

Lab 2: Measurements and the Metric System

The word measure means to determine the size, capacity, extent, volume, or quantity of anything, especially as determined by comparison with some standard or unit. To measure something you need a standard system of units and a device to measure it. Science uses the metric system, the newest version is called the Systeme International d'Unites (SI)

A. Introduction:

The metric system is the measurement system used by scientists and used in everyday life in almost every other country in the world except in the United States. Most of the measurements in the United States use the English system of pounds, inches, and ounces. England abandoned the old fashion method long ago. The basic units of measurements include: meter (length); liter (volume); gram (weight); second (time) and Celsius or Kelvin (temperature). The metric system is based on units of ten. Below is a table with the units of the metric system. For example, there are 1,000 meters in a kilometer.

Table 2 Prefixes				
Symbol	Prefix	Power of Ten	Ordinary Notation	U.S. Name
Y	yotta	10^{24}	1 000 000 000 000 000 000 000 000	
Z	zetta	10^{21}	1 000 000 000 000 000 000 000	
E	exa	10^{18}	1 000 000 000 000 000 000	
P	peta	10^{15}	1 000 000 000 000 000	
T	tera	10^{12}	1 000 000 000 000	trillion
G	giga	10^9	1 000 000 000	billion
M	mega	10^6	1 000 000	million
k	kilo	10^3	1 000	thousand
h	hecto*	10^2		100 hundred
da	deka*	10^1		10 ten
		10^0		1 one
d	deci*	10^{-1}	0.1	tenth
c	centi*	10^{-2}	0.01	hundredth
m	milli	10^{-3}	0.001	thousandth
μ	micro	10^{-6}	0.000 001	millionth
n	nano	10^{-9}	0.000 000 001	billionth
p	pico	10^{-12}	0.000 000 000 001	trillionth
f	femto	10^{-15}	0.000 000 000 000 001	
a	atto	10^{-18}	0.000 000 000 000 000 001	
z	zepto	10^{-21}	0.000 000 000 000 000 000 001	
y	yocto	10^{-24}	0.000 000 000 000 000 000 000 001	

Reference: US Metric Association

B. Unit Conversion

When you need to convert from one unit to a different unit you need to multiply by a conversion factor.

Example 1: There are one thousand milliseconds in one second, so if you are asked to convert 0.001 seconds into milliseconds you would:

Make sure the units you are converting from always cancel out so all you are left with are the units that you are converting to.

Example 2: If you have 0.0100 grams, how many milligrams is this?

D. Relationship between English and Metric Units

Length		Volume		Mass	
English	Metric	English	Metric	English	Metric
1 in	2.54 cm	1 ft ³	28.32 L	1 lb	453.59 g
39.37 in	1 m	1.057 qt	1 L	1 oz	28.35 g
1 mile	1.609 km	1 gal	3.7853 L	1 dram	1.772 g

To convert from the English system to the metric or visa versa use the same method as you used above.

