# 2a

Name : _____

# Metric Supplement

## Objectives:

1. Metric System: Become familiar with the use of the metric system. Understand the relative size of metric units and be comfortable conveying information in Metric units. Become familiar with simple systems for measuring length, weight and volume
2. Understand how to convert between metric units. (ie. cm to nm)

## 1.A Metric System :

Physiology is a *quantitative* science in which validity of physiological theory is evaluated and studied in terms of measurable variables (i.e.: temperature, pH, pressure, concentration). The Metric System is used almost exclusively to measure physiological processes. It is therefore essential that you are comfortable in using the metric system. The metric system (from the Greek term metrikos, meaning "measure"), was first developed in late eighteenth century France. The modern definitions of the units used in the metric system are those adopted by the General Conference on Weights and Measures, which in 1960 established the International System of Units, also known (in French) as Systeme International d'Unites, and abbreviated SI (in all languages). The metric system utilizes units that are based on the decimal system and related to each other by the power of ten. Unlike the American-British system (commonly called the English system) of measurement (inch, foot, yard, mile); metric units are easily inter-converted by simply multiplying or dividing by ten (which ALL of us are capable of doing).

When learning how to use the metric system, you become a “Decimal Jockey.” Whenever you change units you can simply move the decimal of a number to the right of left, therefore affecting its value.

Jump to RIGHT : MULTIPLY

| | |
|---|---|
| 1.0 x 10 = 10.0 | Jump decimal **one** place to the **right;** ONE zero in 10 |
| 1.0 x 100 = 100.0 | Jump decimal **two** places to the **right;** TWO zeros in 100 |
| 1.0 x 1,000 = 1,000.0 | Jump decimal **three** places to the **right;** THREE zeros in 1,000 |

Jump to LEFT : DIVIDE

| | |
|---|---|
| 1.0 / 10 = 0.1 | Jump decimal **one** place to the **left;** ONE zero in 10 |
| 1.0 / 100 = 0.01 | Jump decimal **two** places to the **left;** TWO zeros in 100 |
| 1.0 / 1,000 = 0.001 | Jump decimal **three** places to the **left;** THREE zeros in 1,000 |

**Exercise 1.A** : Changing the value of a number

1. Multiply 10 by 100.

   10.0 x 100 = _____

   In which direction must you move the decimal (to the right or the left)? _____

   How many decimal places where moved ? _____

2. Divide 10 by 10,000.

   10.0 ÷ 10,000 = _____

   In which direction must you move the decimal (to the right or the left)? _____

   How many decimal places where moved ? _____

3. Looking at the value of ten that you multiplied or divided by (100 or 10,000) what is the relationship between the number of zeros in the number and the number of decimal places you should move?

   a. Multiply by 100,000 : The number of decimal places moved : _____

   b. Dividing by 1,000 : The number of decimal places moved : _____

4. When multiplying or dividing what is the relationship between the direction that the decimal is moved and the function you are accomplishing?

   a. Multiplying : The decimal is moved to the _____

   b. Dividing : The decimal is moved to the _____

## 1.B Basic Units of Measurement :

The Metric System uses a system of PREFIXES, which denote the valve of a number (placement of the decimal) combined with the type of measurement being made or the BASIC UNIT of measurement. The primarily used measurements can be expressed in four ways: length, volume, mass, or temperature. The metric system utilizes four basic units to express these measurements.

| | |
|---|---|
| Length : Meter (m) | (1m = 39.37 inches) |
| Volume : Liter (*l* ) | (1 *l* = 0.264 gal) |
| Mass : Gram (g) | (454g = 1 lb) |
| Temperature : Centigrade (Celsius) (°C) | (0 °C = 32°F) |

**One ml = one cubic centimeter (cc) = one gram of water!**
**1 ml = 1 cc = 1 gm $H_2O$**

In order to change the value of a measurement one needs only to incorporate an additional prefix to the measurement. Each prefix is used to describe how much of the basic unit is present.

