2008
A.Ancheta
Name:_______________________________ Period: ________ Date:____________________

Toxin: Solution Preparation

When a substance, called a **solute**, is dissolved in another substance, called the **solvent**, a solution is formed. **A solution is a uniform distribution of solute in solvent.** For example, vinegar is a solution of acetic acid, the solute, in water, the solvent. The amount of solute in a solvent is important and can be expressed in several different ways. Some common units of concentration and dilution will be discussed in this handout.

I. **Molar solutions**

Before we can make molar solutions, we need to review molar mass. Molar mass is expressed in grams/mole and is the mass of one mole of the atom or molecule.

Practice Problems – review of molar mass

1. Calculate the molar masses of the following chemicals (show work):

a. Cl_2

b. KOH

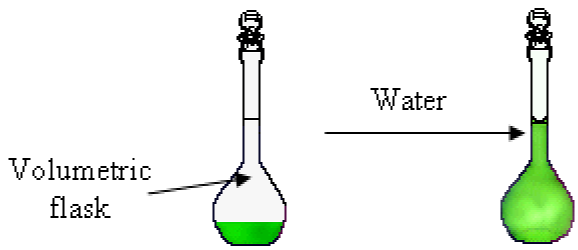
c. $BeCl_2$

d. $FeCl_3$

e. BF_3

Preparation of molar solution

Molarity (M) means the number of moles of solute per liter of solution. To prepare a 1 M solution, you add formula weight of compound to 500-mL distilled or deionized water in a 1000-mL volumetric flask half filled with distilled or deionized water. Allow the compound to dissolve completely, swirling the flask gently if necessary. Once the solute is completely dissolved and the solution is at room temperature, dilute to the mark with water. Invert the flask several times to mix.



Example 1: How many grams of Sodium Chloride (NaCl) will you need to make a 100 mL of 1 M NaCl solution?

Step 1: Find the Molar mass of NaCl.

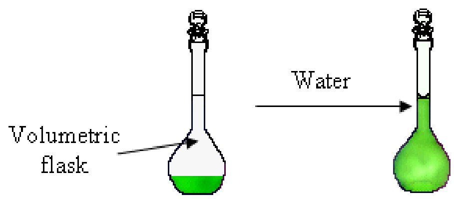
Step 2: Multiply volume needed by the concentration needed to figure out number of moles compound needed.

$$100 \text{ mL} \times \frac{1 \text{ mole NaCl}}{1000\text{mL water}} = 0.1 \text{ mole NaCl}$$

Step 3: Multiply by the molar mass of NaCl to figure out grams of compound needed.

$$0.1 \text{ mole NaCl} \times \frac{58.5 \text{ g NaCl}}{1 \text{ mole NaCl}} = 5.85 \text{ g NaCl}$$

Step 4: Prepare the solution by slowly adding 5.85 g sodium chloride to 50 mL distilled or deionized water in a 100-mL volumetric flask. When all the solid is dissolved and the solution is at room temperature, dilute to the mark and invert the flask several times to mix.



Practice Problems – Molar solution

Please explain the answer in detail showing pictures of the proper equipment used.

1. Explain how you would prepare a 100 mL of 0.1 M sugar ($C_6H_{12}O_6$) solution.

2. How many grams of solid NaOH will you need to prepare a 100ml of 6M NaOH? How would you prepare this solution?

3. Explain how you would prepare a 100 mL of 0.1 M NaCl.

II. **Percent (%) solutions**

In this class we will learn to prepare mass percent solutions only. **Mass percent** means the number of grams of solute per 100 g of solution. For example, 10 g sodium chloride in 90 g water is a 10% by mass solution. Note: Density of water is 1g/ml. We will be using graduated cylinder.

mass percent = mass of solute/mass of solution

= 10 g / (10 g + 90 g) x 100%

= 10%

Practice Problems – Percent (%) solution

Please explain the answer in detail showing pictures of the proper equipment used.

1. How would you prepare a 100mL of 1% NaCl solution?

2. How many grams of sucrose will you need to prepare a 250 ml of 1% sucrose solution? Show work.

III. **ppm (parts per million)**

We will not be preparing any ppm solutions but you need to know the unit because it is frequently used to explain mineral/toxin concentration in water and in air.

It is a way of expressing very dilute concentrations of substances. Just as per cent means out of a hundred, so parts per million or ppm means out of a million. Usually describes the concentration of something in water or soil. One ppm is equivalent to 1 mg (or 1mL) of a substance per 1 liter of water (mg/l) or 1 milligram of something per kilogram soil (mg/kg).

Practice Problems – ppm solution

1. 5.00 mg of lead is in 2.00 kg of water.

