Chemistry 101
SCIENTIFIC MEASUREMENTS
Pre-Lab Exercises

Student:__________________________
Date:_____________________________
Instructor:_________________________
Section:___________________________

1. What are the two parts of a measurement?

2. How many liters (L) are in 32.0 pints? (1 pint = 473 mL, 1 L = 1000 mL)

   [________ L]

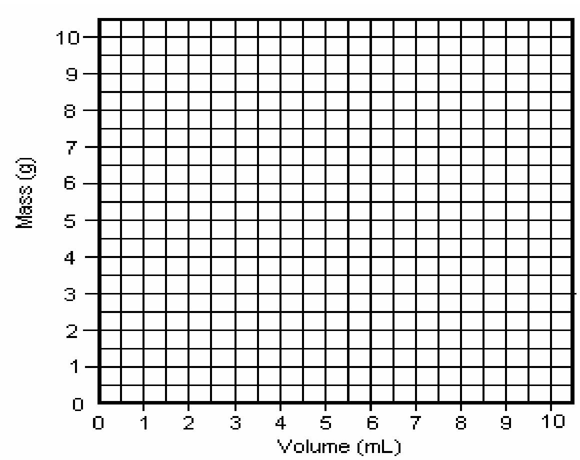
3. A student who had a meter stick and a lot of time wanted to see how many meters are in a mile. He measured a mile, one meter at a time, and came up with a measured value of 1525 m. The accepted value for one mile is 1609 m. Find the percent error in the student's measurement.

$$percent\ error = \frac{|accepted\ value - measured\ value|}{accepted\ value} \times 100$$

   [________ %]

4. Plot the data in the following table on the graph below. Draw a "best-fit" straight line through the points on the graph. The data show the relationship between mass and volume for ethanol.

Mass	Volume
1.7 g	2.2 mL
3.9 g	4.6 mL
5.2 g	6.3 mL
7.4 g	9.7 mL



5. Determine the slope of the line drawn in the above graph.

   [Slope = ________ g/mL]

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Partner:____________________________
Instructor:__________________________
Section:__________ Date:______________

Measurements and Significant Figures

Throughout this experiment, and for the rest of Chemistry 101, you will make a number of measurements. A measurement is a number you generate and the appropriate unit that describes the number. Examples of measurements are the mass of an object or the volume of a liquid used in a reaction. When recording your data on the lab reports, *always include the units with the measured numbers*. Recording a mass of 10 has no value or meaning because it is not clear if it represents 10 pounds, 10 grams or some other quantity.

Another thing to remember when working in the laboratory is that any measured number has a degree of uncertainty. This uncertainty results from the fact that neither the instrument used to make the measurement nor the person making the measurement are perfect. Quite often, scientists express their degree of confidence in a measured number by how many decimal places they report for their measurement. As you make the measurements for this lab, pay attention to the instructions given on how many decimal places to report for each measurement. Use the equipment correctly and make appropriate estimates so that you report the correct number of decimal places as instructed.

PROCEDURE AND REPORT

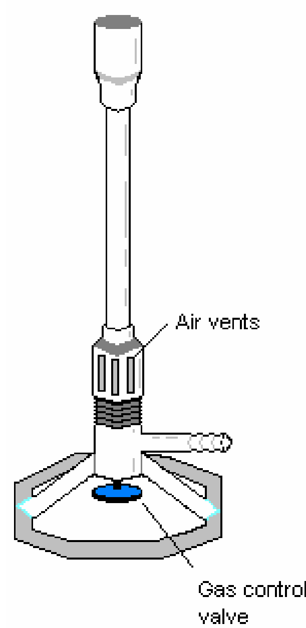
Using a Bunsen Burner

Sketch of Flame

1. A Bunsen burner has two adjustments. The valve at the base of the burner controls the amount of fuel being burned and the position of the top of the burner controls the amount of oxygen available for combustion. Light a Bunsen burner and practice adjusting the flame height by turning the valve at the base of the burner. Adjust the amount of oxygen available for combustion by turning the top of the burner. *Be careful not to turn the top of the burner counterclockwise to the point that it is removed from the base of the burner.*

2. The temperature of the flame is dependent upon the amount of fuel and oxygen available for combustion. Turn the top of the burner clockwise until it is tight against the base of the burner (air vents closed). Adjust the flame height, using the valve at the base of the burner, to about 6 to 8 inches. The yellow color in the flame is an indication that not enough oxygen is available for complete combustion and that the burner is not properly adjusted. Place a nichrome wire in different regions of this flame to determine if the flame is hot enough to make the wire glow. Make a mental note of how brightly, if at all, the wire glows.

