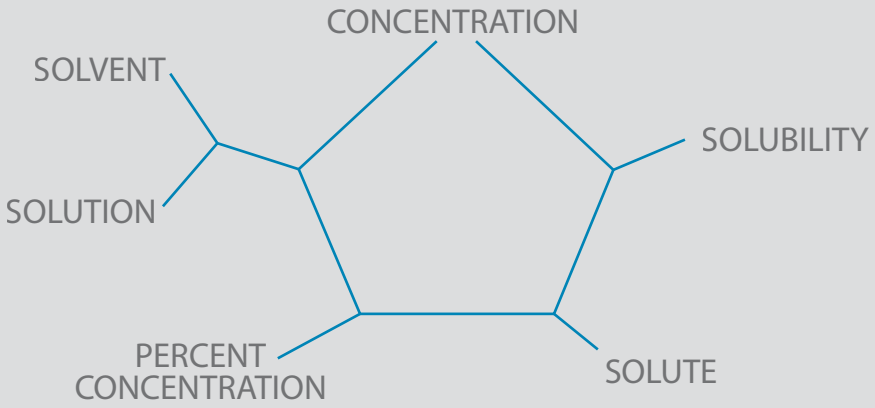
CHAPTER 3

CHEMICAL SOLUTIONS- PERCENT CONCENTRATIONS

OBJECTIVES AND VOCABULARY

At the conclusion of this lesson the student should have an understanding (as evidenced by successfully completing the quiz at the end of this lesson) of:

1. The nature of a solution as being a solute dissolved into a solvent
2. How to determine the amount of solute and solvent to use to prepare a solution of known percent concentration.



A solution is a mixture. We normally think of a solution as something dissolved in water. But it could be something dissolved in oil as well.

Imagine that you have 4 glasses that appear to each contain water. The first has just water; the second has water and salt; the third has water and sugar; and the fourth has water and quinine (very bitter). They all look alike. Does that mean that they really are alike? Appearance may not always be the best judge. Suppose you taste each (which you never do in a chemistry lab). Now are they all alike? Obviously not. What if you have 2 clear glasses of water and one has a little salt and the other has a lot of salt? Could you tell the difference? It would be quite obvious that what a liquid contains and how much it contains are both very important. Along the same line of thought, have you ever taken a large drink of pickle juice?

An easy way to describe a solution is that a **solute** is dissolved into a **solvent** to make a **solution**. Most substances studied in chemistry are dissolved in water. This makes water the solvent. When you prepare a salt water solution, salt is the solute, water is the solvent, and salt water

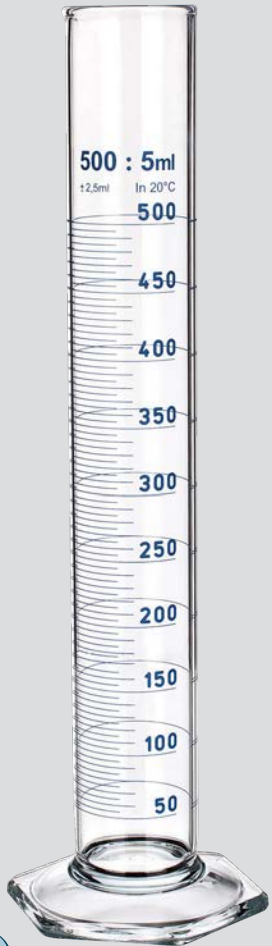
is the solution. Some important solutions include sea water, fresh water, rain water, and the body fluids that bathe your cells.

How well something dissolves is called its **solubility.** The amount of solute divided by the amount of solution is the **concentration**. When you go to a doctor's office they often take a blood sample. The concentrations of several solutes in your blood are used to determine the health of your body and cells. This is a lot better than going after you with a scalpel.

A common method of indicating concentrations is the **percent concentration.** This is found by dividing the mass of the solute by the total mass of the solution and multiplying it by 100 to get a percent.

REACTIONS IN ACTION

If you dissolve 10 grams of NaCl (sodium chloride, table salt) in water to make 100 grams of solution, you get a 10 percent NaCl solution.



10 divided by 100 is 0.1.
0.1 multiplied by 100 is 10 percent.

If you add 10 grams of NaCl to 90 grams of water, you will have a total of 100 grams of solution.

It is easier to measure out NaCl (a solid) on a balance than water, which is a liquid. One gram of water at room temperature is very close to the mass of one milliliter of water. So, instead of measuring out 90 grams of water on a balance, it is easier to measure out 90 ml of water in a graduated cylinder.

To prepare the solution, measure out the 90 ml of water and add the 10 grams of NaCl to it. Even though you only get a volume of 90 ml of solution, it is 90 ml of a 10 percent NaCl solution.

Study this example.

How would you prepare 90 ml of a 10 percent sucrose (table sugar) solution? Add 10 grams of sucrose to 90 ml of water. This gives 100 grams of solution and 10 out of the 100 (10 percent) is sucrose.