2. 2.50 grams of solute dissolves in 3,500,000 grams of water.

Safe Water Levels for Drinking

In the United States, the Environmental Protection Agency regulates public drinking water by monitoring levels of arsenic, lead, chlorine, fluoride and microbial contaminants such as cryptosporidium. Safe drinking water is often scarce in the developing world. In Africa, for example, only 46 percent of people have access to clean water.

- Arsenic is a naturally occurring substance in soil and groundwater which can cause cancer and various other ailments. Formerly, the maximum standard for arsenic in drinking water was 50 parts per billion. In 2002, the EPA reduced this to 10 ppb, due to research suggesting that people consuming water with 20 ppb arsenic have a 0.7 percent increased risk of developing cancer in their lifetime. Arsenic is especially a problem in private wells.
- The EPA suggests that if water has a lead content above 15 ppb, you should take action to replace old pipes, filter water or drink bottled water. The actual enforced lead standard is higher than this, however. Children are especially susceptible to lead poisoning.

- A small amount of fluoride in water is usually considered to be beneficial for dental health. Higher concentrations of fluoride can be toxic. The current EPA standard for fluoride is 4 milligrams per liter of water, but a study by the National Research Council suggested that this standard is too high and should be lowered.

IV. Dilutions

When preparing a dilution, decide the volume and molar concentration of the resulting solution that you require. Use the following equation to determine how much of the concentrated reagent is needed to prepare the diluted solution,

$$M_1 \times V_1 = M_2 \times V_2$$ where M is molarity and V is volume.

Slowly add the calculated volume of concentrated reagent to a proper-sized volumetric flask half filled with distilled or deionized water and swirl the flask to mix. Once the solution is at room temperature, dilute to the mark with water and invert the flask several times to mix.

For example, what volume of 10 M acetic acid is required to prepare 1.0 L of 0.50 M acetic acid?

$$10\ M \times V_{reagent} = 0.50\ M \times 1.0\ L$$

$$V_{reagent} = 0.050\ L = 50\ mL$$

A volume of 50 mL of 10 M acetic acid is required to prepare 1.0 L of 0.50 M acetic acid.

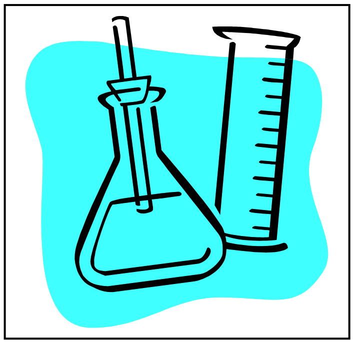
Practice Problems – Dilution

Please explain the answer in detail showing pictures of the proper equipment used.

1. You need to prepare 100 mL of 6M HCl from a concentrated (12M) HCl. How would you go about preparing the solution?

2. How would you prepare a 250mL of 0.1M NaCl solution from 2.0 M NaCl solution?

3. How would you prepare a 250mL of 1M KOH solution from 6.0 M KOH solution?



GENERAL INSTRUCTIONS FOR SOLUTION PREPARATION

1. Choose the appropriate equipment for the job—correct balance, right size pipets/pipettor, appropriately sized glassware, a magnetic stir bar that fits the glassware.
2. Weigh out solid material and add to the vessel you're making your solution in (usually a flask or a beaker). Add partial volume of solvent (usually distilled water) and stir to dissolve.
3. If needed, transfer solution to appropriate vessel (usually a graduate cylinder) to adjust final volume. Cover (parafilm will help here) and mix well.
Note: if a volumetric flask is being used for solution preparation, the transfer step above is not necessary—dissolution and final volume adjustment may be carried out using the same vessel.
4. Transfer solution to an appropriately sized storage bottle.
5. Label storage bottle with the following information:
* Name of solution
* Ingredients (if not clear from name)
* Storage conditions
* Disposal instructions
* Initials of preparer
* Date of preparation
* Any special precautions that must be taken with solution

(ex. Ethidium bromide: Mutagen!)
6. Clean up. You must follow proper disposal method

Definitions:

a. **Deionized water:** Water which has been specifically treated to remove minerals.
b. **Distilled water:** water heated to the boiling point, vaporized, cooled, condensed, and collected so that no impurities are reintroduced.
c. **Solute:**
d. **Solvent:**
e. **Translucent:**
f. **Transparent:**
g. **Molar solution:**
h. **Percent Solution:**
i. **Media:**

Draw the following glassware:
a. **volumetric flask**
b. **Erlenmeyer flask**
c. **Graduated cylinder**
d. **Beaker**
e. **Electronic balance**
f. **Weighing boat**
g. **Spatula/Scoopula**