

Lab Activity: Measuring with Metric

Names _____

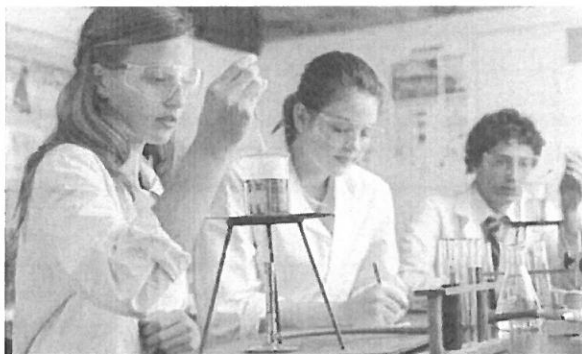
Date _____ Period _____

Introduction:

The purpose of this activity is to practice using the metric system. To conduct a scientific investigation, a researcher must be able to make accurate measurements. 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.

This ten-based system is similar to our monetary system, in which _____ cents equals a dime, and _____ dimes equals a dollar.



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).

Figure 2.1

Standard units of the metric system

Measure	Unit	Example
Length	Meter (m)	Height of a typical door handle (1 m = approx. 39 inches)
Mass	Gram (g)	Mass of one dollar bill (1 g = 0.035 oz)
Volume	Liter (l)	Volume of large fast food soda (1 l = approximately 1 quart)
Temperature	Celsius ($^{\circ}\text{C}$)	Water freezes at 0°C and boils at 100°C

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Figure 2.2 shows the metric units and their prefixes.

Measurements are further expressed using a “**superunit**” prefix or subunit prefix. **Superunits** contain Greek prefixes to show multiples of the base unit, so they make the base unit larger. Latin prefixes, on the other hand, represent “**subunits**” that make the base unit smaller.

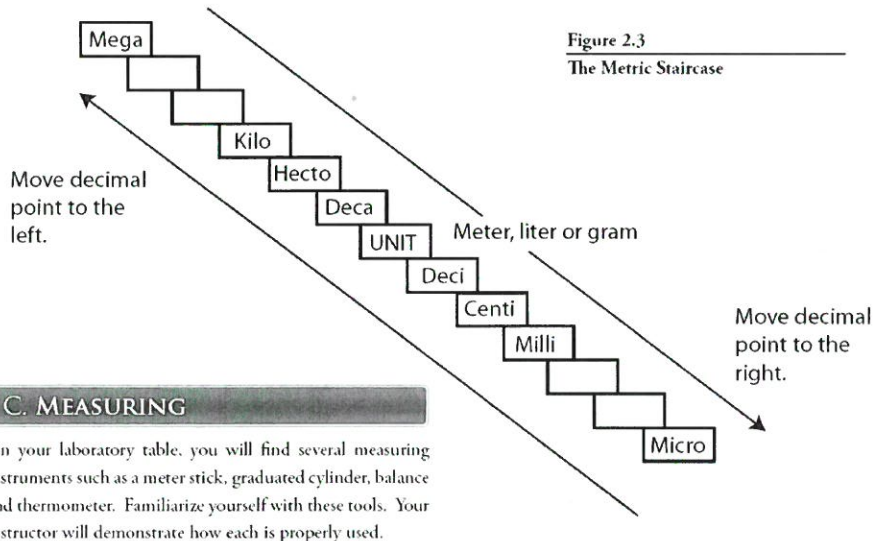
Figure 2.2
Common metric system prefixes and their values

	Prefix	Symbol	Value		
Superunit	Kilo	K	Thousand	1000.0	10^3
	Hecto	h	Hundred	100.0	10^2
	Deca	da	Ten	10.0	10
Unit	Meter	m	One	1.0	1
	Gram	g			
	Liter	l			
Subunit	Deci	d	Tenth	0.1	10^{-1}
	Centi	c	Hundredth	0.01	10^{-2}
	Milli	m	Thousandth	0.001	10^{-3}
	Micro	μ	Millionth	0.000001	10^{-6}
	Nano	n	Billionth	0.000000001	10^{-9}

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.



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Heed these 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 a metric measurement is less than one, precede the decimal with a ZERO.
For example, *don't write* .55 mm, write 0.55 mm

Points will be deducted for incorrect format.