3. Now properly adjust the burner by turning the top of the burner counterclockwise until a sharp inner blue cone forms in the flame. Again place the nichrome wire in different regions in the flame and try to determine the hottest part of the flame by how brightly the wire glows. Sketch a picture of the flame and place an "X" at the hottest point in the flame.



Temperature Measurements

1. Place five digital thermometers in a large container filled with ice and distilled water. Make sure all thermometers are turned on and set to display the temperature in ^{o}C. Stir the ice water with the thermometers until the displayed temperature for each thermometer becomes constant. Record the temperature read from each thermometer in the table below. Be sure to include units with the measured number.

	#1	#2	#3	#4	#5
Temperature					

2. Why did all the thermometers not give the same reading?

3. Which thermometer(s) gave the most accurate measurement(s) (refer to the melting point of water)?

4. What is the average temperature calculated from the five measurements? ___________
   Calculations:

Volume Derived From Length Measurements

1. Using a ruler, measure the length, width, and height of a wooden box provided by your instructor. Make the measurements in terms of cm to two decimal places. Record the values in the table below.

2. Obtain the volume of the box by finding the product of length x width x height. Record the volume in the table below.

3. Repeat steps 1 and 2 for the same box using inches rather than cm. Report the measured values to one decimal place. (Remember 1/8 of an inch equals 0.125 inches.)

Length (cm)	
Width (cm)	
Height (cm)	
Volume (cm^3)	

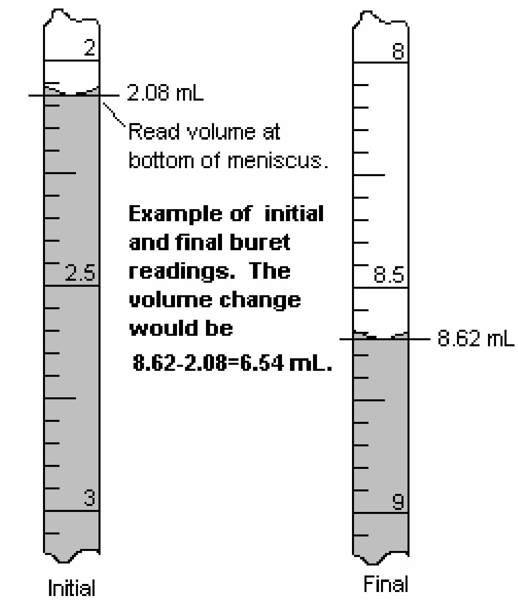
Length (in)	
Width (in)	
Height (in)	
Volume (in^3)	

4. Using the fact that 1 in^3 = 16.39 cm^3, convert your volume measured in terms of in^3 to cm^3.
   Calculations:

Is the volume obtained by converting in^3 to cm^3 identical to the volume obtained by measuring cm^3 directly? Why or why not?

Measurement of Volume Using a Buret

1. Fill a 10 mL buret with distilled water. It is not important that you fill it exactly to 0.00 mL. Record the initial buret reading to two decimal places (0.01 mL). Be sure to read the buret from top (0 mL) to bottom (10 mL). When making measurements, use the bottom of the meniscus, and interpolate (estimate) between marked increments if necessary as shown in the example to the right.



2. Fill a teaspoon with water discharged from the buret. Record the final buret reading in the table below. The measured volume of the tablespoon is found by subtracting the initial buret reading from the final buret reading. Record the measured volume of the teaspoon and convert this value to both cm^3 and liters.

3. Refill your buret and repeat the measurements outlined in steps 1 and 2 and record your results in the table for Trial #2.