**METRIC PREFIXES :**

| Number | Meaning | Factor | Exponent | Abbreviation |
|---|---|---|---|---|
| 1,000.0 | one thousand | (10x10x10) | $10^3$ | kilo (K) * |
| 100.0 | one hundred | (10x10) | $10^2$ | hecto (h) |
| 10.0 | ten | (10) | $10^1$ | deka (da) |
| 1.0 | one | (1.0) | $10^0$ | |
| 0.1 | one tenth | (1/10) | $10^{-1}$ | deci (d) * |
| 0.01 | one hundredth | (1/10x10) | $10^{-2}$ | centi (c) * |
| 0.001 | one thousandth | (1/10x10x10) | $10^{-3}$ | milli (m) * |
| 0.000001 | one millionth | (1/10x10x10x10x10x10) | $10^{-6}$ | micro (μ) * |
| 0.000000001 | one billionth | (1/10x10x10x10x10x10x10x10x10) | $10^{-9}$ | nano (n) |

✯ *Indicates most commonly used physiological units*

Physical properties can be measured by simply combining *basic units* with the appropriate *prefix*

For Example:

| | | |
|---|---|---|
| One liter of soda (1*l* ) | = | one liter (1*l*) |
| One hundred liters of soda (100 *l* ) | = | one hecto liter (1h*l* ) |
| One thousand meter jog around campus | = | one kilo meter (km) |
| A moth is one hundredth of a meter long | = | one centi meter (cm) |
| An ant is one thousandth of a meter long | = | one milli meter (mm) |
| An ant's leg weighs one millionth of a gram | = | one micro gram (μg) |

## Exercise 1.B : Converting Basic Units

1. Length Basic Unit: *Meter*

   One meter cut into 100 piece: each piece equals 0.01 m or 1 centi meter

   a. One meter cut into 1,000 pieces: each piece equals 0.001 m or 1 _____ meter

   b. 1,000 meters combined: equal 1,000 m or 1 _____ meter

2. Volume Basic Unit: *Liter*

   One liter poured into 10 cups: each cup contains 0.1 liters or 1 deci liter

   a. One liter poured into 100 cups: each cup contains _____liter or 1centi liter

   b. One liter poured into 1,000,000 cups: each cup contains _____ liters or 1 _____ liter

   c. 1,000 liters combined in a jug: equal 1,000 liters or 1_____ liter.

3. Weight Basic Unit: *Gram*

   a. 10 grams: equals 1 _____ gram

   b. 1,000 grams combined: equal a total of 1 _____ gram

   c. One gram divided into 1,000 pieces: each piece weighs 0.001 grams or 1 _____ gram

## 1.C Metric Conversions: Dimensional Analysis

Metric conversion is the process through which the *units of measurement* are changed WITHOUT changing the *value of the number*.

| | | |
|---|---|---|
| One thousand meters (1,000 m) | = | One kilo meter (1.0 km) |
| One hundredth of a gram ($10^{-2}$g) | = | One centi gram (1.0 cg) |
| One thousandth of a liter ($10^{-3}$ *l* ) | = | One milli liter (1.0 m*l* ) |

The steps used in changing the units for a number are based on the principle that MULTIPLYING by ONE does NOT change the value of a number.

| | |
|---|---|
| 10/ 10 = 1 | deka/deka = 1 |
| 1 x 10/ 10 = 1 | 1 x deka/deka = 1 |

**Conversion factors** are ratios of numbers with different units which equal ONE.

✯ *Fractions which equal ONE*

| | |
|---|---|
| 1,000 m / 1.0 km = 1 | 1 x 1,000 m / 1.0 km = 1 |
| $10^{-2}$g / 1.0 cg = 1 | 1 x $10^{-2}$g / 1.0 cg = 1 |
| $10^{-3}$ *l* / 1.0 m*l* = 1 | 1 x $10^{-3}$ *l* / 1.0 m*l* = 1 |