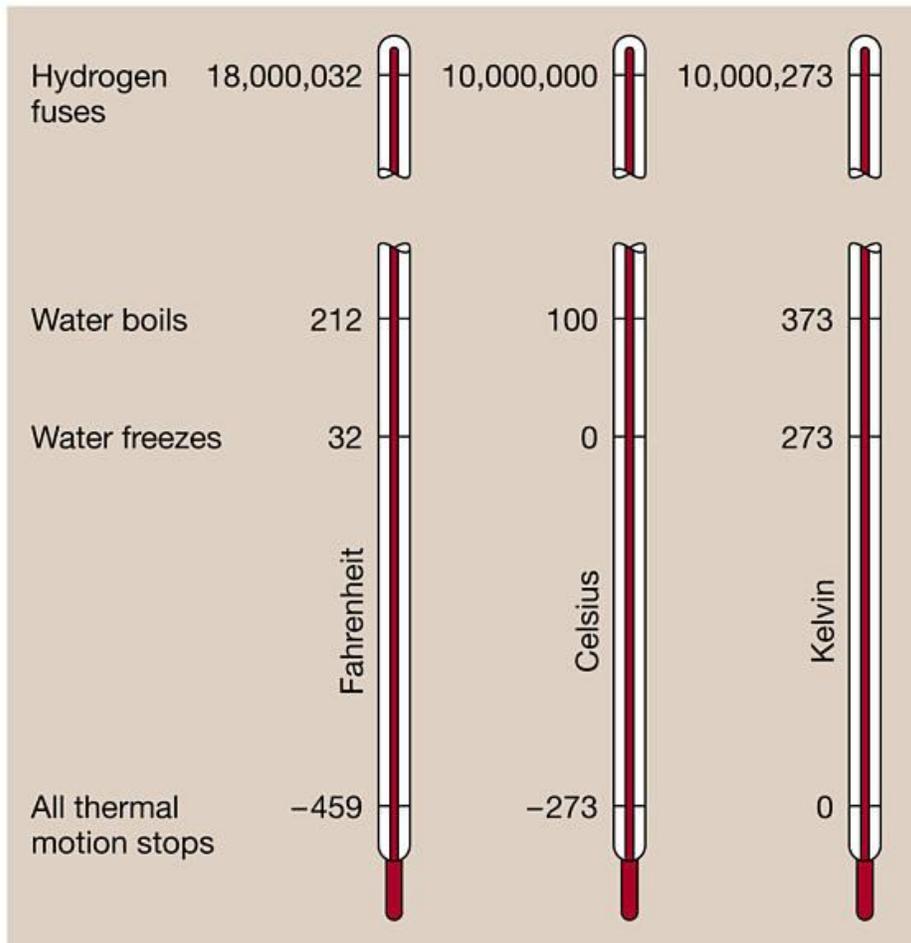
Example: Your friend asks you if you want to run a 10 km race, how many miles would you be running?

E. Temperature

Scientists use either the Celsius or the Kelvin scale. The Fahrenheit scale is used commonly in non-science settings in the United States. Both Celsius and Fahrenheit scales use degrees as units, the Kelvin scale units are called kelvins. The conversion factor for degrees F and C is: $9^{\circ}\text{F} = 5^{\circ}\text{C}$. Water freezes at 0°C or 32°F or 273 kelvins.

$$\text{K} = ^{\circ}\text{C} + 273$$

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 9^{\circ}\text{F}/5^{\circ}\text{C}) + 32$$

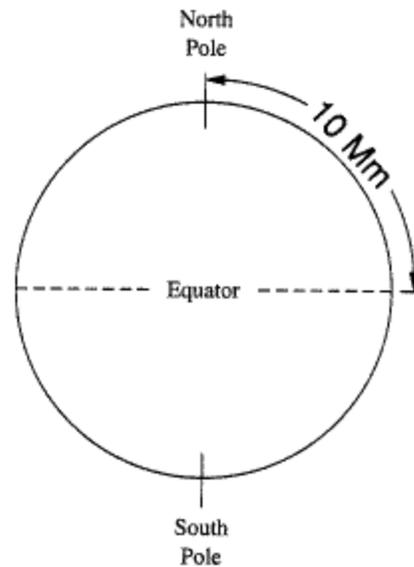
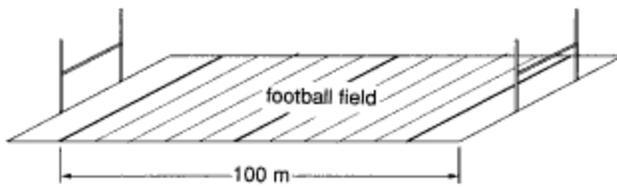
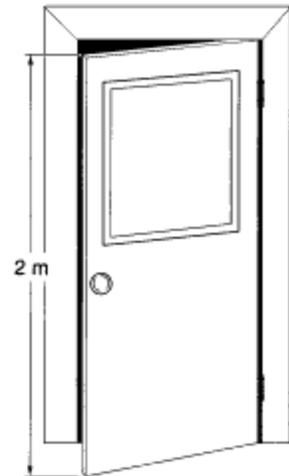
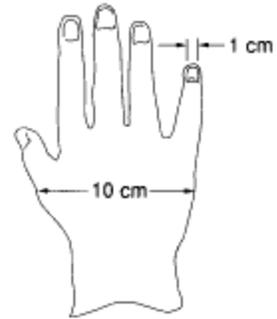