Practice converting Metric Units

Use the staircase diagram Figure 2.3 to convert the following metric units into new metric units.

8 meters = _____ mm

0.98 kg = _____ g

22.1 ml = _____ l

0.00003 m = _____ mm

10,900 cm = _____ m

57 mm = _____ cm

0.0034 mg = _____ g

0.98 kg = _____ mg

0.0087 l = _____ µl

349 ml = _____ µl

660 g = _____ mg

4590 µl = _____ ml

1. LENGTH

Metric units of length measurement *most commonly* used in biology include the meter (m), centimeter (cm), millimeter (mm), micrometer (µm), and nanometer (nm). See Table 2.1, below.

Table 2.1 Metric Units of Length Measurement				
Unit	Meters	Centimeters	Millimeters	Relative Size
Meter (m)	1 m	100 cm	1000 mm	largest
Centimeter (cm)	0.01 (10 ⁻²) m	1 cm	10 mm	↓
Millimeter (mm)	0.001 (10 ⁻³) m	0.1 cm	1.0 mm	
Micrometer (µm)	0.000001 (10 ⁻⁶) m	0.0001 (10 ⁻⁴) cm	0.001 (10 ⁻³) mm	
Nanometer (nm)	0.000000001 (10 ⁻⁹) m	0.0000001 (10 ⁻⁷) cm	0.000001 (10 ⁻⁶) mm	smallest

How many cm are in a meter? _____

How many mm are in a centimeter? _____

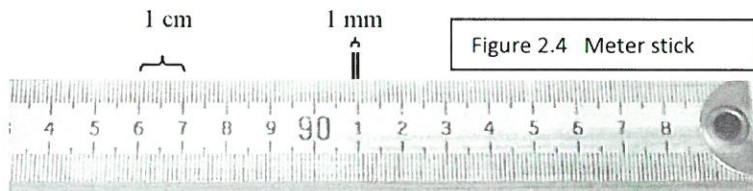
How many µm are in a millimeter? _____

How many nm are in a micrometer? _____

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Meter, Centimeter, and Millimeter

1. Obtain a meter stick. On the opposite side find the English measurement units of “inches”. How many inches are in a meter? _____. Therefore, one meter is roughly equivalent to a *yard*.



2. Turn the meter stick over and observe the metric subdivisions (Fig. 2.4). How many centimeters are in a meter? _____

The prefix *centi-* means 100. How many cents (pennies) are in a dollar? _____

3. How many millimeters are in a centimeter? _____. The prefix *milli-* means a thousand. How many millimeters are in a meter? _____.

4. 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) _____.

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

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

Width of classroom door opening (in meters) _____ m

Length of whiteboard (in meters) _____ m

Length of a dollar bill (in centimeters) _____ cm

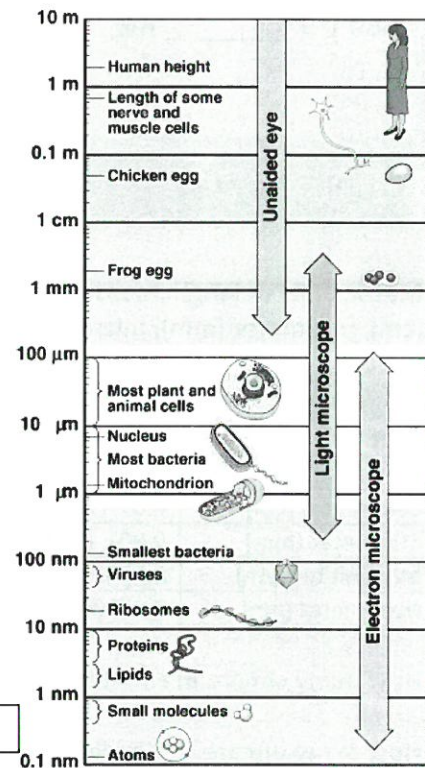
Width of your pen (in millimeters) _____ mm

Which of your fingernails is closest to 1 cm in width? _____

Millimeter, Micrometer, and Nanometer

As you will discover in upcoming laboratory exercises (using microscopes), the units micrometer (μm) and nanometer (nm) are useful in microscopy for measuring very tiny objects like cells or even viruses. Figure 2.5 shows that cells are generally much smaller than a millimeter (mm).

Figure 2.5 Measuring Small Objects



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