Metric Measurements
Student Version

In most laboratory investigations where data is collected, precise measurements must be taken before observations and analysis of the data can be made. In scientific work, as well as everyday measuring in nearly every country outside of the United States, the Metric System is used. The Metric System is universal in all fields of science, so even scientists conducting research in different parts of the world who don't speak the same language can understand each other's data. In this activity, metric measurements for length, volume, and mass will be reviewed using common classroom materials. Students will also practice using common laboratory equipment, such as metric rulers, meter sticks, and balances.

Key Concepts:

- The **Metric System**, also referred to as the **International System of Measurement (SI)**, is what the scientific community uses to measure data precisely.
- Units of measurement, such as feet, pounds, inches, and miles are part of the English System of Measurement that we use daily in the United States. These measurements are not part of the Metric System.
- **The Metric System is based on the number 10**. Thus, it is quite easy to change one unit into another because all units are related to one another by powers of 10.
- The three basic units of the Metric System that will be used in this laboratory investigation are **grams** (mass), **liters** (volume), and **meters** (length).
- **Volume** generally refers to how much of something (e.g. liquid, gas) a container can hold.
- **Mass** refers to how much something weighs.
- **"Symbol"** refers to the abbreviation, or initials, used to denote a specific metric measurement (mL, kg, cm).
- **"Name"** refers to the full description of a specific metric measurement (e.g. milliliter, kilogram, centimeter). The first part of the name (*milli, centi, kilo*) refers to the amount or size of substance being measured. The second part of the name (*liter, gram, meter*) refers to the basic type of unit based on what is being measured: mass, volume, or length.

Part 1 - Pre-Lab Questions

Q1. Why do scientists and other people in most countries use the Metric System for measurements?

Q2. Why is it easy to change from one unit to another in the Metric System?

Q3. Why is it difficult to convert English units of measurements that we use in America, such as miles to yards or feet?

Q4. Name several aspects of everyday life that would change if our country converts to using the Metric System.

Part 2 - Measuring Length

Use meter sticks to measure the length, width, and height of a lab table or desk in the classroom. Record your measurements to the nearest hundredth of a meter (centimeter) in Data Table #1.

Data Table #1

Lab Table/Desk Measurements	
Dimension	**Centimeter (cm)**
Length	
Width	
Height	

Use metric rulers to measure the length of a test tube and the diameter of its mouth. Record you measurements to the nearest millimeter in Data Table #2.

Data Table #2

Test Tube Measurements	
Dimension	**Millimeter (mm)**
Length	
Diameter of Mouth	

Q5. What is the longest length your meter stick can measure? Metric ruler?

Q6. What is the smallest length your meter stick can measure?

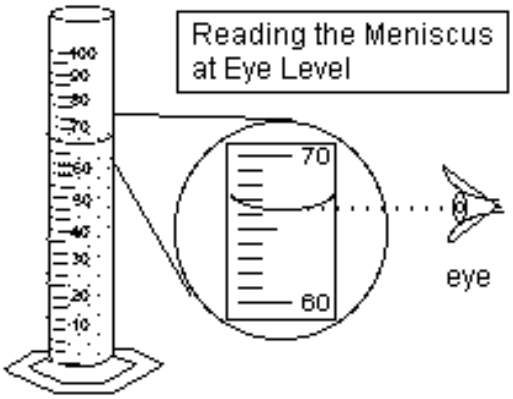
Part 3 - Measuring Liquid Volume

1. Fill the small test tube to the top with water. Pour the water into the graduated cylinder.

2. The surface of the liquid will be slightly curved. This curvature is referred to as the **meniscus**. The meniscus is created by a property of water called **adhesion**. Adhesion is when water molecules are attracted to materials other than water molecules. Water molecules are attracted to the molecules that make up the graduated cylinder which cause the meniscus to form.

