Online Actvity 1

Laboratory Math

Introduction

Chapter 1 in the CHM 101 textbook introduces you to the concept of dimensional analysis – using units to help you solve math problems. Many of the calculations that you will need to complete for the CHM 102 lab can be solved through the use of dimensional analysis. However, a number of the conversion factors that you will need to use will not be introduced until later in the semester.

In order to help you to work through your lab calculations more easily, this activity will introduce you to some of the concepts and conversion factors that are commonly used when conducting experiments in chemistry. You will learn more about these topics later in the semester, but this introduction should be sufficient to enable you to perform the calculations that you will need for lab.

Amount of material

When you are performing an experiment in chemistry, you often need to start by weighing out a certain amount of material. The atoms and molecules that make up all materials are very small – much too small to be seen with the human eye. It is not possible for you to go into a lab and count out, for example, 20 molecules of table sugar (sucrose). As a result, chemists need other ways to talk about the amount of material. Since atoms and molecules are so small, it is most convenient to talk about them in large groups. The grouping that chemists use is the **mole (mol)**. A mole of material is a specific number of atoms or molecules of that material – much like a dozen is a specific number of eggs, or donuts, or other items. One dozen always refers to 12 of something. Since atoms and molecules are so small, the mole is much, much, larger than 12. One mole of atoms or molecules is 6.022×10^{23} atoms or molecules. A mole of sucrose will give you enough sucrose molecules for you to see and be able to measure. However, you still cannot count the actual particles. What you need to be able to do in a lab setting, is to measure out the mass of a material using a balance. Therefore, you need a conversion factor to relate the number of moles of something to the mass of that amount of material.

The conversion factor that relates mass and moles is the molar mass, and it is specific to each element or compound.

$$Molar\ Mass\ = \frac{mass\ (g)}{number\ of\ moles\ (mol)}$$

The mass of each element that is written on the **Periodic Table** can be read as the molar mass of that element, and has units of grams/mole. The molar mass of a compound can be found by adding together the molar masses of all of the elements in the compound.

Water, H_2O, contains two hydrogen atoms and one oxygen atom. Therefore, the molar mass of water would be:

H = 1.00794 g/mol x 2 = 2.01588 g/mol

O = 15.9994 g/mol x 1 = 15.9994 g/mol

18.01528 g/mol ->with correct sig figs: 18.0153 g/mol

If you had 3.56 moles of water, and wanted to know how many grams of water you had, you would use the molar mass of water as a conversion factor:

$$mass\ of\ water = 3.56\ mol\ x \frac{18.01528g}{1\ mol} = 64.1g\ water$$

Likewise, if you had 8.432g of water, and wanted to know how many moles of water you had, you would also use the molar mass as the conversion factor, and the equation would be

$$moles\ of\ water = 8.434\ g\ x\ \frac{1\ mol}{18.01528\ g} = 0.4682\ mol\ water$$

Concentration

Concentration is a measurement of how much material is present in a solution. Remember that a solution is a homogeneous mixture of materials. In a solution, the material that you have less of is said to be "dissolved in" the other material, and is referred to as the "solute". The material that you have more of is called the "solvent". Concentration units tell you the relative amount of solute to solvent; they are ratios, and as a result they can also be used as conversion factors.

The most common unit of concentration that you will see in CHM 101 is molarity (M), which refers to the number of moles of solute per liter of solution (M = mol/L). Since molarity is a ratio of moles to liters, it can be used as a conversion factor to convert between the number of moles of material and the volume of a solution.

For example, if you had 20.0 mL of a 3.57M solution of sucrose, you could determine the number of moles of sucrose using the conversion factor 3.57 mol/L. Note that we must first convert the volume into liters to make sure that our units cancel.

$$moles\ sucrose = 0.0200\ L\ x \frac{3.57mol}{1\ L} = 0.0714\ mol\ sucrose$$

If you have the molar mass of your solute, you can also use molarity to find the mass of the solute by using a two-step process – use the molarity to calculate the number of moles, then use the molar mass to calculate the mass of that number of moles.

