Lab 1. The Metric System and Measurement

Overview

During this lab, you will be measuring length, volume, temperature, and mass of different objects. You will become familiar with the use of different devices to measure these properties and determine the accuracy and precision of the instruments and your measurements. You will learn the units and conversions in the metric system, as well as practice proper recording of data. For the rest of the semester, you will be applying these skills and knowledge when measuring the physical and chemical properties of your water sample.

Learning objectives

1. Be able to measure and calculate the linear dimensions of objects using the metric system.
2. Be able to measure volumes of liquids using different laboratory vessels.
3. Be able to determine the precision and accuracy of measurement of a beaker, a graduated cylinder and a graduated pipette.
4. Be able to measure the mass of a solid using a double-beam balance.
5. Be able to use a thermometer to measure the temperature of a liquid.
6. Be able to record results using significant figures and correct units.

Materials and equipment

- Sugar
- Ice water
- Boiling water
- Small plastic scoops or spoons
- Metric rulers
- Geometric shape cut outs (cardboard or hard plastic)
- Large test tubes
- Bottles for water samples (glass or plastic)
- 100 ml beaker with volume markers
- 250 ml beaker
- 100 ml graduated cylinder
- 10 ml pipette
- Pipette pump
- Double-beam balance
- 500 ml beakers
- Thermometer
- Hot plate

Background

Concepts to understand

Make sure you have a clear understanding of the following concepts after reviewing the provided videos and reading materials:

- Measurement
- Units in the metric system
- Data
- Uncertainty
- Precision
- Accuracy
- Significant figures
- Meniscus
- Kilo, Hecto, Deca, deci, centi, milli, micro, nano

Procedures for measuring

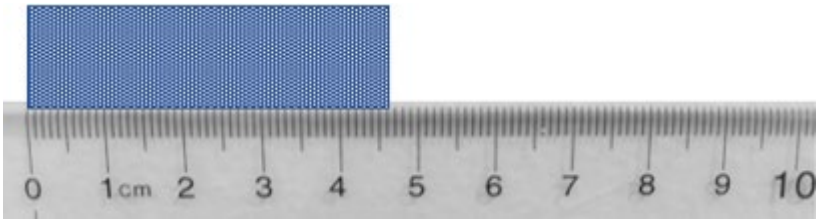
Every student must do all the calculations, record all the results and draw the graphs during the lab activity. Your instructor will write her/his initials once you have completed recording your results.

A. Measuring length and width of different geometric shapes

Steps

1. Obtain two different geometric shape cutouts from your instructor.
2. Using the metric ruler provided in your workspace, measure the length and width of each one of the shapes. Record your measurements in the table below. Make sure you use significant figures, so in the example below (Figure 1), the ruler markings are every 0.1 cm. The correct reading is 4.58 cm, the two first digits, **4.5**8 are known exactly, the 4.5**8** is uncertain. When measuring, you record all the digits that are known exactly, plus the first one that is uncertain.

   Figure 1. Measuring length of a cut out rectangle



3. Using the values you obtained, calculate the area of the geometric shapes. You calculate the area of a square or a rectangle, by multiplying width X length. Record your results in the following table and don't forget the units!

If multiplying or dividing measured values, the result should be reported with the lowest number of significant figures used in the calculation.

For example: 4.58 cm X 2.53 cm = 11.59 cm^2 (omit the other decimals you obtain when you perform the multiplication).

Table 1. Shape measurement

Shape	Width	Length	Area

B. Measuring the Volume of your Water Sample

Steps:

1. Obtain your water sample from your instructor.
2. Pour your water sample into the 100 ml beaker.
3. Measure the volume of water in the beaker and record this measurement in the table below. Remember to write the numerical value and the units, as well as the significant figures.
4. Carefully transfer the water in the beaker into the 100 ml graduated cylinder.
5. Measure the volume of water in the 100 ml graduated cylinder and record your measurement in the table below. Remember to write the numerical value and the units, as well as the significant figures.

Table 2. Volume measurement

Vessel	Volume
100 ml beaker	
100 ml graduated cylinder	

6. Do the measured values have the same number of significant figures? Explain your answer (why yes, or why no)

7. Empty the water of your graduated cylinder into the beaker, and then pour enough water back into the graduated cylinder to measure 10ml; pour the rest of the water in the beaker into the sink and dry the beaker.
8. Pour the 10ml of water you measured with the graduated cylinder, back into the beaker. Using a 10ml pipette, measure the volume of water in the beaker. Write the volume you obtained below. Remember to write the numerical value and the units, as well as the significant figures.

Table 3. Volume measurement

Vessel	Volume measured
100 ml graduated cylinder	
10 ml pipette	

C. Measuring Mass

1. Use a double-beam balance to obtain the mass of a 250-mL beaker. Record the mass in the table below. Remember to write the numerical value and the units, as well as the significant figures.
2. Remove the beaker from the balance and add three scoops of sugar to the beaker.
3. Obtain the new combined mass of the beaker and the sugar. Record this new mass in the table below. Remember to write the numerical value and the units, as well as the significant figures.
4. Use your two measurements to determine the mass of the sugar and record it in the table below. Remember to write the numerical value and the units, as well as the significant figures.

Table 4. Mass measurement

Sample	Mass
250 ml beaker	
250 ml beaker + 3 scoops of sugar	
Sugar	

D. Measuring Temperature

Steps:

1. Obtain a thermometer from your instructor. Before making your measurements, examine the markings on the thermometer.
2. Obtain three 500 ml beakers.
3. Fill one beaker with tap water
4. Half fill another beaker with tap water, the add ice to fill beaker.
5. Obtain hot water from your instructor. ***Handle the beaker with insulating gloves***
6. Measure the temperature in each one of the beakers and record your results below. Remember to write the numerical value and the units, as well as the significant figures.

Table 5. Temperature measurement

Sample	Temperature	Unit
Tap water		
Hot water		
Ice water		

7. Compare your results of each measurement with those of your other group members. Are the measurements close in value? What does this tell you about the precision of your measurements as a group

First and Last Name

SUBMIT

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