Chemistry   Name..

Unit 7 – Molarity   Hour............

When you buy a bottle of a certain brand of lemonade you expect it to taste just as sweet as the last time you bought that kind of lemonade. Likewise, when doctors prescribe a certain ointment, they expect the concentration of medicine to be consistent. How do companies ensure that their products taste or perform the same every time you purchase them? Many companies, including pharmaceutical companies, keep track of the concentration of a solution by measuring its **molarity** – a ratio of the number of solute particles to the volume of the solution. In this activity you will learn about molarity and how to represent concentration quantitatively.

Model 1 – Lemonade Mixtures*
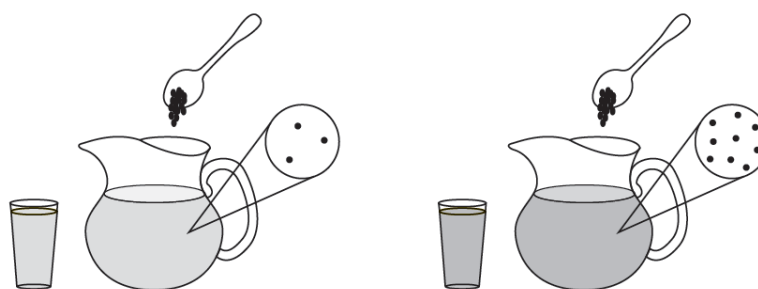
    * Both pitchers were filled with enough water (solvent) to provide 2 L of solution. The solid lemonade mixture consists of several molecules. The dissolved sugar molecule (solute) is indicated with a •

1. Refer to Model 1.

   a. What is the solvent in this scenario? _____ The solute? _____

   b. Lemonade Solution 1 has (more/less/the same) volume of solution as Solution 2.

   c. Lemonade Solution 1 has (more/less/the same) quantity of solute as Solution 2.

2. Lemonade Solution 2 is considered to be **concentrated**, and Lemonade Solution 1 is considered to be **dilute**. Examine the two pictures in Model 1. List two ways to differentiate a concentrated solution from a dilute solution.

   _____

   _____

3. A glass is filled with the concentrated lemonade solution from Model 1.

    a. The concentration of the lemonade solution in the glass is (the same, different than) the concentration of the lemonade solution in the pitcher.

    b. Does the solution in the glass contain the same number of solute particles as the solution in the pitcher? If no, explain how your answer to part a can be true. *Hint:* Consider both amount of solute and amount of solvent.

    _____

    _____

4. Do the terms "concentrated" and "dilute" provide any specific information about the quantities of solute or solvent in a solution? Explain.

    _____

    _____

5. The lemonade solution in Model 1 is classified as a **mixture** because it contains more than one type of particle (*e.g.* sugar molecules, flavoring molecules, coloring molecules, water molecules, etc). A **homogeneous** mixture is a mixture that is uniform throughout while a **heterogeneous** mixture is non-uniform throughout. Identify the following mixtures as being **homogeneous** or **heterogeneous**.

    a. Air   _____

    b. Trail mix   _____

    c. Mint chocolate chip ice cream   _____

    d. Soda   _____

    e. Lemonade   _____

    f. Cheeseburger   _____

Model 2 – Chemical Solutions
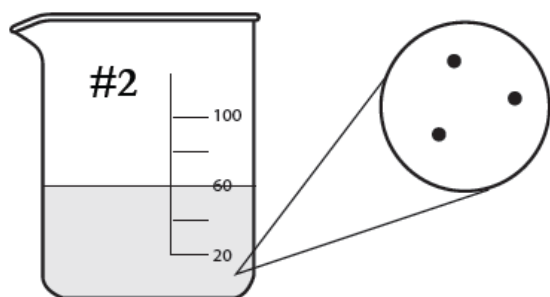
Dilute Solution   Concentrated Solution
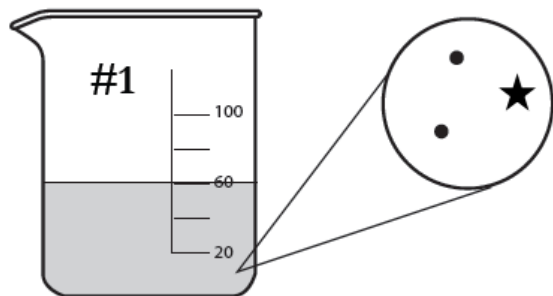
1 M $CuCl_2$(aq)
0.06 mole $CuCl_2$ in 0.06 L
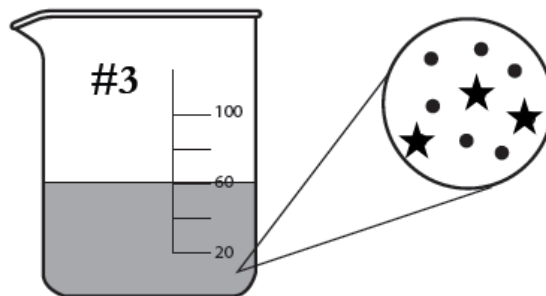
3 M $CuCl_2$(aq)
0.18 mole $CuCl_2$ in 0.06 L