Add 10 grams of sucrose to 90 ml of water. 10 grams of sucrose and 90 grams (ml) of water give 100 grams of solution.

$$\frac{10}{100} \times 100\% = 0.1 \times 100\% = 10\%$$

How would you prepare a 20 percent solution of NaCl?

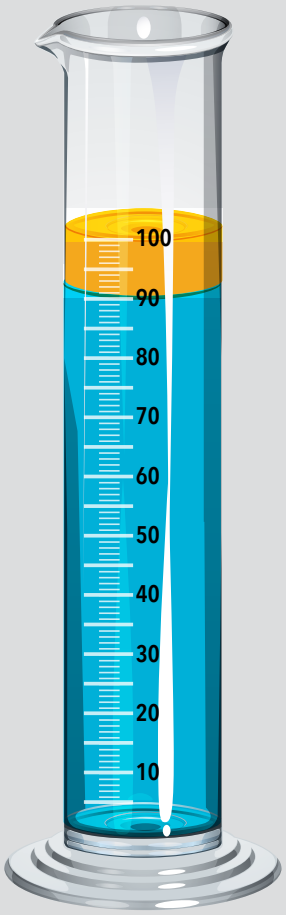
Add 20 grams of NaCl to 80 ml (grams) of water to make 100 grams of 20 percent NaCl solution. 20 grams of NaCl and 80 grams of water equal 100 grams of solution.

$$\frac{20}{100} \times 100\% = 0.2 \times 100\% = 20\%$$

If you need more than 80 ml of 20 percent NaCl solution, double the amounts. Add 40 grams of NaCl to 160 ml (grams) of water to make 200 grams of NaCl solution.

$$\frac{40}{200} \times 100\% = 0.2 \times 100\% = 20\%$$

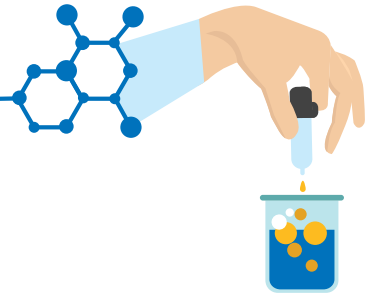
NON-SOLUBLE LIQUID



The oil represents 10 percent of the total liquid in the graduated cylinder.

LAB INSIGHTS

LABORATORY 3



PREPARING PERCENT CONCENTRATION SOLUTIONS

REQUIRED MATERIALS

- Graduated cylinder (10 ml)
- Stirring rod
- Weighing boats / weigh paper
- Scale
- Table salt
- Beaker (100 ml)
- Beaker (250 ml)
- Laboratory scoop

INTRODUCTION

Percent concentrations are not difficult to understand but can be challenging to prepare. Percent concentrations are used more often in medical or physiological applications rather than in a chemistry lab. If you do not pursue chemistry further in college, you will use percent concentrations and probably not use molar concentrations.

PURPOSE

The purpose of this lab exercise is to gain experience with percent concentrations and to get comfortable with their preparation.

PROCEDURE

1. Water & Salt (Part 1)
   A. Measure out 9 ml of water with a graduated cylinder.

      (1 ml of water has a mass of 1 gram, so 9 ml of water has a mass of 9 grams.)

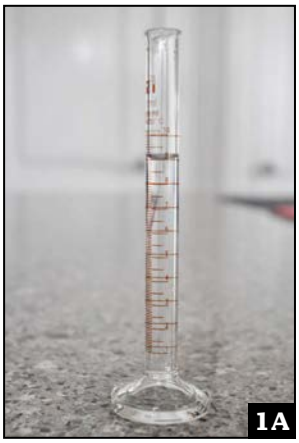
   B. Place the weighing boat onto the scale. (Important: See “Weighing” in Appendix 1 on page 272)

   C. Measure out 1g of NaCl (see lab procedures: Weighing)

   D. Pour the water into a 100 ml beaker and dissolve the 1 g of NaCl into it. Use a stirring rod to help dissolve the NaCl.

   E. What is the percent concentration of the solution? Remember that the percent concentration is the mass of solute (NaCl) divided by the mass of the solution (NaCl and H2O) x 100 percent.

   F. How would you prepare twice the volume of the same percent concentration solution of NaCl and water?


1A


1B


1C


1D

2. Water & Salt (Part 2)

   A. Measure out 16 ml of water and pour it into a 100 ml beaker.

   B. Measure out 4 g of NaCl and dissolve it into the 16 ml of water.

   C. What is the percent concentration of NaCl in your solution?

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3. How would you prepare 85 ml of a 15 percent sucrose (table sugar) solution? Prepare this solution.

4. Determine the solubility of NaCl in water.
   Solubility is defined as the maximum amount of a solute that can dissolve into a given volume of solvent.