Calculations:

	Initial Buret Reading	Final Buret Reading	Teaspoon Volume (mL)	Teaspoon Volume (cm^3)	Teaspoon Volume (L)
Trial #1					
Trial #2					

4. Based upon your two trials, calculate the average measured volume of a teaspoon in units of mL.
   Average volume:__________
   Calculations:

5. The accepted volume of 1 teaspoon is 4.93 mL. Percent error is used as an indication of how closely measured values correspond to accepted values. The equation for calculating percent error is:

$$percent\ error = \frac{|accepted\ value - measured\ value|}{accepted\ value} \times 100$$

Calculate the % error in your average measured volume of the teaspoon. **% error: _____________**
Calculations:

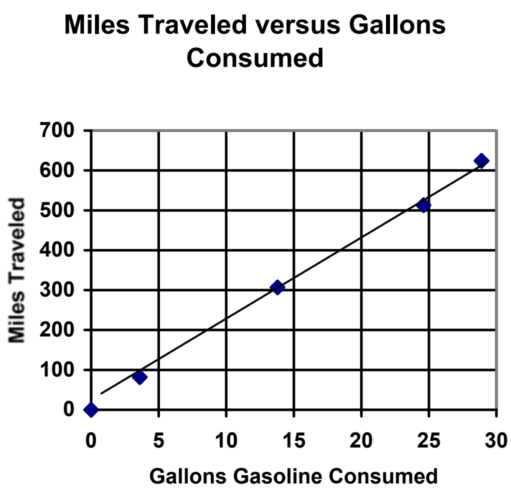
Volume, Mass, and Graphing

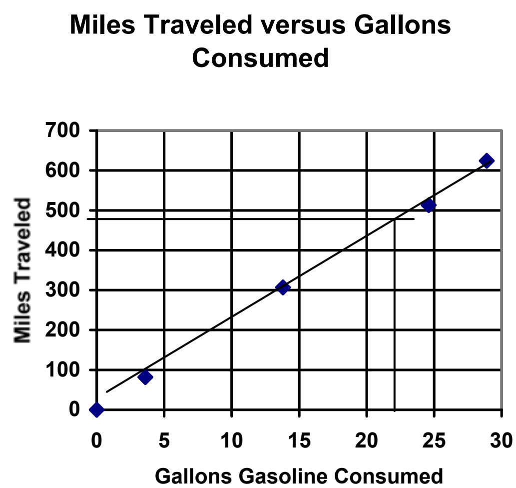
Graphs are used to visually display physical quantities or measurements that are related to or dependent upon one another. The following is an example that will illustrate how a graph may be used.

The following table summarizes the total miles traveled and the total gallons of gasoline consumed during the course of a 624 mile trip.

Total Miles Traveled	Total Gallons of Gasoline Consumed
0	0
82	3.6
307	13.8
513	24.6
624	28.9

This data is plotted in the graph of miles traveled versus gallons of gasoline consumed shown below. In the graph, the data point (0,0) is included because the traveler had traveled 0 miles and used no gasoline at the beginning of the trip. The "best-fit" straight line has been drawn through the data points. Notice that none of the points fall exactly on the line but the line is drawn to minimize the distance of any one point from the line.





Using the graph, it is possible to find the slope of the best-fit line and to make estimates of the relationship between miles traveled and gallons of gasoline consumed. The simplest way to approximate the slope is to take the ratio of rise/run or the increase in the y-axis divided by the increase in the x-axis. Since the line crosses the points (0,0) and (15,330), the slope can be found by 330 miles/ 15 gallons = 22 miles/gallon. Notice that the axis units were included with the numbers therefore the slope has the same units as the ratio of the physical quantities. The slope in this instance actually gives the gas mileage for the trip in units of miles/gallon.

The graph can also be used to answer questions such as: how many gallons of gasoline can the driver expect to use when traveling 475 miles? To answer this question using the graph that has been constructed, it is necessary to find the point on the "best-fit" line that corresponds to both 475 miles on the y-axis and a point on the x-axis. The graph on the right illustrates that extrapolating down from the point on the line that corresponds to 475 miles gives a value of approximately 22 gallons on the x-axis. The graph indicates that the traveler can expect to use about 22 gallons to travel 475 miles.

