowry theory** define acids and bases?

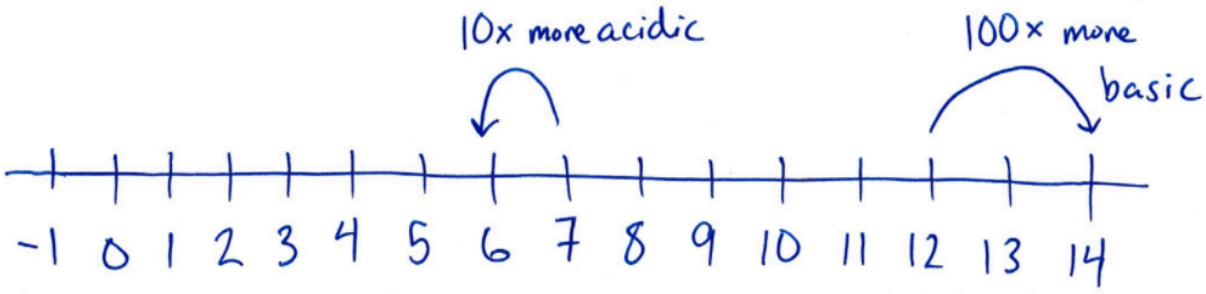
What chemical equation describes the self-ionization of water?

pH scale:

$$pH = -\log_{10}[H_3O^+]$$

Why is the pH of water considered to be **7.00**?

*The acidity and alkalinity of substances increases <u>ten-fold</u> for each whole number that you move on the pH scale!



Concept Check: Vinegar has a pH of approximately 2.0. If the pH of milk is approximately 6.0, how many times more acidic is vinegar than milk?

What is the relationship between **$[H_3O^+]$** and **$[OH^-]$** on the pH scale?

MORE BASIC

MORE ACIDIC

	$[H_3O^+]$	pH	$[OH^-]$	pOH
BASIC	1.0×10^{-15}	15.00	1.0×10^{1}	−1.00
	1.0×10^{-14}	14.00	1.0×10^{0}	0.00
	1.0×10^{-13}	13.00	1.0×10^{-1}	1.00
	1.0×10^{-12}	12.00	1.0×10^{-2}	2.00
	1.0×10^{-11}	11.00	1.0×10^{-3}	3.00
	1.0×10^{-10}	10.00	1.0×10^{-4}	4.00
	1.0×10^{-9}	9.00	1.0×10^{-5}	5.00
	1.0×10^{-8}	8.00	1.0×10^{-6}	6.00
NEUTRAL	1.0×10^{-7}	7.00	1.0×10^{-7}	7.00
ACIDIC	1.0×10^{-6}	6.00	1.0×10^{-8}	8.00
	1.0×10^{-5}	5.00	1.0×10^{-9}	9.00
	1.0×10^{-4}	4.00	1.0×10^{-10}	10.00
	1.0×10^{-3}	3.00	1.0×10^{-11}	11.00
	1.0×10^{-2}	2.00	1.0×10^{-12}	12.00
	1.0×10^{-1}	1.00	1.0×10^{-13}	13.00
	1.0×10^{0}	0.00	1.0×10^{-14}	14.00
	1.0×10^{1}	−1.00	1.0×10^{-15}	15.00

Why can we assume that the **$[H_3O^+]$** is equal to the **concentration of a strong acid**?

Example: What is the pH of a solution in which $[H_3O^+] = 3.7 \times 10^{-4}$ M?

Example: What is the pH of a 0.0150 M solution of HNO_3?

How do we determine the concentration of **hydronium ions $[H_3O^{1+}]$** if we know **pH**?

Example: If a solution has a pH of 2.14, what is the concentration of H_3O^+?

Practice:

1) Determine the pH of a 0.500 M solution of HCl.

2) Calculate $[H_3O^+]$ for a solution in which the pH is 5.89.

pOH:

$$pOH = -\log[OH^-]$$

*Some strong bases (such as calcium hydroxide) have **2x the $[OH^-]$** as the original base!