   A. Measure out 100 ml of water using a graduated cylinder and pour it into a 250 ml beaker.

   B. Fill a weigh boat approximately half full with NaCl and record the mass.

   C. Gradually add the NaCl to the 100 ml of water while stirring until no more will dissolve.

      You may need to refill the weigh boat with additional NaCl to be added to the water. If you do, keep track of the mass of the additional NaCl used.

   D. Determine the maximum number of grams of NaCl that will dissolve in 100 ml of water.

4B


4C

Calculate the percent concentration of NaCl as

$$\frac{\text{the number of grams of NaCl}}{\text{(grams of NaCl + water)}} \text{ x } 100\%$$

For example, if you dissolve 23 g of NaCl into 100 ml of water and no more dissolves, the **solubility** is

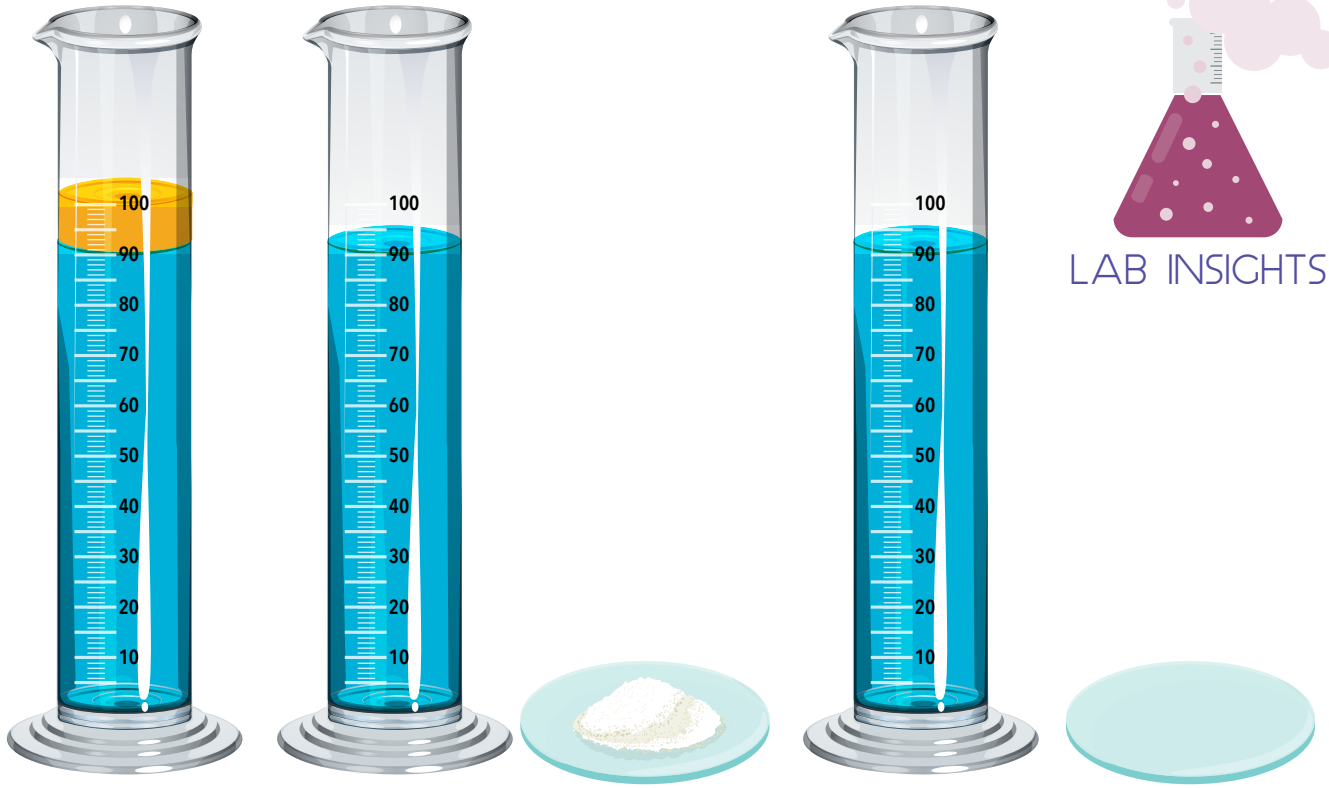
$$\frac{23 \text{ g NaCl}}{100 \text{ ml } H_2O}$$

The **percent concentration** is

$$\frac{23 \text{ g NaCl}}{(23 \text{ g NaCl} + 100 \text{ g } H_2O)} \text{ x } 100\% = \left(\frac{23}{123}\right) \text{ x } 100\% = 19\%$$

The lab report should include a description of all your procedures and the answers to your calculations. Be sure to always show your work. This way it is evident that you have a grasp of the concepts even if you made an arithmetic error somewhere.

NON-SOLUBLE VS SOLUBLE



The oil is 10 percent of the total liquid in the graduated cylinder, and the oil is not soluble in the water.

The NaCl on the plate is 10 percent of the total solution.

When the NaCl is poured into the water, it dissolves because it is soluble in water.

LAB INSIGHTS