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Example: It is 60°F outside, what is the temp in $^{\circ}\text{C}$?

The basic unit of measurement for distance is the meter. Below are examples of distances using the metric system.

Multiples of meter EXAMPLES	
Ym	the universe
Zm	galaxies
Em	farther stars
Pm	nearer stars
Tm	solar system
Gm	star diameters
Mm	planets
km	cities
m	arm's length
mm	dime thickness
μm	bacteria
nm	viruses
pm	atoms
fm	protons, neutrons



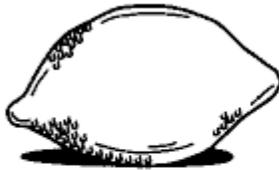
Weights

The basic unit of measurement for weight is the gram. Below are examples of weights using the metric system.

- Grain of sand
1 mg



Nickel (5¢)
5 g



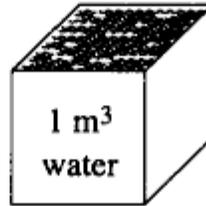
Lemon
100 g



Liter of water
1 kg



Human adult
50 to 100 kg



Cubic meter of water
1 Mg (metric ton)

Procedure 1: Measuring length using the metric system

Step 1: Using the metric rulers, measure following items.

Step 2: Record the length in the space provided below.

Length of binder paper (cm)	
Length of binder paper (mm)	
Width of binder paper (cm)	
Width of binder paper (mm)	
Width of your outstretched hand (cm)	
Width of your outstretched hand (m)	
Length of your pencil (cm)	
Length of your pencil (mm)	
Width of lab bench (cm)	
Width of lab bench (m)	
Length of your shoe (cm)	
Length of your shoe (m)	

Procedure 2: Measuring weights using the metric system

Step 1: First estimate the weight of the object you are given, record the estimated weight in the table below.

Step 2: Using the triple beam balance, measure the following items and record their weights below, remember to include units.

Step 2: Weigh the empty weigh boat, record the weight below.

Step 3: Using the pipet, add 1 mL of water to the weigh boat. Note: The instructor will show you how to use the pipets

Step 4: Weigh the weigh boat with the 1 mL of water, record the weight below.

Object	Estimate weight (g)	Actual Weight (g)	Actual Weight (kg)
Paper clip			
Pencil			
Tennis ball			
Metal weight			
Empty weigh boat			
Weigh boat + 1 mL water			
1 mL water			

Procedure 3: Measuring volumes

Step 1: First estimate the number of drops of water are in 1 ml of water. Record your guess in the table below

Step 2: Fill the graduated cylinder to the 1 ml line using a disposable dropper pipette, counting the drops.

Step 3: Record the number of drops in the table below.

Step 4: Keep adding drops of water to the 2 ml line, record number below

Step 5: Keep adding drops of water to the 3 ml line, record number below

Step 6: Take the average of the three measurements

Est # drops	Counted # drops	Counted # drops	Counted # drops	Avg

Procedure 4: Measuring temperature

Step 1: Using the Celsius thermometer, measure the temperature of the room and the water baths

Step 2: Record the temperature below in Celsius, Then calculate the temp in Fahrenheit and Kelvin.

	Celsius	Fahrenheit	Kelvin
Room Temp			
Water bath A (ice)			
Water bath B (boiling)			