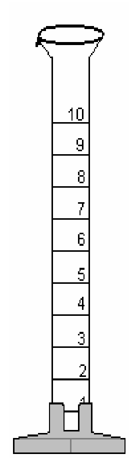
Volume, Mass, and Graphing (Continued)

Now you will use a balance and a graduated cylinder to generate data relating the mass and volume of water. You will then make and use graphs to answer questions similar to those illustrated in the above example.

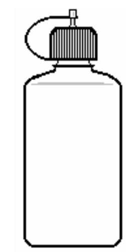
1. Turn on a balance and wait until zeros are showing. Place a clean, dry 10 mL graduated cylinder on the balance and record the mass to two decimal places.
   Mass of graduated cylinder:________________

2. Obtain a plastic chemical bottle, like the one shown to the right, containing distilled water.

3. Using the plastic bottle, carefully place 35 to 40 drops of water into the graduated cylinder. *Be very careful not to get water on the balance!!* Record the number of drops placed in the graduated cylinder in the table below. Determine the mass of the water placed in the cylinder, to two decimal places, by subtracting the mass of the empty cylinder from the mass of the cylinder containing water. Record the volume of water placed in the cylinder to one decimal place. Be sure to measure volume from the bottom of the meniscus and interpolate between marked increments if necessary. Report appropriate units with each measurement.



Graduated Cylinder


Chemical Bottle

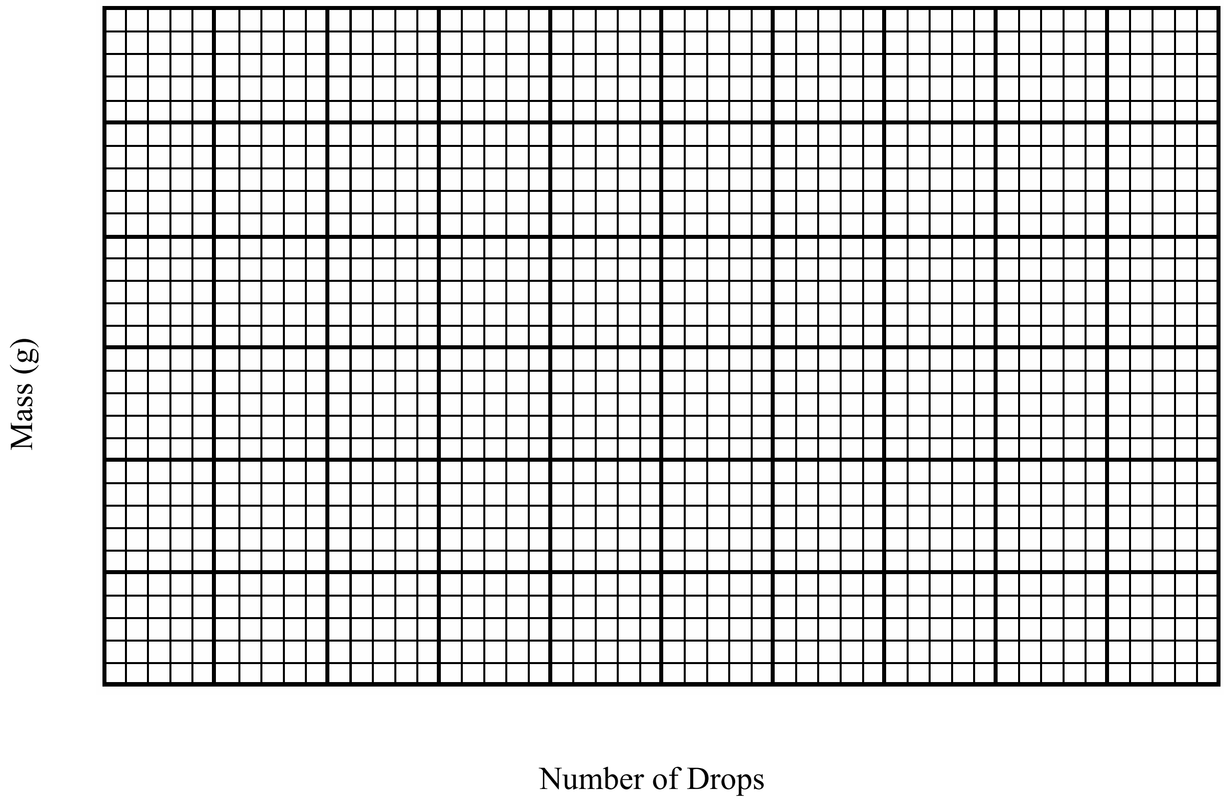
4. Place an additional 20 to 25 drops of water in the graduated cylinder. Record the number of drops added and the total drops in the graduated cylinder (i.e., sum of drops from step 3 and 4). Determine the new mass of water in the cylinder and volume of water in the cylinder.