Example: Determine the pOH of a solution in which [OH-] = 6.3×10^{-2} M.

Example: Determine the $[OH^-]$ of a solution of potassium hydroxide that has a pOH of 2.78.

What is the relationship between **pH and pOH**?

Example: What is the pOH of a 0.015 M solution of $HClO_4$?

Example: What is the $[H_3O^+]$ in a 0.10 M solution of $Ca(OH)_2$?

Practice:

1) What is the pOH of a solution that has a pH of 3.41?

2) What is the $[H_3O^+]$ in a solution that has a pOH of 12.87?

3) If the $[OH^-] = 1.7 \times 10^{-12}$ M, what is the pH of the solution?

How the definition of an acid/base different by the **Brønsted-Lowry** interpretation?

When HF interacts with H_2O…
When NH_3 interacts with H_2O…

Example: Fire ants produce a weak acid called formic acid, HCO_2H, as a defense mechanism against predators. Show the conjugate base formed by formic acid from its interaction with water. Identify all conjugate pairs.

Example: The compound nicotine, $C_{10}N_2H_{14}$, acts as a weak base when in solution. Show the conjugate acid that is formed from nicotine when it accepts a proton from water. Identify all conjugate pairs.

Practice: For the following weak acids, write the formula of the conjugate base.

HF	HCN
H_2SO_4	NH_4^+

Practice: For the following weak bases, write the formula of the conjugate acid.

HCO_3^{1-}	HPO_4^{2-}
C_6NH_7	CH_3NH_2

Neutralization:

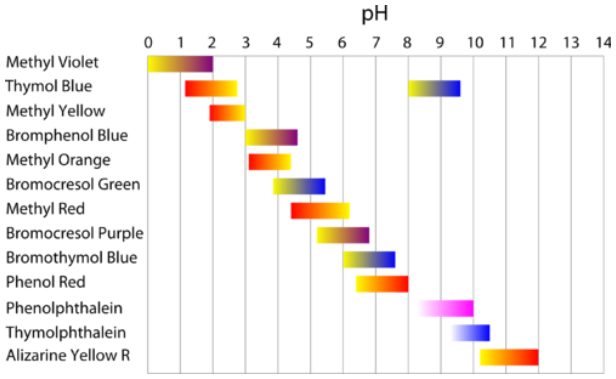
What **products** are formed from a neutralization reaction between a strong acid and a strong base?

Example: How would we represent the neutralization reaction of hydrochloric acid (HCl) with sodium hydroxide (NaOH)?

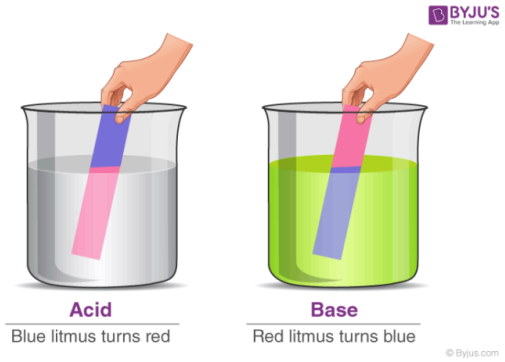
Example: How would we represent the neutralization reaction of calcium hydroxide, $Ca(OH)_2$, and nitric acid, HNO_3?

Note: The neutralization of a weak acid or base does <u>NOT</u> produce a solution with a pH of 7!

Indicator:



How do acids and bases react differently to **litmus paper**?



How else can pH be measured?

<u>Neutralization Predictions</u>

How do we mathematically determine how much strong acid will be required to neutralize a strong base (or vice-versa)?

Example: Hydrochloric acid can be neutralized by the following reaction:

$$\mathbf{HCl + NaOH \rightarrow H_2O + NaCl}$$

If 50.0 mL of HCl are at 0.10 M, how many mL of 1.0 M NaOH will be required to completely neutralize the acid?