**Exercise 1.C** : Using conversion factors any number can be represented with different units

1. 1,000g (grams) = _____ kg (kilograms)

*Conversion factor : 1 kg / 1,000 gms = 1*

$$1{,}000\text{g} \times \frac{1\text{ kg}}{1{,}000\text{g}} = \underline{\quad 1\text{ kg}\quad}.$$

2. 10 cm (centimeter) = _____ m (meter)

*Conversion factor : 1 m / 100 cm = 1*

$$10\text{ cm} \times \frac{1\text{ m}}{100\text{ cm}} = \underline{\qquad\qquad\text{ m}}$$

3. 100 ml (milliliter) = _____ cl (centiliter)

*Conversion factors : 1 l / 1,000 ml = 1*
*1 l / 100 cl = 1*

$$100\text{ ml} \times \frac{1\text{ l}}{1{,}000\text{ ml}} \times \frac{100\text{ cl}}{1\text{ l}} = \underline{\qquad\qquad\text{ cl}}$$

4. 32.6 mg (milligrams) = _____μg (microgram)

Conversion factors : 1 g / _____ mg = 1
1 g / _____ μg = 1

$$32.6 \text{ mg} \times \frac{1 \text{ g}}{\text{mg}} \times \frac{\text{\_\_\_\_\_ μg}}{1 \text{ g}} = \text{\_\_\_\_\_ μg}$$

5. 0.05 mm (millimeter) = _____ km (Kilometer)

Conversion factors :

0.05 mm x = _____ km

*With the information given; COMPLETE the attached METRIC WORKSHEET : Come SEE me is you are having problems !!!*

# 2a

**Name**: _____

# Metric Supplement

## 2.A Additional Laboratory Exercises :

### Exercise 2.A1 : Linear Measurement

a. What is the base unit of length: _____

b. What does each numbered line on a meter stick represent? _____

c. What does each non-numbered line on a meter stick represent? _____

### Exercise 2.A2 : Linear Measurement

When measuring, it is important to be accurate but to not go beyond the accuracy of the device you are using to do the measuring. For example, 5.7926mm is a measurement beyond the accuracy of a meter stick. You can measure 5mm easily and perhaps estimate the 0.7mm, but there is no way to possibly measure the 0.09261.

a. Use a small metric rule to measure the length of each of the lines below. Record the measurements in millimeters and centimeters using the most accurate units.

_____ mm _____ mm

_____ cm _____ cm

b. Which unit can be measured most accurately with the rulers provided ?

### LABORATORY SUMMARY QUESTIONS :

1. Give the metric units for:

   a. the weight of 1cc (cubic centimeter) of water _____

2.

   a. The basic metric unit for volume : _____

   b. The basic metric unit for weight : _____

   c. The prefix denoting 100 : _____

   d. The prefix denoting 1/100 : _____

   e. The prefix denoting 1/ 1,000,000 _____

3. Which is the larger unit :

a. Milli or Centi _____

b. Kilo or Deka _____

c. Micro or Nano _____

4. Compute the following conversions between metric units:

| | | |
|---|---|---|
| 1.0 km = _____ m | 0.1 g = _____ μg | 0.035 L = _____ml |
| 1.0 ml = _____ l | 0.0001 ml = _____ μl | 0.83 cm = _____mm |
| 100.0 cm = _____ m | 0.35 kg = _____ mg | 3500 μl = _____ml |
| 1.0 cg = _____ mg | 66 g = _____kg | 2100 mg = _____g |

5. An electrocardiogram paper speed is 2.5 cm / sec,
what is its speed in mm / sec _____

6. The heart pumps approximately 5.0 liters/ min.

a. How much blood does it pump in an hour? _____

b. How much blood does it pump in a day _____

c. How much blood does it pump in a year? _____