5. Repeat step 4, three additional times to complete the table below.

Number Of Drops Added	Total Number Of Drops In Cylinder	Mass of Water in Cylinder	Volume of Water in Cylinder
0	0	0	0

6. Prepare graphs of the data in the table. The graph axes have already been labeled with units but it is necessary to number the axes. Try to select the scales (i.e., place the numbers) so that the data will fill as much of the available graph space as possible. For each graph, plot the data from the table that corresponds with the axes on the graph, remember that for each graph the point (0,0) will also be a data point (there were 0 drops, 0 g and 0 mL of water at the beginning of the experiment). Once the data have been plotted, start at (0,0) and use a ruler to draw the “best-fit” line through the data points (do not just “connect-the-dots”).

Graph #1: Mass versus Number of Drops



7. Find the slope of Graph #1, remember to include appropriate units for the slope.
   Calculations:

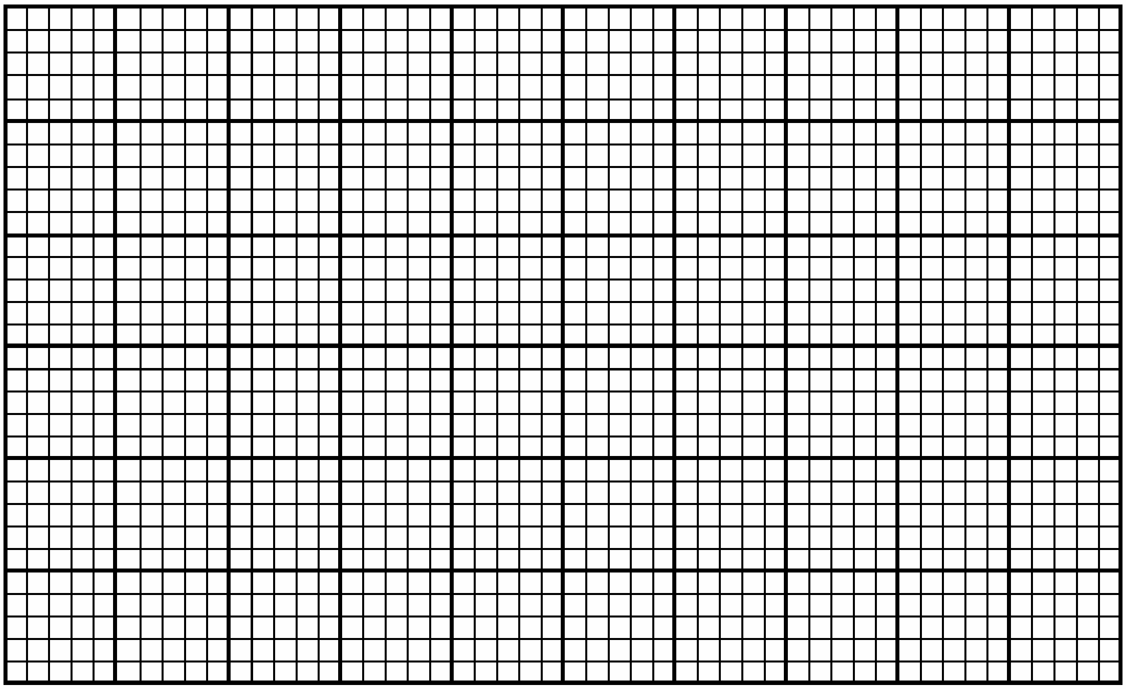
   Slope of Graph #1: ____________________