Often when working in a lab, you start with a very concentrated stock solution to which you need to add solvent to make it less concentrated before you can use it. The term for adding solvent to make a solution less concentrated is "dilution". There is a very simple formula to determine the concentration of a diluted solution, and this formula can also be used to determine the amount of solvent needed to dilute a concentrated solution to obtain the desired concentration, or the amount of concentrated solution needed to make a certain volume of dilute solution. That equation is:

$$M_1V_1 = M_2V_2$$

M_1 is the initial concentration of the solution

V_1 is the initial volume of the solution

M_2 is the final concentration of the solution

V_2 is the final volume of solution

If we started with the 3.57M solution of sucrose, and we wanted 500.0mL of a 1.25M solution, we could solve for the unknown V_1 to find out how much of the stock solution we would need to add to a 500.0mL flask to make 500.0mL of the desired solution by diluting to a total volume of 500.0mL.

$$(3.57M)(X) = (0.25M)(0.5000L)$$

$$X = 0.0350L = 35.0mL$$

Calculations to submit for your Online Activity 1 report

Since you may need to use some of the conversion factors described in the introduction before you reach those topics in your lecture courses, this activity was designed to have you practice some of the calculations that use them. The goal is for you to be fully prepared when you encounter these types of calculations in lab, so if there is anything that you do not understand, make sure to seek help through email or zoom office hours.

To receive full credit, make sure to do the following:

- Record all values with the correct number of significant figures and units.
- Place all answers on the line when provided.
- Show calculations for any numerical answers; **work must be shown to receive credit**.
- See any 102 TA via zoom before your assignment is due if you have any questions.
- Each question is worth 5 points.

1. How many moles are present in 3.79 g of copper?

Answer:_ _____

2. If you wish to use 5.50 mol of arsenic in a reaction, how many grams of arsenic would you need to weigh out?

Answer: _____

3. What is the molar mass of table salt (NaCl)?

Answer: _____

4. On a balance, you weighed out 264.4 g sucrose. If the molar mass of sucrose is 342.3 g/mol, how many moles of sucrose do you have?

Answer: _____

5. If you have a flask containing 15.6 mol of water, what is mass of water in the flask?

Answer:_____

6. If you have a flask containing 20.2 mol of water, what is the volume of water in the flask in mL at room temperature? (You will need two conversion factors here, one discussed in the introductory material for this assignment, one covered in chapter one of your text.)

Answer: _____

7. If you have 56.8 mL of a 0.150M solution of sucrose, how many moles of sucrose do you have?

Answer: _____

8. You have a 2.50M solution of lithium nitrate (68.946 g/mol). What volume of solution would you need to take to get 0.342moles of your solute?

Answer: _____

9. You have a 2.50M solution of lithium nitrate (68.946 g/mol). What volume of solution would you need to take to get 40.5g of your solute?

Answer: _____

10. If you dissolve 0.456 moles of solute in 250.0mL of solution, what is the concentration of your solution?

Answer: _____

11. You have 1.500 moles of an unknown metallic element. You go to a balance, and find that the mass of the 1.500 moles is 161.80g. What is the unknown element?

Answer: _____

12. You have 200.0mL of a 0.455M solution of sucrose. What mass of sucrose do you have?

Answer: _____

13. What is the mass of 4.27 moles of lithium nitrate?

Answer: _____

14. How many moles are there in 284.7g water?

Answer: _____

15. What mass of sucrose would you need to make 25.00mL of a 0.500M solution of sucrose?

Answer: _____

16. You have a 3.48M stock solution of table salt. How much of this solution (mL) would you need to use to make 250.0mL of a 1.26M solution?

Answer: _____

17. If you dilute 2.00mL of a 1.50M solution to achieve a final concentration of 0.350M, what is the volume in mL of the final solution?

Answer: _____

18. What mass of sucrose would be needed to make 500.0mL of a 2.50M solution?

Answer: _____

19. You take 5.0 mL of a 1.50M solution of sucrose and dilute it to 250.0mL. What is the mass of sucrose in 100.0 mL of the diluted solution?

Answer:_____

20. You take 2.5 mL of a 1.00M solution of lithium nitrate and dilute it to 500.0mL. What is the concentration of your diluted solution?

Answer: _____