Name ________________________

Lab One: Measurements, Metric Conversions, and Map Comprehension

During the course of the semester, you will be reading and using various topographic maps. Part of this will require measuring distances on maps. Your answers will ultimately be based on these measurements, so accurately taking measurements is a good technique to master. This lab will allow you to practice this technique prior to the labs which require map measurements. In addition to measuring map distances, you will learn how to convert these map units into real-world units. This is accomplished by understanding and applying the map scale and then converting those units into meaningful distances. As such, we will practice converting units within the English system as well as within the Système International (S.I.) a.k.a. the "metric" system of measurement. It is also useful to understand how to record your data using the proper rounding.

Understanding map projections is another important map comprehension skill. Through the process of converting a 3-dimensional object into a 2-dimensional surface distortion will occur regarding the distance, direction, shape or size of the object portrayed on the map. A basic understanding regarding which property has been distorted or preserved can help you select a map projection suitable for your intended purpose.

Materials:

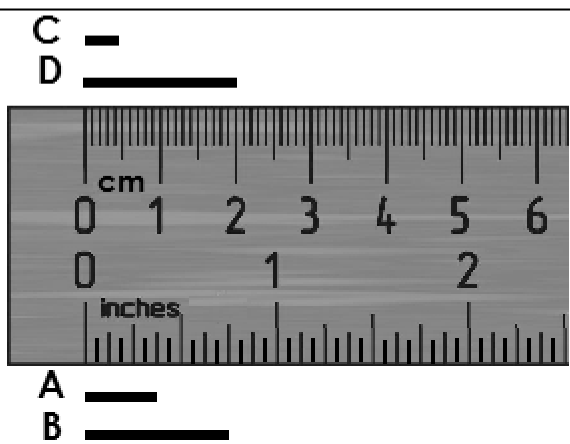
Ruler & calculator

Objectives:

- To practice measuring items
- To practice converting within a system of measurement
- To practice converting between the English System and Système International (S.I.)
- To practice rounding your answers
- Identify types of distortion on map projections

Part 1: Measurement

The image below denotes a ruler with centimeters (cm) on top and inches on the bottom.



Line A: measures 6/16 of an inch

Line B: measures 12/16 of an inch

Line C: measures 5/10 of a centimeter or 5 millimeters

Line D: measures 2 centimeters or 20 millimeters

Measuring in inches: On this ruler, the inch has been subdivided into 16 equal parts. Each line equals 1/16 of an inch.

Measuring in centimeters: On this ruler, the centimeter has been subdivided into 10 equal parts. Each line equals 1/10 of a centimeter, which is a millimeter.

Converting fractions to decimals: Divide the numerator (top number) by the denominator (bottom number). Add decimal to whole number, if applicable.

When measuring distances with a ruler, it is easier to use the decimal form of the measurement instead of using the fractional form. For example, Line A expressed in decimal form is .375 inches (6 divided by 16), Line B is .75 inches (12 divided by 16), and Line C is .5 centimeters (5 divided by 10). Line D does not need to be converted since it is expressed as a whole number.

Exercise 1.1:

1. Draw a line on a piece of paper.
    a. Using a ruler, measure the line in inches and in centimeters.
    b. **Take a picture** of the line with the ruler, so I can check your measurement.
    c. Record the measurement as both a fraction and decimal.

    Line in Inches (as a fraction and a decimal)

    Line in centimeters (as a fraction and a decimal)

    Insert image of line and ruler here:

What if you didn't have access to a ruler? Knowing the size of common household goods may come in handy.

2. Measure the width and height of a credit card, gift card or ID. What is the width in inches? Height?

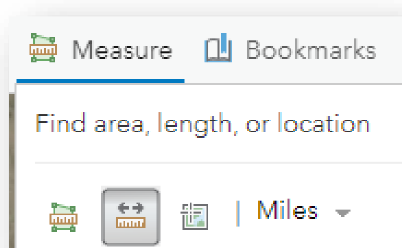
3. Measure the height of a standard 12 ounce can of soda or similar beverage?
    a. What is the diameter of the lid?

4. Revisit the line you drew in Problem 1, approximately how many quarters is the length of that line? What does this tell you about the approximate length in inches?

