

## The Material World: Solution Chemistry

### 9. Molarity (M)

**Molarity = Moles per Liter (moles/L or mol/L) = moles of solute per liter of solution**

$$n = CV$$

n = number of moles of solute

C = concentration of solution

V = volume of solution

**Example1** If 30 grams of NaOH are dissolved and then diluted to 2.0 L with water, what is the molar concentration (molarity) of the solution?

**Example2** How do you make 300 ml of a 0.10 mole/L solution of KCl?

Starting Material	Preliminary Calculation	Procedure
Solute and water have to be turned into a solution of known concentration.	moles = CV, if C is in moles/L	<ol style="list-style-type: none"><li>1. Weigh the calculated amount of solid.</li><li>2. Dissolve in beaker containing less than the desired amount of solvent.</li><li>3. Transfer to a volumetric flask.</li><li>4. Add water to dilute to the mark with solvent and mix.</li></ol> <p>Remember <b>WDTA</b>= We don't trust adults.</p>

### Homework

1. In 100 mL of a solution, there are 3.0 g of NaCl. Find the molarity.
2. In 2.0 L of a solution, there are 3.0 g of KF. Find the molarity.
3. How many grams of KBr are needed to prepare 2.5 L of a 0.25 mole/L solution?

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- How many grams of  $\text{Ca}(\text{ClO})_2$  are needed to prepare 2.0 L of a 0.45 mole/L solution?
- What is the volume of a solution containing 3.0 grams of  $\text{HNO}_3$  if the concentration is 0.10 mole/L.
- Explain how you would actually prepare 3.0 L of a 0.2 mole/L Na Br solution in the lab.

$$n = CV \text{ or } C = \frac{n}{V}$$

**n = moles of solute**

**C = concentration (moles/L= molarity)**

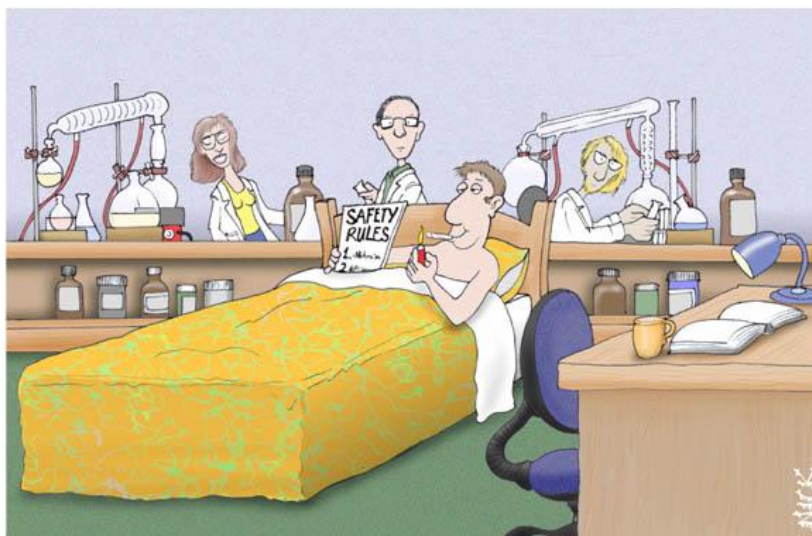
**V = volume of solution in L**

### **STE** Extra Practice with Molarity

- In 10.0 mL of a certain solution, there are 0.050 g of KF. Find the molarity of the solution (moles/L)
- In 2.0 L of a solution, there are 3.0 g of KF. Find the molarity.
- How many grams of NaCl are needed to prepare 1.5 L of a 0.20 mole/L solution?
- How many grams of  $\text{LiNO}_3$  are needed to prepare 500 ml of a 0.10 mole/L solution?
- What is the volume of a solution containing 3.0 grams of HCl if the concentration is 0.50 mole/L.

### **Competency 1**

- Explain how you would actually prepare 2.0 L of a 0.2 mole/L  $\text{MgCl}_2$  solution in the lab.
- Find the **error** in the student's procedure. Explain why.
  - The student weighed 0.10 grams of a solid to make 0.10 L of a solution.
  - He transferred the solid into a beaker.
  - He added less than 100 ml of water and stirred.
  - He used more water to make sure that he got all of the solution out of the beaker as he transferred it into a second beaker.
  - He added water to the 100 ml line



*Recent Advances in Science, #32:*

Dr Ed Henderson demonstrates that it IS possible for someone to become too familiar with the safety rules.

