

Name _____

Chemistry 117 Laboratory
University of Massachusetts Boston

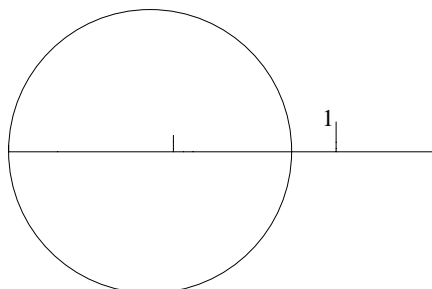
LENGTH AND VOLUME

PRELAB ASSIGNMENT

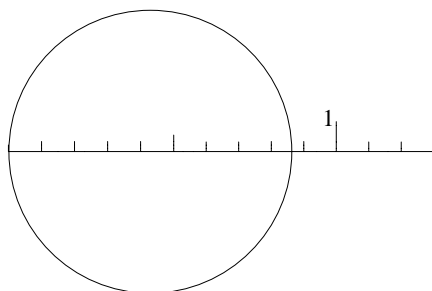
Length and Volume

Almost everything that we do in Chemistry Lab this semester is going to involve measuring something. This first laboratory experiment is designed to give us practice in performing typical measurements and provide some insight into the purpose and value of significant figures.

What is the diameter of this circle? It's larger than 0.5 unit and less than 1 unit. It's closer to 1 unit than 0.5 unit. Would you say it's 0.7 unit, 0.8 unit or maybe 0.9 unit? How about 0.85 unit? How precise can you be? How precise should you be?

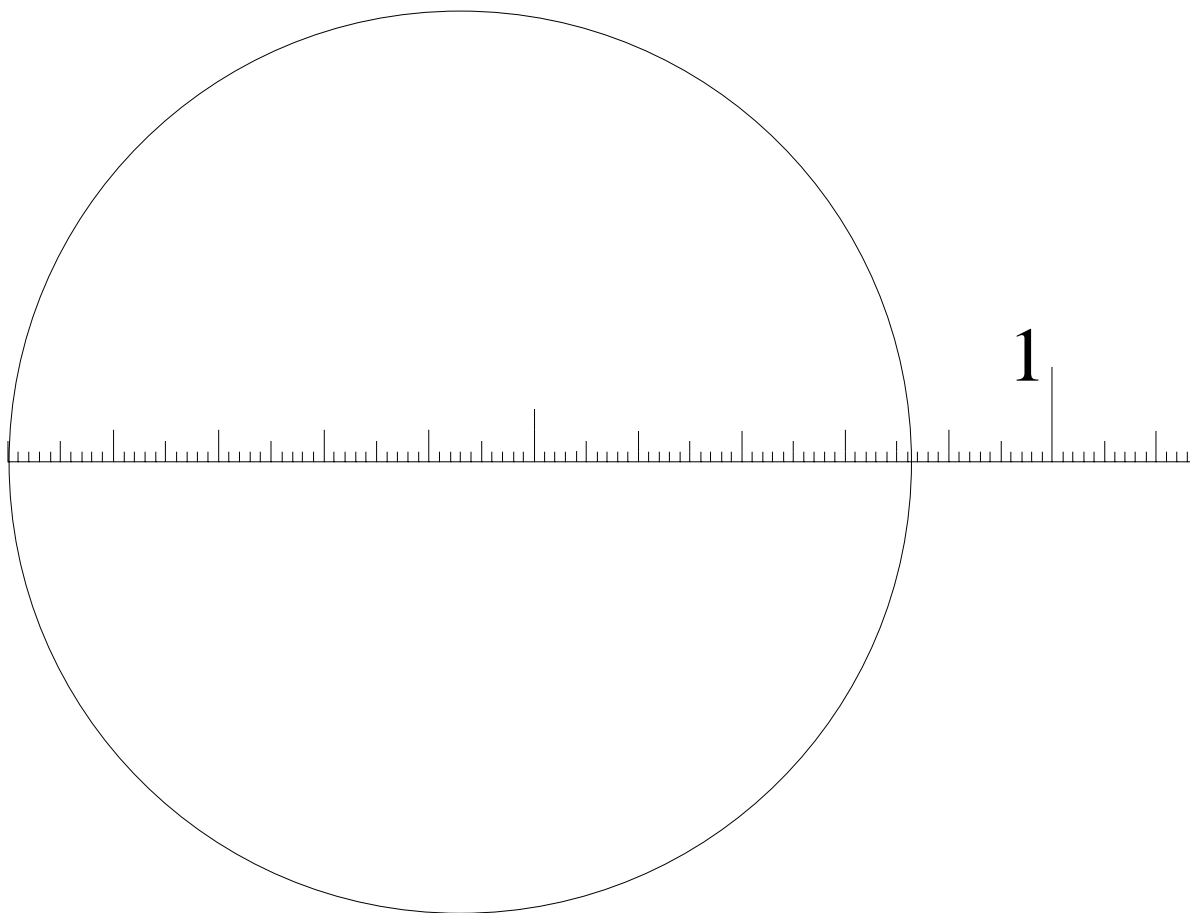


Here is the same measurement with a “better” ruler. It is clear that the circle is larger than 0.8 unit and less than 0.9 unit. It looks about half way between the two. We could say it is close to 0.85 unit, but the last digit is really just a guess.