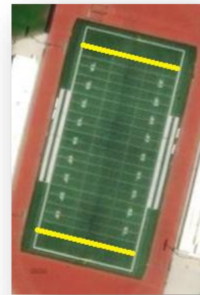
Exercise 1.2:

Open the [Lab 1 Digital Map:] and answer the following questions. You may also access this map from Canvas. Go to the Fullerton College Bookmark. Using the Measure Distance Tool, answer these questions:

1. The Red Pushpin is the location of the library. Imagine that you were to exit the building (blue pushpin) and walk to your car (green pushpin). You can only walk along the sidewalk until you get to the parking lot. How far is it in **feet** from the building's exit to your car? __________



2. You need to drive from the blue star to the orange star. What is the difference in **miles** if you take N. Berkley Ave versus N. Lemon St. and Nutwood Pl?



How accurate are your measurements? Let's find out. Change the Basemap to Imagery and go to the Valencia High School Bookmark to measure the length of the football field. Note: Football fields are 100 yards between the goal lines. I marked the goal lines in yellow on this image:

3. How close were you to the actual length?

Return to the Fullerton College Bookmark (with Basemap as Imagery).

4. Using the measure area tool, measure the area of the field I labeled. How many **sq. feet** is it?

Part 2: Converting Units of Measurement

Unit conversions involve taking a set of measurements expressed as one set of units (e.g., inches) and putting them into a more useful form (e.g., feet). This can occur within one system (e.g., inches to miles) or between systems (e.g., miles to kilometers).

An easy mistake to make during the unit conversion process is to lose track of your units, which often leads to mathematical errors. Here's a useful method to follow whenever performing unit conversions. Using this method will help you avoid making math errors during your unit conversions.

Conversion Factor: a ratio written in fraction form used to express the same quantity in 2 different units. This fraction will always equal 1.

Example #1: Convert 5 feet into inches.

Step 1 : Decide which conversion factor to use.

Since you a trying to convert feet to inches, you need a ratio that expresses the same quantity in both feet and inches. 1 foot and 12 inches represent the same distance. Therefore, when written as a fraction it is equal to 1.

We can write this fraction as

$$\frac{\textbf{12 inches}}{\textbf{1 ft}} \quad \text{or as} \quad \frac{\textbf{1 ft}}{\textbf{12 inches}}$$

Step 2: Multiply the original unit of measurement by the conversion factor.

$$\textbf{5 ft} * \left[\frac{\textbf{12 inches}}{\textbf{1 ft}}\right]$$

Notice that when we set things up this way, we are in effect dividing feet by feet, so the units cancel and we are left with inches as the unit of measurement.

$$\textbf{5 } \cancel{\textbf{ft}} * \left[\frac{\textbf{12 inches}}{\textbf{1 } \cancel{\textbf{ft}}}\right] = \textbf{60 inches}$$

Example #2: Convert 25 inches into feet.

Step 1: Decide which conversion factor to use.

Step 2: Multiply the original unit of measurement by the conversion factor.

$$\left[\ \textbf{25 inches}\ \right] * \frac{\textbf{1 ft}}{\textbf{12 inches}}$$

Notice how inches cancel each other and you are left with feet as the unit of measurement.

$$\textbf{25}\ \cancel{\textbf{inches}} * \left[\frac{\textbf{1 ft}}{\textbf{12}\ \cancel{\textbf{inches}}}\right] \textbf{ = 2.1 feet}$$

Example #3: Convert 500 km into miles.
Step 1: Decide which conversion factor to use.

Since you a trying to convert kilometers to miles, you need a ratio that expresses the same quantity in both kilometers and miles. 1 kilometer and .621 miles represent the same distance. Therefore, when written as a fraction it is equal to 1.

We can write this fraction as

$$\frac{\textbf{1 kilometer}}{\textbf{.621 miles}} \quad \text{or as} \quad \frac{\textbf{.621 miles}}{\textbf{1 kilometer}}$$

Step 2: Multiply the original unit of measurement by the conversion factor.

$$\textbf{500}\ \cancel{\textbf{km}} * \left[\frac{\textbf{.621 miles}}{\textbf{1}\ \cancel{\textbf{km}}}\right] \textbf{ = 310.5 miles}$$

Although this method of unit conversion may seem tedious, it's the best way to avoid making math errors. I highly encourage you to use this method whenever performing unit conversions in this class!!!

One final example, when converting Celsius to Fahrenheit or Fahrenheit to Celsius, insert the given temperature into the equation. If you have Celsius, insert the temperature in place of the C. If you have Fahrenheit, insert the temperature in place of the F. Solve equation.

Example #4: 40° C is what temperature in Fahrenheit?
Step 1: Rewrite equation inserting the temperature in place of the C.