1 M $C_6H_{12}O_6$(aq)
0.06 mole $C_6H_{12}O_6$ in 0.06 L
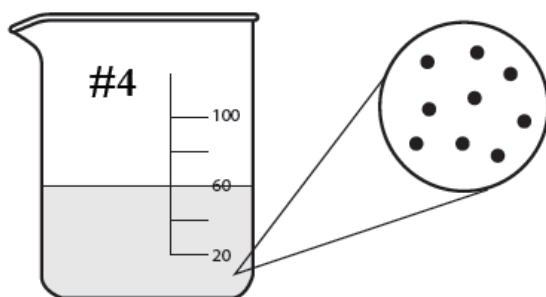
3 M $C_6H_{12}O_6$(aq)
0.18 mole $C_6H_{12}O_6$ in 0.06 L

> M = molarity
> 3 M is read as "three molar"
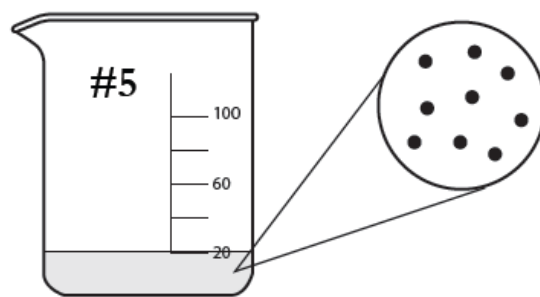
3 M $C_6H_{12}O_6$(aq)
0.06 mole $C_6H_{12}O_6$ in 0.02 L

6. List the beaker numbers for the solutions in Model 2 that are considered to be "concentrated" _____.

7. What does the letter "M" stand for in Model 2? _____

8. Use the data in Model 2 to answer the questions below.
   a. Calculate the ratio of the moles of solute to liters of solution for each solution, $\frac{moles\ of\ solute}{liters\ of\ solution}$.

   b. How does the ratio compare to the molarity of each solution? _____

   c. Write a mathematical equation to show how the molarity (M) of a solution is calculated.

   _____

   d. Which type of solution (dilute or concentrated) will have a larger molarity value?

   _____

9. Consider beakers 3 – 5 in Model 2. Circle the answer below for the quantity that is the same in all of the beakers that contain three molar solutions.

Number of moles of solute Volume of solution Ratio of moles of solute to liters of solution

10. Explain how beaker 5, with fewer moles of glucose, can have the same molarity as beaker 4.

   _____

11. Calculate the molarity of a solution containing 1.5 moles of NaCl in 0.50 liters of solution. Show your work.

12. Calculate the molarity of a solution containing 0.40 moles of acetic acid ($HC_2H_3O_2$) in 0.250 liters of solution. Show your work.

13. A 0.5 M KCl solution contains 74.55 g of KCl (molar mass 74.55 g/mol) in 2000 mL of solution.
   a. Does the ratio 74.55 g KCl / 2000 mL provide the correct molarity for this solution?

   b. What units do the amount of solute and the volume of solution need to be in to obtain the molarity of 0.5 M?

14. Which types of particles – molecular or ionic – are found in beaker 1 in Model 2? _____

    beaker 2? _____

15. Can both dissolved ionic and dissolved molecular compounds produce dilute solutions?

    _____ Concentrated solutions? _____

16. Beakers 1 and 3 in Model 2 contain two types of particles (ignoring water), indicated by a •
    and a *.

    a. What two particles (ignoring water) are in both beakers?(*Hint*: look at the chemical

        formula and your solubility rules) _____

    b. Which particle is indicated by the •? _____ The *? _____

    c. A compound that "splits apart" when it dissolves in water is said to have both

        dissolved and _____.

17. Beakers 2, 4 and 5 in Model 2 contain only one type of particle (ignoring water), indicated by

    a •.

    a. What particle (ignoring water) is found in these beakers? _____

    b. Why is there only one type of particle (ignoring water) in these beakers?

        _____

18. Electrolytic solutions contain free ions and conduct a current as indicated by a glowing light
    bulb. Which beaker in Model 2 is the most electrolytic? Briefly explain your answer.

    _____

    _____

While it is appropriate to write beaker 1 as "1 M $CuCl_2$(aq)" it is important to note the beaker **does not** contain $CuCl_2$. Instead, the beaker contains Cu^{2+} ions and Cl^{1-} ions solvated by water molecules. The formula of $CuCl_2$ indicates that one $CuCl_2$ produces one Cu^{2+} ion and two Cl^{1-} ions. **Thus, a 1 M $CuCl_2$ solution contains 1 M Cu^{2+}(aq) and 2 M Cl^{1-}(aq).**

19. Given what you've read above, beaker 3 contains _____ M Cu^{2+}(aq) and _____ M Cl^{1-}(aq).

20. A student adds 15.0 grams of Na_2SO_4 to 150 mL of water. Calculate the following:

   a. The molarity of Na_2SO_4(aq), [Na_2SO_4]

   b. The molarity of Na^{1+}(aq), [Na^{1+}]

   c. The molarity of SO_4^{2-}(aq), [SO_4^{2-}]

21. An additional 150 mL of water is added to the solution in Question 20. Calculate the following:

   a. The molarity of Na_2SO_4(aq), [Na_2SO_4]

   b. The molarity of Na^{1+}(aq), [Na^{1+}]

   c. The molarity of SO_4^{2-}(aq), [SO_4^{2-}]