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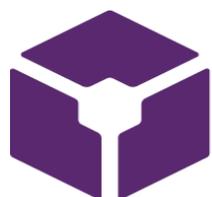**Find, customize, and build content for your course using the LabArchives notebook platform and its course management tools.**

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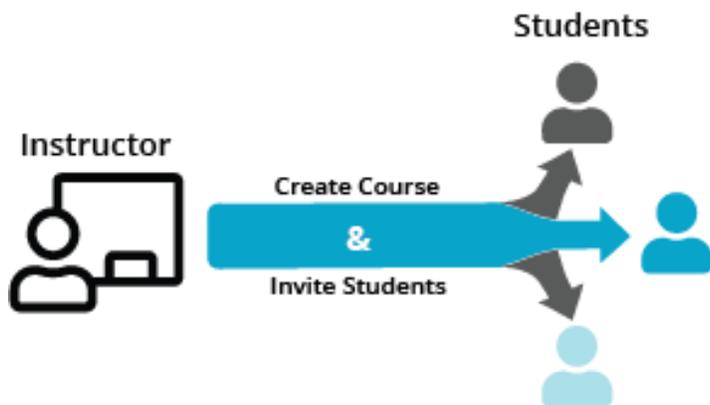
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Lab Builder

Metric System Lab

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Attribution

Instruction Level

- High School
- Undergraduate Lower Division (Freshman, Sophomore)

Topic

- Metric system
- Distance
- Weight
- Volume
- Temperature
- Metric Prefixes
- Conversions

Instruction Type

Traditional

Timeline

- **Procedure:** 1 - 2 hrs

Learning Objectives

- Students will learn to apply the metric system to the measurement of weight, distance, volume and temperature.
- Students will learn how to convert between metric prefixes.
- Students will learn how to convert different units used for weight, distance, volume and temperature.

Additional Resources

You can find the complete *Unfolding the Mystery of Life, Biology Lab Manual for Non-Science Majors* in Lab Builder (link). Popular experiments include:

- Human Genetics and Cytogenetics
- Microbiology, Food Biology and Disease Transmission
- Isolation of DNA from Plants

Introduction

Background

The metric system was designed in France in the 18th century. Before then, it was common for units of length, area, and weight to vary from one country to another and even within the same country. Length could be measured in feet, miles, spans, cubits, hands, furlongs, palms, rods or chains. The metric system brought order to the confusing systems of weights and measures then being used in Europe. In 1875, most industrialized countries signed the Treaty of the Meter which formed the International Bureau of Weights and Measures. We now call this system the International System of Units. Although the US uses this system for scientific measurement, most people still use the more complicated system that involves inches, feet, miles, cups, pints, quarts, ounces, and pounds. The United States, Burma, and Liberia are the only countries that do not routinely use the metric system.

Measuring Distance

Most objects encountered in biology range from under a millimeter to meters in length or diameter. The meter is the standard unit of linear measure. One meter (39.4 inches) is roughly equivalent to one yard (3 feet). 1 Kilometer (km) is 0.6 miles. A finger is measured in cm (2.54 cm in 1 inch). A micrometer (micron) is not visible by unaided human eye. Most cells are in the micron range. To see an object much smaller, an electron microscope must be used.

Measuring Mass

The gram is the basic unit for measuring mass. There are 0.454 kilograms in a pound. An electronic scale is used to measure the mass of an object. The instructor will demonstrate its use.

Labs – Mathematics and Statistics: Metric System

Measuring Temperature

The basic unit of temperature is degrees Celsius. Body temperature is 37ºC.

- Celsius (C) = (5/9)*(ºF - 32)
- Fahrenheit (F) = (ºC * 1.8) + 32

Measuring Volume

The volume of an object is the amount of space it takes up. Volume is a three-dimensional space occupied by gas, liquid or solid. Liquid volume is measured in liters. One liter = 1.06 quarts. The volume of a solid material is determined by multiplying length x depth x width to obtain a cubic number (c3c3).

- Volume in cubic centimeters (cc or cm3cm3) = Length x Width x Depth.

Metric System Prefixes and the Metric Ladder:

Table 1: Metric system prefixes with their respective fraction, decimal and scientific notation.

Prefix	Fraction	Decimal	Scientific Notation
Nano (n) +1 billionth	1/1,000,000,000	0.000000001	10−910−9
Micro (μ) = 1 millionth	1/1,000,000	0.000001	10−610−6
Milli (m) = 1 thousandth	1/1,000	0.001	10−310−3
Centi (c) = 1 hundredth	1/100	0.01	10−210−2
Kilo (k) = 1 thousand	1,000	1000	103103

Table 2: Conversion between metric prefixes.