3. To accurately measure volume, your eye must be at the same level as the bottom of the meniscus.

Record the volume of the water from the test tube and various containers to the nearest milliliter in Data Table #3.



http://chemsrvr2.fullerton.edu/HES/volume/volume_files/meniscus.gif

Data Table #3

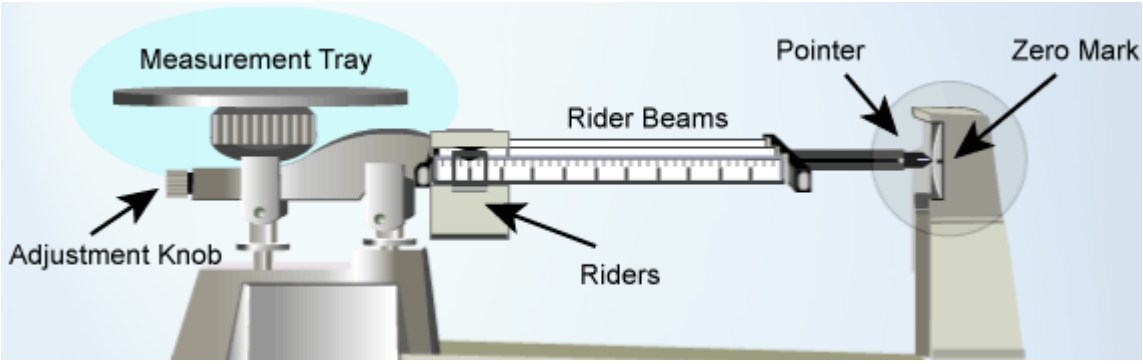
Measurement of Liquid Volume	
Object	**Volume (mL)**
Water in Test Tube	
Container A	
Container B	
Container C	

Q7. What is the largest volume of liquid your graduated cylinder can measure?

Q8. What is the smallest volume of liquid your graduated cylinder can measure?

Part 4 - Measuring Mass

For Triple-Beam Scale:



http://www.explorelearning.com/ELContent/gizmos/ELScien ce_Deliverable/ExplorationGuides/images/EL_MSPS_TripBeamBal1.gif

1. Move riders are all the way to the left so that the pointer rests on zero.
2. Place object to be measured on measurement tray.
3. Move the rider on the *middle beam* to the right one notch at a time until the pointer drops below zero. Move the rider left one notch.
4. Move the rider on the *back beam* one notch at a time until the pointer drops below zero again. Move the rider left one notch.
5. Slide the rider along the *front beam* until the pointer stops at zero. The mass of your object is equal to the *sum* of the readings on *all three beams*.
6. Record the mass of the object to the nearest tenth of a gram in Data Table #4 and then remove the beaker from the scale.
7. Repeat steps #2 through #7 other objects.

For Digital Scale:

https://escali.com/media/catalog/product/cache/1/image/9df78eab33525d08d6e5fb8d27136e95/p/r/primo-p115m_angle.jpg

1. "Tare" (reset) the scale so that the screen reads 0.0 grams.
2. Place object to be measured on measurement tray
3. Record the mass of the object, and repeat steps 2 and 3 for any additional objects.

Find the mass of the below objects and record the masses to the nearest tenth of a gram in Data Table #4. For the 50 mL beaker plus 40 mL of water use the graduated cylinder to place exactly 40mL of water in the beaker and find the *combined* mass of the beaker and water.

Data Table #4

Measurement of Mass	
Object	**Mass (g)**
50mL Beaker	
Rubber Stopper (or equivalent)	
Coin (specify type)	
50mL beaker plus 40mL of water	

Q9. What is the smallest mass of an object your balance can measure?

Q10. What is the largest mass of an object your balance can measure (assuming you used a triple-beam or digital balance)?

Concept Questions

Q11. What is the mass of 40mL of water?

Q12. As part of this investigation, you found the mass of 40mL of water. Based on your observations, what is the approximate mass of 1mL of water?

Q13. Using a 100mL graduated cylinder, how would you measure a volume greater than 100 mL?

Q14. Do you think the United States should adopt the metric system for everyday use? Why or why not?

References:

1. Activity adapted from: Levine, Joseph, S. (2002). *Biology: Laboratory Manual A/Laboratory Skills*, Pearson Prentice Hall.
2. Cheryl Dudeck, Science Department Chair/Science Teacher, King College Prep High School, 4445 S. Drexel Avenue, Chicago, IL. 60653.
3. Elena F. Koslover, Graduate Research Assistant, Biophysics Program, Stanford University, Stanford, CA. 94305.