8. Use Graph #1 to predict the mass of 73 drops of water: ________________

9. Use Graph #1 to predict the number of drops of water in 1 g of water: _______________

Graph #2: Volume versus Number of Drops

Volume (mL)



Number of Drops

10. Find the slope of Graph #2, remember to include appropriate units for the slope.
    Calculations:

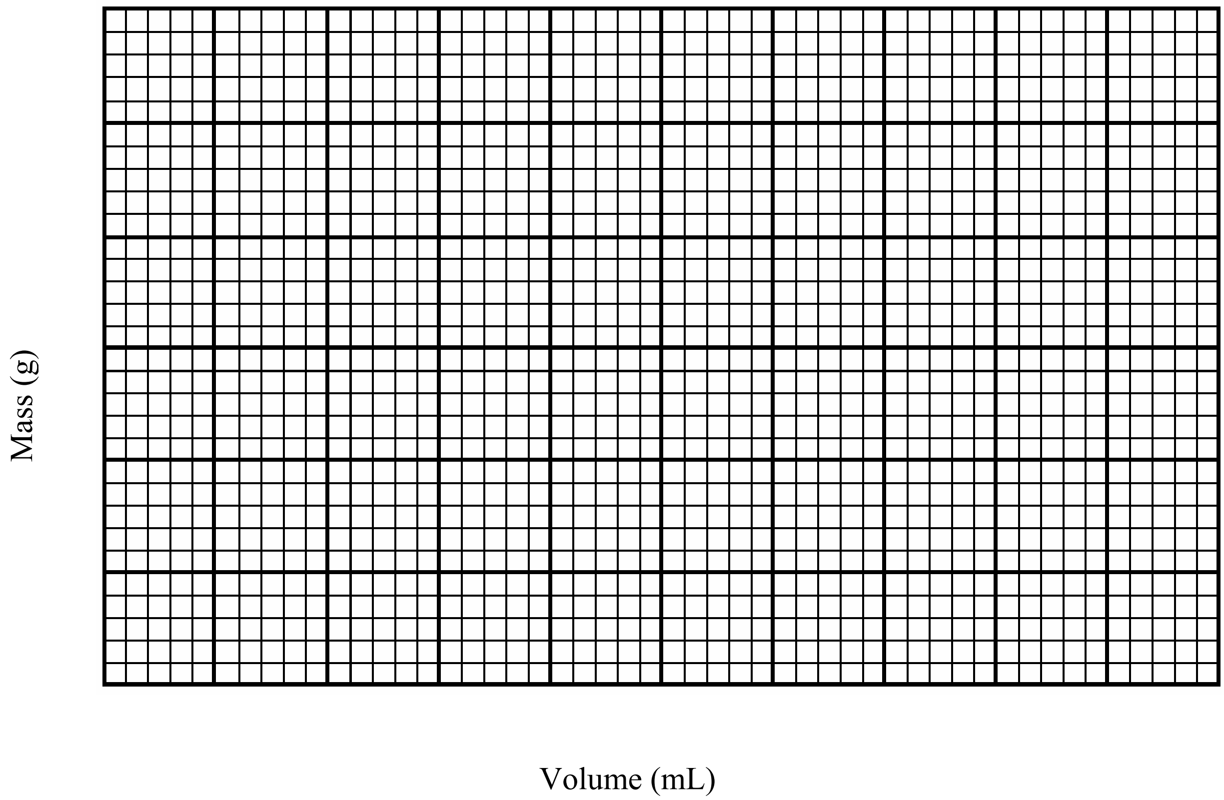
    Slope of Graph #2: ____________________

11. Use Graph #2 to predict the number of drops of water in 1 mL of water: _______________

    This value, the number of drops in 1 mL, will be useful in future labs. When dispensing an approximate volume of a solution from a chemical bottle, you can now simply count the number of drops rather than taking the time to measuring the volume with a graduated cylinder.

12. Use Graph #2 to predict the volume of 98 drops of water: _____________

Graph #3: Mass versus Volume



13. Find the slope of Graph #3, remember to include appropriate units for the slope.
    Calculations:

    Slope of Graph #3: ____________________

14. Use Graph #3 to calculate the density (mass/volume) of water: ______________