**Honors Biology Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Metric and Measurement Lab Date\_\_\_\_\_\_\_\_\_\_\_Hour\_\_\_\_\_\_\_**

**Introduction**

The purpose of this activity is to practice using the metric system. In today’s exercise you will become familiar with metric system units and converting between large and small metric units. In each of the sections that follow, you will familiarize yourself with the appropriate metric units that scientists commonly use, and then you will take the measurements of some everyday objects. The metric system is the standard system of measurement in the sciences, including biology, chemistry, and physics. It has tremendous advantages because all conversions, whether for volume, mass (weight), or length, are in units of ten. Standard Metric Units The International System of Measurement (SI), commonly called the metric system, has been adopted as the official system of measurement by most countries. Unlike our traditional system of measurement (inch, foot, yard, mile), the metric system is based on standard units that can be easily converted by simply multiplying or dividing by ten. The standard metric unit for length is the meter. Gram is the standard unit of mass and liter the standard unit of volume. Temperature is measured in degrees Celsius (or Kelvin).

**Metric Conversions**

Conversions within the metric system can be made easily using a metric staircase. Each step of the staircase represents a ten-fold change in the value of the measure or a shift of the decimal point one place. Therefore, each step you move down the staircase represents multiplication by ten or a movement of the decimal one place to the right. Each step up the staircase represents a division by ten or the movement of the decimal point one place to the left. Two steps up or down the staircase represents a movement of the decimal point two places to the left or right and three steps up or down the staircase represents a movement of the decimal point three places to the left or right. If you have trouble, ask your instructor to demonstrate how to make conversions within the metric system using the staircase.

**Draw the metic staircase below. Include all labels for quantities and prefixes.**

**Rules**

1. You should always use DECIMALS (never fractions!) to express metric measurements. For example: write 2.25 cm, not 2 ¼ cm

2. If reading a metric instrument, always estimate one decimal place past the smallest increment. If the smallest marking represents .1 mL, then your answer should be recorded to the .01 mL.

**Metric Conversion Practice**

1. 5.712 g =\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kg

2. 222.7 L =\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ dL

3. 16.45 m =\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cm

4. 39.56 g =\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mg

5. 10.5 g =\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ dkg

6. Ethan lives at one end of Park Avenue. Brian lives at the other end of the avenue. It is 5.8 kilometers from one end of Park Avenue to the other. If Ethan walks 2.79 kilometers toward Brian’s house, how many more METERS does he have to walk to get there?

**Lab Activity:**

**Length**

1. Obtain a ruler. Find the English measurement units of “inches”. How many inches are in a foot? \_\_\_\_\_\_.

2. Turn the ruler over and observe the metric subdivisions. How many centimeters are in a foot? \_\_\_\_\_\_ How many cm in an inch?\_\_\_\_\_\_\_

3. The prefix centi- means 100. How many cents (pennies) are in a dollar? \_\_\_\_\_\_

4. How many millimeters are in a centimeter? \_\_\_\_\_\_\_\_. The prefix milli- means a thousand. How many millimeters are in a meter? \_\_\_\_\_\_\_\_.

5. For measuring smaller objects, it is preferable to use a metric ruler, rather than a meter stick. Obtain a penny. Measure its diameter \_\_\_\_\_\_\_\_, then its width (thickness) \_\_\_\_\_\_\_\_.

6. Why is it preferable to measure a penny in millimeters rather than centimeters or meters? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Use a ruler or meter stick to measure the following:**

1. Width of classroom door opening (in meters) \_\_\_\_\_\_\_ m
2. Length of whiteboard (in meters) \_\_\_\_\_\_\_ m
3. Length of a dollar bill (in centimeters) \_\_\_\_\_\_\_ cm
4. Width of your pen (in millimeters) \_\_\_\_\_\_\_ mm
5. Which of your fingernails is closest to 1 cm in width? \_\_\_\_\_\_\_\_\_\_
6. Height of the lab desk (in meters) \_\_\_\_\_\_\_\_ m

**Volume**

The basic unit of volume in the metric system is the liter (symbol is L or l). The most common derived unit used for small amounts of liquids is the milliliter (mL) (10-3 or 1/1000 of a liter). **The volume of a milliliter is equal to the volume of a cube 1 centimeter per side. Sometimes these are expressed as cc (cubic centimeters**) such as on the side of a medical syringe.

Use a metric ruler to measure a slide box. What is written on your slide box?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Record the measurements below. Length = \_\_\_\_ cm, width = \_\_\_\_\_ cm, height= \_\_\_\_\_ cm. The volume (or space) occupied by the slide box can be expressed in cubic centimeters (cc or cm3 ) by multiplying L x W x H. Use your measurements to calculate this for the box: \_\_\_\_\_\_\_\_\_\_ For the purposes of this activity, understand that 1 cm3 = 1 mL, so the box has a volume of \_\_\_\_\_\_\_\_ mL.

In the biology laboratory, liquid volume is usually measured in milliliters, using an appropriately sized graduated cylinder. The measurement marks etched on the side are called “graduations”. When liquid is poured in, the top of the liquid forms a slight curve, called a “meniscus”. For accuracy, the volume of the liquid should be (1) read at the graduation closest to the bottom of the meniscus, you should read this (2) on a flat lab surface; (3) at eye level (crouch down). How many milliliters of liquid is in the graduated cylinder in this picture? \_\_\_\_\_\_\_\_

Tip: The smaller the vessel, the more accurate your measurement will be.

**Practicing Measurement Accuracy**

At your lab table you should have a glass bottle, a small cup, and a test tube. Find and record their volumes below. Note that you have a faucet and sink to help with this task.

Tip: Very small volumes of water can be accurately measured using a scale, because each milliliter of water weighs 1 gram. To measure water this way, first put a small beaker on the scale, “zero” the scale by pressing the tare button (to “zero” it out). Be sure the readout shows a little “g” after the zero. If it says “N” the reading is not in grams. Now add the water to the beaker. Each gram that the scale reads equals 1 ml of water. Answer this: 1. How many grams does 73 mL of pure water weigh? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Now, check the accuracy of your measuring instruments.

1. Put 50 mL in a beaker. Pour the water into a 100 mL graduated cylinder. How much water is in the cylinder? \_\_\_\_\_\_\_\_\_\_\_
2. Put 5 mL of water in a 100 mL graduated cylinder. Pour the water into a 10 mL graduated cylinder. How much is in the smaller cylinder?

Was there a difference? Why?

**Mass**

For obvious reasons, electronic balances are the preferred method of massing materials in science labs. These must be plugged in and turned on. Be sure to turn OFF and UNPLUG at end!

Use the electronic balance to measure the following objects from your lab table. Object: Measurement: Penny \_\_\_\_\_\_\_\_ g Paper Clip \_\_\_\_\_\_\_\_ g Safety Goggles\_\_\_\_\_\_\_\_ g

Convert the body weight (if known) of one person from your lab group to metric kilograms \_\_\_\_\_\_\_\_ lbs x 0.4536 = \_\_\_\_\_\_\_\_ kg

**Temperature**

Record the following temperatures in degrees Celsius. How many decimal places should you have in your answer? \_\_\_\_\_\_

Air \_\_\_\_\_\_

Surface of your skin \_\_\_\_\_\_\_\_

Cool tap water. Place your beaker in the sink at your lab table and let the cold tap water run into the beaker for at least a full minute. Important: allow the thermometer to stabilize in the water for a minute before taking a reading. \_\_\_\_\_\_\_\_\_\_\_

*Lab activity adapted from Sylvia Mader Human Biology laboratory manual, 13th edition.*