Name______________________________Date of Data Collection___________________

Class Period _________ Lab Days/Period________ Teacher_____________________

Metric Measurement

Background: Scientists can only expect to communicate effectively if they are using a common "language". While the actual language changes from country to country, the one thing that remains fairly constant is the language of the metric system. Quite surprisingly the United States is not a "metric" nation like most countries. We still use what some consider to be an antiquated "English" system. The beauty of the metric system is that all measurements are based on "10's" making it simpler to convert from unit to unit. The universal "language" of science is based in the metric system and that is the main purpose of this lab experience.

Laboratory Safety Precautions: The following symbols represent the precautions that are required for this lab:

There are no safety precautions required for this laboratory.

Purpose: The purpose of this laboratory experience is:

-to learn to "speak" the universal language of science using metric measurements.
-to learn to convert metric to metric and metric to english/english to metric.
-to get a better "feeling" of just how big a certain unit of metric measure actually is and apply that knowledge when considering units.

Procedure/Discussion: There are several prefixes that are associated with metric units that can be attached to the base metric unit in order to create a new metric unit. Knowing the decimal meaning of the prefix establishes the conversion factor relationship between the newly created unit and the base unit.

For example: the prefix "kilo" means 10^3 or 1,000. Therefore, if we are to use, for instance, a "gram" and we attach the kilo prefix in front, we get "kilogram"

In addition, the relationship between the two units is now more easily understood. Since I know that "kilo" means 1000 then one kilogram unit is the same as (or equal to) 10^3 "gram" units. The prefixes that are most important are listed below along with their decimal and exponential equivalents:

Name_____________________________Date of Data Collection___________________

Class Period _________ Lab Days/Period________ Teacher_____________________

Prefix	Decimal Equivalent	Exponential Equivalent
Pico-	0.000000000001	10^{-12}
Nano-	0.000000001	10^{-9}
Micro-	0.000001	10^{-6}
Milli-	0.001	10^{-3}
Centi-	0.01	10^{-2}
Deci-	0.1	10^{-1}
No prefix	1.0	10^{0}
Deka-	10.0	10^{1}
Hecto-	100.0	10^{2}
Kilo-	1,000.0	10^{3}
Mega-	1,000,000.0	10^{6}
Giga-	1,000,000,000.0	10^{9}

There are several dozen prefixes used but these above are most commonly used in Science measurements. In this lab we will briefly explore the following areas of measurement: Mass, Dimension, Volume, and Area

Mass Measurement

Mass in the metric system has several units that scientists use most often. For comparison, the gram is the standard unit of mass in the metric or SI system. The gram (abbreviated g or gm) is roughly the same meaning as the English dry ounce. It takes about 29 grams to equal one dry ounce. A larger mass unit similar to the English pound is the kilogram. The kilogram is the same as 1000 grams and represents 2.2 pounds in mass.

Dimensional Measurement

Now let us go over dimensional measurement that is measure of length, width, and height. The basic metric unit of dimension is the meter (m). The meter is analogous to the English yard. A meter is equal to slightly more than a yard (about 10% larger).
One meter is equal to 1.09 yards or 39.36 inches. A larger metric unit used often is the kilometer(km) which is analogous to the English mile. One kilometer is equal to 0.62 miles. In countries where the metric system is the national standard, signposts and posted speed limits are in km or km per hour. For example, the most common speed limit in Canada is 100, but that is 100 km/hr or about 60 miles per hour!!

All metric rulers are calibrated the same. The numerically numbered position (major calibrations) are equal to centimeter marks, and then there are ten equally spaced position (minor calibrations) in between each of the numbered positions each of which are equal to 0.1 cm(1 mm). According to this calibration, one can record measurements with one position of estimation to the nearest 0.01 cm.

Name______________________________Date of Data Collection___________________

Class Period __________ Lab Days/Period________ Teacher______________________

Another instrument most often used in Biology labs is called a micrometer (sometimes referred to as the micron). As the name implies it can measure to the nearest micrometer and is used for very precise measurements of diameters. It is most commonly used in "sizing up" cells under the microscope and is commonly given the symbol "mu", which looks like: μ

Volume Measurement

The third type of measure is measure of volume. Actually we can break this down into the measure of

1. solid volume (regular and irregular)
2. fluid (liquid and gas) volume

Measurement of Fluid Volumes

Let's now discuss measure of fluid volume. There are several instruments used to directly measure fluid volumes. The graduated cylinder is the most commonly used in the lab. However, there are several others. The pipet, buret, and volumetric Flask measure fluid volumes more precisely than most graduated cylinders.

The basic metric unit of measure for volume is the liter(l) unit. The liter is similar to the English quart. One liter being the same as 1.06 quarts. It is basically a fluid volume unit as is the smaller metric unit called the milliliter(ml). The milliliter is similar to the English fluid ounce. One fluid ounce is equal to about 30 ml.

Other metric units of volume that are more often associated with volumes of solids is the cubic centimeter(cc or cm3) which is equal to a milliliter. Be certain that you understand that the cc may look like a dimensional unit since it has the word "centimeter" in it. However, it also has the word "cubic" which always indicates a volume unit.

You can think of a cubic centimeter as a cube 1 cm on each edge. The volume of such a cube would be 1cm X 1cm X 1cm or 1 cm^3. We also use the cubic meter(m^3) often in science to measure large volumes in space.