Multiply → or ← Divide										
Kilometer	1000	Meter	100	Centimeter	10	Millimeter	1000	Micrometer	1000	Nanometer

To convert kilometer to meter, you multiply the amount of kilometers by 1000. To convert from meter to kilometer, you divide the amount of meters by 1000.

Remember:

- The metric system is based on units of 10. Count zeros.
- Consult the metric ladder as to how many spaces to move the decimal point.
- Move the decimal left when converting from a smaller to larger value (DIVIDE)
- Move the decimal right when converting from a larger to smaller value (MULTIPLY)

Conversions:

- 1 pound = 0.454 kilograms
- 1 kg = 2.2 pounds
- 1 inch = 2.54 centimeters
- 1 meter = 39.4 inches
- 1 quart = 0.946 liters
- 1 liter = 1.057 quarts

Pre-Lab Assignment

1. *Purpose Statement:* In one or two sentences, specifically describe the purpose of the day's experiment/lab work. What are you trying to learn or achieve, and how?
2. How many kilometers are in one meter?
3. How many millimeters are in 5 meters?
4. How many liters are in 80 nanoliters?

Procedure

Protocol

Measuring Distance

1. Obtain a human bone. Handle with care. Consult the articulated skeleton to find out the location of the bone.

2. Measure the length of the bone in centimeters (cm).

3. Use the meter stick to measure the length of your arm or leg, thumb.

4. Answer questions in the results section.

Measuring Mass

1. Obtain a small object such as dice. Record the mass in the results section.

2. Tare the weigh boat. Empty the salt into the weight boat. Record the mass in the results section.

3. Answer questions in the results section.

Measuring Volume

1. Measure the volume of a small item, such as dice, using a small metric ruler.

2. A solid volume of 1 cubic centimeter equals a liquid volume of 1 milliliter. A person receives an injection of insulin (an important drug for diabetics).

3. Fill a 50 mL graduated cylinder with 20 mL of water. Bend down so meniscus is at eye level. A meniscus is the curvature of the surface of the water. Measure at the lowest point of the meniscus.

4. Use the displacement method to determine the volume of the item that you measure in step 1. Examine the meniscus to ensure accuracy

5. Answer questions in the results section.

Measuring Temperature

1. Obtain a thermometer and record the temperature of the environments listed in the results section.

2. Calculate the environments listed in the results section.

Results

Measuring Distance

1. What part of the body is the bone from?

2. The scientific name of the bone is the?

3. The length of the bone =_____cm = _____millimeters(mm)= _____ m

4. The body part, the _____ = _____ cm = _____ mm

Labs – Mathematics and Statistics: Metric System

Measuring Mass

1. The mass of the object is _____ grams (g) = _____ milligrams (mg)

2. The mass of the salt is _____ g = _____ mg

3. You should consume less than 3 grams of salt/day. You weighed an amount that many in the United States consume daily. How does this compare with the recommended amount?

4. A person weighs 90.000 grams (g). What is the mass in kilogram (kg)? What is the mass in pounds?

5. What is your height in inches? Centimeters? Meters?

6. Could a normal person be 3 meters tall? What is the height in feet/inches?

7. A bottle of water is 500 mL. Approximately how many cups of water does a person consuming this bottle drink?

Measuring Volume

1. Measure the volume of a small item, such as dice, using a small metric ruler. The volume of the item is _____ cc.

2. The volume of injection is 1.25 milliliters, convert to cubic centimeters.

3. Use the displacement method to determine the volume of the item that you measured in step one. The volume of the item is _____ mL = _____ cc

4. What is displacement?

Measuring Temperature

1. Obtain a thermometer and record the temperature of the following environments:

   o Room temperaure (ºC):

   o Ice water temperature (ºC):

   o Skin temperature (ºC):

2. Calculate

   o Water boils at 212 ºF or _____ ºC

   o Body temperature is 37ºC or _____ ºF

   o Water freezes at 32ºF or _____ ºC

Post-Lab Assignment

1. How many decimal positions are moved to convert a meter to a kilometer?

2. What metric measure would you use for your height? Why?

3. How many millimeters are in 7.3 centimeters?

4. How many meters are in 103 millimeters?

5. How many grams are in 12 kilograms?

6. How many kilograms are in three micrograms?

7. 1230 milliliters = _____ liters?

8. 3,200,000,000 nanograms (ng) = _____ grams?

9. 1,200,000,000 ng = _____ mg = _____ g = _____ kg?

10. What is the one metric measurement used for volume?

11. Body temperature is _____ degrees Celsius.

12. A block measures 3 x 4 x 2 cm. What is the volume in cubic centimeters? milliliters?