

## AR Chemistry: Colligative Properties Problem Set

1. What is the particle concentration of:  
a. a 1.0 M NaCl solution?

$$\text{NaCl} = 2 \text{ particles: } 1.0 \text{ M} \times 2 \text{ particles} = \mathbf{2.0 \text{ M particles}}$$

- b. a 2.0 M H<sub>2</sub>SO<sub>4</sub> solution?  
c. a 1.5 M NH<sub>4</sub>Cl solution?  
d. a 3.5 M Na<sub>2</sub>CO<sub>3</sub> solution?  
e. a 2.5 M CaCl<sub>2</sub> solution?

2. What are the boiling and freezing points for the solutions in problem 1?

1a)  $2.0 \text{ M particles} \times +0.5 \text{ C} / 1.0 \text{ M} = +1 \text{ C}$  (**101 C**)  
 $2.0 \text{ M particles} \times -1.9 \text{ C} / 1.0 \text{ M} = \mathbf{-3.8 \text{ C}}$

3. What is the particle concentration when?

- a. 45.0 grams of NaCl are dissolved in an 800. mL solution?

$$\begin{aligned} 45.0 \text{ g NaCl} \times 1 \text{ mol} / 58.44 \text{ g} &= 0.770 \text{ mol NaCl} \\ M &= \text{mol} / L = 0.77 \text{ mol} / 0.80 \text{ L} = 0.963 \text{ M} \\ \text{NaCl} &= 2 \text{ particles: } 0.963 \text{ M} \times 2 \text{ particles} = \mathbf{1.93 \text{ M particles}} \end{aligned}$$

- b. 115 grams of CaCl<sub>2</sub> are dissolved in a 1.50 L solution?  
c. 39.2 grams of Na<sub>2</sub>CO<sub>3</sub> are dissolved in a 2.35 L solution?  
d. 72.0 grams of C<sub>12</sub>H<sub>22</sub>O<sub>11</sub> are dissolved in 2100 mL of solution?  
e. 41.6 grams of Ca(OH)<sub>2</sub> are dissolved in 1200 mL of solution?

4. What are the boiling points and freezing points for the solutions in problem 2?

3a)  $1.93 \text{ M particles} \times +0.5 \text{ C} / 1.0 \text{ M} = +.97 \text{ C}$  (**100.97 C**)  
 $1.93 \text{ M particles} \times -1.9 \text{ C} / 1.0 \text{ M} = \mathbf{-3.67 \text{ C}}$

5. What is the particle concentration of a solution that has:

- a. a boiling point of 102 C?

$$+2 \text{ C} \times 1 \text{ M particles} / +0.5 \text{ C} = \mathbf{4.0 \text{ M particles}}$$

- b. a freezing point of -5 C?  
c. a boiling point of 103.7 C?  
d. a freezing point of -7 C?  
e. a melting point of -8.4 C?

6. How many moles of solute are in each of the following solutions?:

- a. a 1.20 L solution of NaCl that has a boiling point of 104 C.

$$\begin{aligned} +4 \text{ C} \times 1 \text{ M particles} / +0.5 \text{ C} &= 8.0 \text{ M particles} \\ 8.0 \text{ M particles} \times 1 \text{ M NaCl} / 2 \text{ M particles} &= 4.0 \text{ M NaCl} \\ 4.0 \text{ M} &= \text{mol} / 1.20 \text{ L}; \text{ moles} = \mathbf{4.80 \text{ moles NaCl}} \end{aligned}$$

- b. a 2.50 L solution of C<sub>12</sub>H<sub>22</sub>O<sub>11</sub> that has a freezing point of -3.8 C.  
c. a 1.75 L solution of Na<sub>2</sub>CO<sub>3</sub> that has a freezing point of -7.9 C.  
d. a 300 mL solution of CaCl<sub>2</sub> that has a freezing point of -5.0 C.  
e. a 1200 mL solution of Ca(OH)<sub>2</sub> that has a boiling point of 102.8 C.