(1.8 *** 40°**) + 32 ° = ° F

Step 2: Solve equation

(72°) + 32° = 104° F **104° F is your answer**

Example #5: 86° F is what temperature in Celsius?
Step 1: Rewrite equation inserting the temperature in place of the F.

(1.8 ***** C°) + 32 ° = **86** °

Step 2: Solve equation

$$C° = \frac{(86° - 32°)}{1.8°}$$ **30° C is your answer**

Exercise 1.3:

Now you try a few conversions using the following conversion factors. Show your work.

English System	Système International
1 foot = 12 inches (in)	1 meter(m)= 100 centimeters (cm) = 1000 millimeters
1 mile (mi) = 5280 feet = 63360 inches	1 kilometer (km)= 1000 meters
1 gallon (gal) = 4 quarts	1 kilometer = 100,000 cm =1,000,000 mm

1. $28 \text{ in} * \left[\frac{\_\_\_\_\_\_\text{ft}}{\text{in}}\right] = \_\_\_\_\_\_\_\_ \text{ft}$

2. 6 km * $\left[\dfrac{\_\_\_\_\_\_\_\_\_\_ m}{km}\right]$ = ____________ meters

3. 16 quarts = __________ gallons

4. 0.25 meters = __________ millimeters

5. 500000 centimeters = ________ kilometers

Practice converting between English System and Système International, using the following conversion factors. Show your work.

<u>Conversion Factors</u>:

1 kilometers (km) = .621 miles(mi)
1 kilograms (kg) = 2.205 pounds (lbs)
1 liter = 1.057 quarts

If given Celsius= (1.8 * °C)+32 ° = ° F

If given Fahrenheit = $\dfrac{(° F - 32°)}{1.8}$ = °C

6. 100 miles * $\left[\dfrac{\_\_\_\_\_\_\_\_ km}{miles}\right]$ = ___________ km

7. 0.5 lbs * $\left[\dfrac{\_\_\_\_\_\_\_\_ kg}{lbs}\right]$ = ____________ kg

8. 4 quarts = ____________ liters

9. 13 ° C = ____________ ° F

10. 20 ° C = ____________ ° F

11. 77 ° F = ____________ °C

12. 50 ° F = ____________ °C

<u>Part 3: Rounding</u>

Your answer cannot be more precise than your inputs. When rounding, look 1 digit to the right of the desired precision.

Example # 1: 1.6877 rounded to one decimal place (nearest tenth)

Step 1: Underline the digit corresponding with the desired precision.

In this case, you are rounding to one decimal place, so underline the 6.

1.<u>6</u>877

Step 2: Look at the digit to the right of the desired precision.

In this example, look at the 8.

Step 3:

If the digit in Step 2 is between 5 – 9 = increase the underlined digit by 1 and drop remaining digits

If the digit in Step 2 is between 0 – 4 = underlined digit remains the same and drop remaining digits

8 is between 5- 9 so, the underlined digit is increased by 1 and the rest of the digits are dropped.

Answer: 1.6877 rounded to one decimal place (nearest tenth)= 1.7

Exercise 1.4:

Round the following numbers to the nearest tenth.

1. 1.3556 = ______________

2. 21.4333 = _____________

Round the following numbers to the nearest hundredth (two decimal places).

3. 3.546 = ______________

4. 24.9312 = _____________

Round the following numbers to the nearest whole number.

5. 24.589 = ______________

6. 12.158 = _____________

Part 4: Identify types of distortion on map projections

Only a globe can accurately display the properties of shape, size, distance, and direction. Once a 3 dimensional surface has been projected onto a 2 dimensional surface some form of distortion will occur. As a map user, you need to determine what property has been distorted and/or preserved based on the map projection. Three common map projections are listed below.

Conformal projections → preserve the property of shape

Hints for determining if a map is conformal:

- Latitude and longitude cross at 90°angles
- Size is distorted. Greenland will appear larger than Africa on this projection.