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and then carefully mixed.

### 10. Electrolytes and Non-electrolytes

If you place a light bulb containing two electrodes in a sugar solution, the light fails to illuminate. What happens if you dip the same gadget into a NaCl solution?



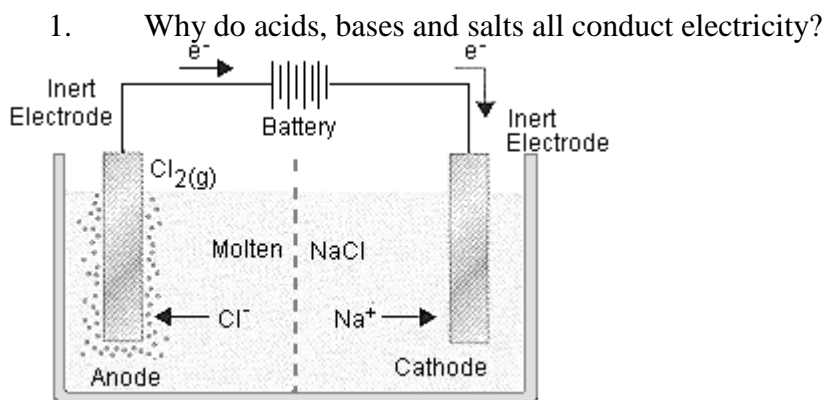
#### A Definitions

Electrolyte:

Acids, bases and salts in solution are all examples of electrolytes.

Non-electrolyte:

Examples:



Here we are explaining why molten NaCl conducts. Explaining why aqueous NaCl conducts is complicated by the fact that water is a better electron acceptor than  $\text{Na}^+$ .

2. From the point of view of physical properties, what do electrolytes have in common? Non-electrolytes?

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3. What chemical properties do electrolytes share? Non-electrolytes?

### **B Strength of Electrolytes**

This depends on what percent of the original molecule splits into ions. If the percent is high, the molecule will be a **strong electrolyte**. Otherwise it will be a poorer conductor of electricity and is considered to be a **weak electrolyte**.

#### **Examples:**

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### Exercises





- Which of the following properties is **common** to acids, bases, and salts?
  - They all react with metals to produce hydrogen gas.
  - They all turn litmus paper red.
  - They all conduct electricity.
  - They all are slippery to the touch.
- Compare (list similarities) and contrast (list differences) the physical and chemical properties of electrolytes and non-electrolytes.
- Is it a good idea to go swimming in the sea with an approaching storm, even if the water remains calm?
- How do electrolytes and non-electrolytes help us survive driving in wintry conditions?
- Draw a diagram explaining how a molten solution of KBr conducts electricity. Also show two equations.
- Only 5% of acetic acid molecules become  $\text{H}^+$  ions.
  - Is acetic acid a weak electrolyte?
  - Give an expected physical property of acetic acid.

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### 11. pH : A Closer Look

$[H^+] = 10^{-pH}$ , where  $[H^+]$  = concentration of  $H^+$  in moles of  $H^+$  per litre of solution

Based on this formula, fill out the amount of  $H^+$  for pH= 0 to 14.

pH	$[H^+]$	Examples
0		
1		 <p>Stomach acid comes in at pH = 1.4</p>
2		
3		
4		
5		 <p>Rain from unpolluted skies is at pH = 5.6</p>
6		 <p>Tomatoes love a pH range of 6.2 to 6.8</p>
7		
8		 <p>8.2= good for brushing teeth</p>
9		
10		

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11		
12		
13		
14		

**Example 1** Compare pH = 3 to pH = 7 based on the amount of  $[H^+]$ .

**Example 2** What would be the pH of rain that is 100 X more acidic than normal?

### Exercises

1. What is the  $[H^+]$  at a pH of 6?
2. Where does the  $[H^+]$  come from if we a basic solution at pH = 8?
3. Compare pH = 3 to pH = 7 based on the amount of  $[H^+]$ .
4. a) What would be the pH of rain that is 10 times more acidic than normal (normal = 5.6) ?  
b) What atmospheric gas do you think forms an acid and lowers the pH of rain from 7 to 5.6?
5. a) Look up the definition of buffer.  
b) Soil is said to be a good buffer. What would happen to the pH of soli if it received a small amount of acid? Of base?