Length and Volume

Here there is the same circle enlarged with a more precise ruler. It looks as if the circle is at least 0.86 unit. We can see that it is a little larger, maybe 0.861 unit or 0.862 unit. We are sure of the eight and the six, but are really guessing at the last digit. It is generally accepted that we can estimate a single graduation to the nearest tenth.



The “quality” of our measurements can have a great impact on calculations that we may make later with them. In this quick experiment you will measure a polystyrene sphere with a ruler. Using this measurement you can then calculate the volume of the sphere.

You will then measure the volume of the sphere using a graduated cylinder. Be sure that you learn the correct technique for reading volume with this instrument. After measuring the volume by this method you should compare your results with 5 of your lab mates.

As you record your measurements and carry out calculations, be sure to include the appropriate units with the numbers and the correct number of significant figures.

Length and Volume

IN THE LABORATORY

1.	Measure the diameter of a polystyrene sphere in centimeters using the metric ruler. Report this number to two places after the decimal:	
2.	Calculate the volume of the polystyrene sphere in cm^3 : [volume = $(4/3) \times \pi \times \text{radius}^3$] (Remember diameter = 2 x radius!):	
3.	Fill a 25 mL graduated cylinder with about 12 mL of water and measure the volume of water in milliliters. Report this number to two places after the decimal:	
4.	Add one polystyrene sphere, measure total volume. Report this number to two places after the decimal:	
5.	Calculate volume of one polystyrene sphere: [Volume of sphere = total volume - volume of water]:	
6.	Add nine more polystyrene spheres [10 total], measure total volume. Report this number to two places after the decimal:	
7.	Calculate volume of ten polystyrene spheres: [Volume of ten spheres = total volume - volume of water]:	
8.	Calculate average volume of spheres: [Volume of one sphere = $(1/10)$ volume of ten spheres]:	

You now have three different measurements of the volume of a polystyrene sphere from #2, #5 and #8. From different members of your lab class, obtain five other values for each of the three methods:

	#2	#5	#8
	From Ruler	From water displacement of one sphere	From water displacement of ten spheres
Your number:			
Labmate #1			
Labmate #2			
Labmate #3			
Labmate #4			
Labmate #5			

Length and Volume

The most commonly used measure of uncertainty is called the *standard deviation*. To find the standard deviation of these volumes, first calculate the mean by adding up all the values and then dividing by the number of values:

$$\text{Mean} = \frac{\text{Your Volume} + \text{Labmate \#1} + \text{Labmate \#2} + \text{Labmate \#3} + \text{Labmate \#4} + \text{Labmate \#5}}{\text{number of values}}$$

	From Ruler	From Water displacement of one sphere	From Water displacement of ten spheres
Mean		mL	mL

The standard deviation is a measure of the differences between the actual numbers and the mean. We do this by subtracting the mean from each value, squaring it, summing up the squares, divide by one less than the number of values and finally taking the square root:

$$\text{Standard Deviation} = \sqrt{\frac{(\text{Your Volume} - \text{mean})^2 + (\text{Labmate \#1} - \text{mean})^2 + (\text{Labmate \#2} - \text{mean})^2 + (\text{Labmate \#3} - \text{mean})^2 + (\text{Labmate \#4} - \text{mean})^2 + (\text{Labmate \#5} - \text{mean})^2}{(\text{number of values} - 1)}}$$

On this worksheet report the difference of the mean from each of the values:

	#2	#5	#8
	From Ruler	From Water displacement of one sphere	From Water displacement of ten spheres
Your number- mean:			
Labmate #1- mean:			
Labmate #2- mean:			
Labmate #3- mean:			
Labmate #4- mean:			
Labmate #5- mean:			

Length and Volume

On this worksheet report the square of the difference of the mean from each of the values:

	#2	#5	#8
	From Ruler	From Water displacement of one sphere	From Water displacement of ten spheres
(Your number- mean) ² :	cm ⁶	mL ²	mL ²
(Labmate #1 - mean) ² :			
(Labmate #2 - mean) ² :			
(Labmate #3 - mean) ² :			
(Labmate #4 - mean) ² :			
(Labmate #5 - mean) ² :			

Total of these squares:

	From Ruler	From water displacement of one sphere	From water displacement of ten spheres
Total of Squares:	cm ⁶	mL ²	mL ²

Now divide these numbers by 5 and take the square root to get the standard deviations:

	From Ruler	From Water displacement of one sphere	From Water displacement of ten spheres
Standard Deviation:	cm ³	mL	mL

Which of these measurements of volume do you think is the most reliable?

Which of these measurements of volume do you think is the least reliable?

Why?