Equivalent (or equal area) projections → preserve the property of size

Hints for determining if a map is equivalent:

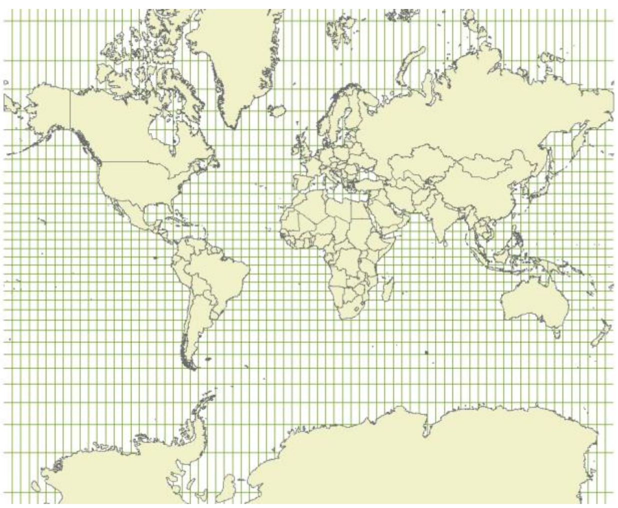
- Size is preserved. Greenland and Mexico are approximately the same size on a globe and will look similar in size on this projection.
- South American and African countries may look elongated.

Compromise projections → seek to minimize overall distortion, but do not preserve any of the properties.

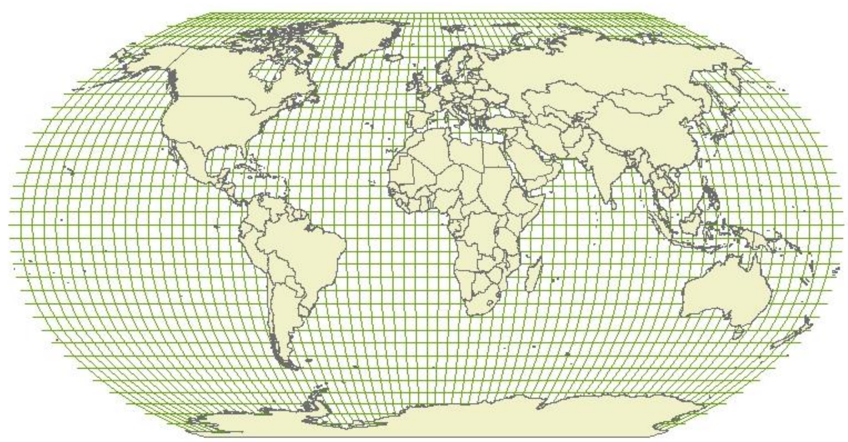
Hints for determining if a map is a compromise projection:

- The map does not fit perfectly into the other two categories.

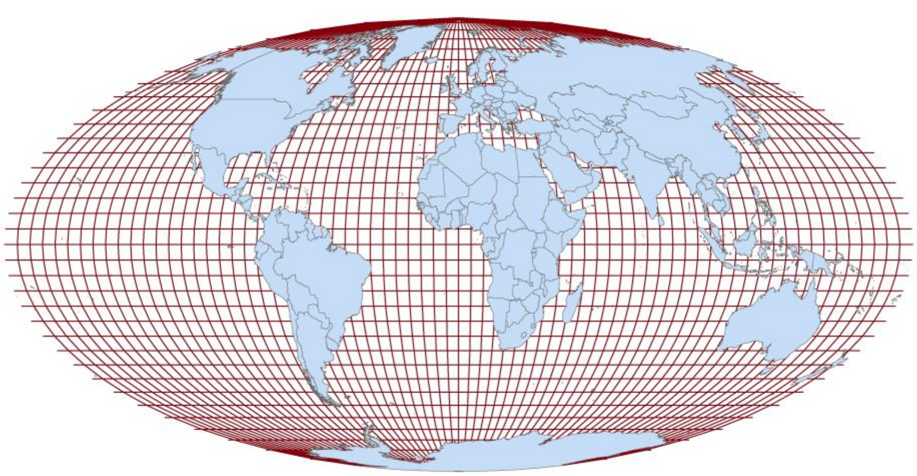
Map A



Map B



Map C



Exercise 1.5:
Small scale map projections cannot preserve both shape and size. Analyze the maps on the previous page and answer the following questions.

1. Map A is most likely which type of projection? Explain your reasoning.

2. Map B is most likely which type of projection? Explain your reasoning.

3. Map C is most likely which type of projection? Explain your reasoning.

4. Out of the three types of projections (Conformal, Equivalent (or equal area) or Compromise), which projection would be the best for measuring the extent of a Tropical Rainforest? Explain your reasoning.

5. Out of the three types of projections (Conformal, Equivalent (or equal area) or Compromise), which projection would be the best for a general reference world map? Explain your reasoning.

Exercise 1.6:
Explore how much conformal maps can distort size by visiting TheTrueSize.com website and answering the following questions.

1. Which is bigger Russia or the continent of Africa?

2. Which is bigger Poland or Kenya?

3. Which is bigger Alaska or Brazil?