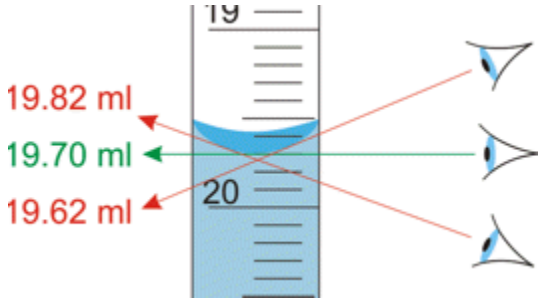
# Metric Measurement Lab

**Background**: The efficiency and effectiveness of the metric system has long been evident to scientists, engineers, and educators. This lab will enable you to develop an appreciation of the efficiency of the metric system and the ability to take accurate measurements using this system. In order to understand completely the usage of the Metric System, you need to be familiar with the history of how the system came into being and with conversion factors – be sure to reference the website notes for these topics. In addition, the graphic below will serve to remind you how to read the meniscus that forms in graduated cylinders.




**Objective**: In this investigation, you will learn how to accurately measure length, volume, temperature and mass using scientific equipment.

**Materials**:

| | | |
|---|---|---|
| Water | two (2) beakers | graduated cylinder |
| Ice cubes | measuring object | two (2) Celsius thermometers |
| triple beam balance | metric ruler | watch |
| stirring rod | rock | calculator |

**Experimental Procedure**:

**Note**: be sure to use the proper units for all answers recorded on the Data Tables.

1. Complete length, mass, volume and density measurements using metric instruments.

- using a metric ruler, measure the length, width and height of an object. Express your answer to the nearest 0.10 of a cm. Record your answer in **Data Table 1**.
- using your measurements of the object, calculate the volume of the object. Express your answer to the nearest 0.10 of a cubic-centimeter ($cm^3$.) Record your answer in **Data Table 1**.
- using the triple-beam balance, determine the mass of the object. Express your answer to the nearest 0.10 of a g. Record your answer in **Data Table 1**.
- using your found values of volume and mass, calculate the density of the object. Record your answer in **Data Table 1**.

2. Measure the volume of a liquid. **Note**: you may need to use the "over-flow" beaker in the event the amount of liquid exceeds the capacity of the graduated cylinder.

- pour the water from beaker "A" into the graduated cylinder.
- measure the amount of water in the graduated cylinder. To accurately measure the volume, your eye must be at the same level as the bottom of the meniscus. The meniscus is the curved surface of a column of liquid. Record your answer in **Data Table 2**.
- repeat steps a and b for beaker "B."
- when finished measuring, replace water back into beakers.

3. Determine the volume of a solid object using displacement.

- fill the graduated cylinder up to 50 ml with water.
- record your rock sample number and exact volume of water from graduated cylinder in **Data Table 3**.
- place the rock into the graduated cylinder by sliding it down slowly. Determine the volume of the rock and water.
- record your answer in **Data Table 3**.
- determine the volume of the rock. Record your answer in **Data Table 3**.

4. Measure the temperature of a liquid.

- fill beaker "A" and beaker "B" with **exactly** 100 ml of water. Record this volume in **Data Table 4**.
- place a thermometer in each beaker. Wait two (2) minutes and then record the temperature of the water in each beaker in **Data Table 5**.
- carefully add three (3) ice cubes to the water in beaker "B." **DO NOT STIR**.
- after one (1) minute, observe the temperature of the water in each beaker. Record the temperatures in **Data Table 5**.
- after five (5) minutes, observe the temperature of the water in each beaker. Record the temperatures in **Data Table 5**.
- find the volume of water in beaker "A." Record the volume in **Data Table 4**.
- Stir the water and ice in beaker "B." Continue to stir until the ice has been melted completely. After the ice in beaker "B" has melted, find the volume of water and record the volume in **Data Table 4**.

**Analysis Questions**:

1. What is the largest volume that your graduated cylinder is able to measure?

2. What is the smallest volume that your graduated cylinder is able to measure?

3. Did the temperature of the water in beakers A and B change during the investigation? Explain.

4. Was there a difference in the volume of water in the beakers at the end of the investigation? Explain.

5. Of the following graduated cylinders: 100 ml, 25 ml or 10 ml, which would you use to accurately measure 8 ml of a liquid? Explain.

6. Using a Celsius thermometer, how would you determine the temperature of the classroom? Would you change your procedure if you were using a Fahrenheit thermometer? Explain.

7. When ice was added to beaker B, the thermometer was not removed. Explain why.

8. Suppose the water in beaker B had been stirred after the ice had been added. What would be the effect of this on the temperature of the water? Does stirring have an effect on the final temperature of the water? Explain.

9. Why do you think the water in the graduated cylinder forms a meniscus?

10. Evaporation is sometimes described as a cooling process. This is because as a liquid evaporates it takes heat from its surroundings. Using water, two (2) Celsius thermometers, a small piece of gauze and some thread, **design** an investigation to test the first statement. Indicate the control and the variable; include problem, hypothesis, procedure and your expected observations and conclusions.

**DATA TABLE 1**

| | |
|---|---|
| The letter/code of the object: | |
| The length of the object: | |
| The width of the object: | |
| The height of the object: | |
| The volume of the object: | |
| The mass of the object: | |
| The density of the object: | |

**DATA TABLE 2**

| | Volume of Water (ml) |
|---|---|
| Beaker A | |
| Beaker B | |

**DATA TABLE 3**

| | |
|---|---|
| Rock number: | |
| Volume of water: | |
| Volume of water and rock sample: | |
| Volume of rock sample: | |

**DATA TABLE 4**

| Volume of Water (ml) | | |
|---|---|---|
| | Beginning of Investigation | End of Investigation |
| Beaker A | | |
| Beaker B | | |

**DATA TABLE 5**

| Temperature of Water (ºC) | | | |
|---|---|---|---|
| | Beginning of Investigation | After 1 Minute | After 5 Minutes |
| Beaker A | | | |
| Beaker B | | | |