Any dimensional relationship such as 100 cm = 1 m can be used to derive a volume unit relationship simply by "cubing" BOTH sides of the relationship so for example:

$$100 \text{ cm} = 1 \text{ m cubed would be:}$$
$$(100 \text{ cm})(100 \text{ cm})(100 \text{ cm}) = (1\text{m})(1\text{m})(1\text{m}) \text{ or } 1 \times 10^6 \text{ cm}^3 = 1 \text{ m}^3$$

You can even do this with English dimensional relationships that result in a newly created volume relationship. For example:

$$1 \text{ ft} = 12 \text{ in. If we cubed both sides we would have:}$$
$$(1 \text{ ft})(1 \text{ ft})(1 \text{ ft}) = (12 \text{ in})(12 \text{ in})(12\text{in}) \text{ or } 1 \text{ ft}^3 = 1728 \text{ in}^3$$

Name_____________________________Date of Data Collection___________________

Class Period _________ Lab Days/Period________ Teacher_____________________

Try it yourself on the following dimensional relationships:

If 1 inch = 2.54 cm Determine the relationship between cubic inches and cubic centimeters? Show your work in this space.

Area Measurement

Area measurement relationships are similar to volume relationships except you square both sides of the dimensional relationship. For example if we wanted to know the relationship between square cm and square m we could begin with the following dimensional relationship between cm and m:

If: 100 cm = 1 m, then $(100\ \text{cm})^2 = (1\ \text{m})^2$ and $10{,}000\ \text{cm}^2 = 1\ \text{m}^2$

BASICALLY, dimensional measurement is one dimensional, area measurement is two dimensional and volume measurement is three dimensional.

Data: The following conversion exercises are submitted as data for this laboratory experience:

1. The system instrument designed to measure different dimensions in science is referred to as the________________ __________ or the _____________ ______________.

2. The graduated cylinder is an instrument that measures _____________.

3. The prefix that signifies 0.001 is __________.

4. The prefix that signifies 1 X 106 is ________.

5. The English unit associated with the meter is _____________.

6. 1 meter = _________mm.

7. A cubic centimeter is a unit of ___________.

Name______________________________Date of Data Collection____________________

Class Period _________ Lab Days/Period________ Teacher______________________

8. The kilogram is associated with the English unit ________.

9. One pico second would be how much of a second (express in exponential notation) ______________.

11. If 1 meter = 100 cm, then what is the relationship between m^3 and cm^3? Show work.

And now, the fun part….

METRIC CONVERSION EXERCISES

Make the conversions within the Metric System and the conversions between the English and the Metric System. Please SHOW ALL WORK AND ALL UNITS to demonstrate that you know what you are doing for conversions between systems.

A. Basic metric equivalencies

See the table at the beginning of this lab or the textbook for further details. The prefixes will be useful.

1. 1 m = ________ cm

2. 1 m = ________ mm

3. 1 cm = ________ mm

4. 1 km = ________ m

5. 1 km = _________ cm

6. 1 kg = ________ g

7. 1 kg = ________ mg

8. 1 l = ________ ml

Name______________________________Date of Data Collection____________________

Class Period _________ Lab Days/Period________ Teacher______________________

B. Conversions between systems - SHOW ALL WORK AND ALL UNITS

To correctly do this portion of the lab, you must know what the conversions are. As such:

Metric to English	**English to Metric**
Length: 1 mm = 0.04 in 1 cm = 0.39 in 1 m = 39.37 in = 3.28 ft 1 m = 1.09 yd 1 km = 0.62 mi	Length: 1 in = 2.54 cm 1 ft = 30.48 cm = 0.305 m 1 yd = 0.914 m 1 mi = 1.609 km
Weight: 1 g = 0.035 oz 1 l = 1.057 qt	Weight: 1 oz = 28.350 g 1 lb = 0.453 kg
Capacity: 1 ml = .2 tsp 1 l = 1.057 qt	Capacity: 1 tsp = 5 ml 1 c = 236 ml 1 qt = 0.946 l 1 gal = 3.785 l

9. 1 mi = ________ km

10. 1 mi = ________ m

11. 1 yd = ________ cm

12. 1 in = ________ cm

13. 50 ft = _________ m

14. 150 lb = ________ kg

15. 5 ft 5 in (65 in) = ________ cm

16. 24 in = ________ cm

17. 100 lb = ________ g

18. 1 lb = ________ g

19. 1 ft = ________ cm

20. 64 oz = ________ g

21. 1 l = ________ qt

Name______________________________Date of Data Collection____________________

Class Period _________ Lab Days/Period________ Teacher_____________________

22. 55 mi/hr = _________ km/hr

23. 40 mi/hr = ________ km/hr

24. 100 km/hr = ________ mi/hr

25. 5 km = ________ mi

26. 10 km = ________ mi

27. 1 kg = ________ lb

28. 1 kg = ________ oz

29. 100 kg = ________ lb

30. 50 m = ________ ft

C. Your personal data (Just for fun)

31. How tall are you (feet and inches)? ____________

32. How many inches tall are you? ___________

33. How many centimeters tall are you? ___________

34. How many meters tall are you? ___________

35. What do you weigh in pounds? ___________

36. What do you weigh in kilograms? ___________

37. What do you weigh in grams? ___________

Name______________________________Date of Data Collection___________________

Class Period _________ Lab Days/Period________ Teacher_____________________

Conclusion: The following can be concluded after completing this lab experience:

What did you learn in this lab? Did you understand what the metric system was all about or did you gain some valuable insight?

____

____

____

____

Why is it important that all scientists use similar units? Give two reasons why is the metric system the best system for use in science.

____

____

____

____