Scientific Measurement

Physical Science

SI System Facts

- **SI** is French for **Systeme International**

- The U.S. is the only country which does not use the SI system as a standard system of measurement because it is too costly to change over

- **Standard** – is an exact quantity used for comparison

- The U.S. uses the older dated **English System of Measurement**
  - Hands, feet, inches, rods, gills, firkin, gallons, Bushel

SI System

- With U.S. English system we have:
  - Miles – long distances
  - Feet – medium range distances
  - Inches – short distances

Base SI Units

❖ *Le Systéme Internationale* (SI) units are standard in science

Quantity	Base Unit	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
temperature	kelvin	K

- Each type of SI measurement as a specific base unit
- SI System based on multiples of ten
  - Meaning each unit is **10 times larger** than the next
  - In the SI system all length is measured in some type of meter
    - Kilometer (km) – long distances
    - Meter (m) – medium range distances
    - Centimeter (cm) – short distances

SI System – Base Units

- To make larger and smaller measurements in the SI system you add a prefix to the base unit

- Same prefixes are used on all base units
  - Kilo, centi, milli etc….

Prefix	Unit Abbr.	Value
Kilo	k	1000
hecto	h	100
deka	da	10
meter gram liter	m g l	1
deci	d	.1 or 1/10
cent	c	.01 or 1/100
milli	m	.001 or 1/1000

SI Measurements

- There are 6 different types of measurements we will be making involving the SI system

Measurement	Base Unit
Length	Meter (m)
Mass	Gram (g)
Volume	Liter (L)
Density	g/mL or g/cm^3
Time	Seconds (s)
Temperature	C and Kelvin (K)

Converting SI Units

Three steps to problems:
Step 1: State the given quantity (number and units) and unknown
Step 2: Indicate Ratio (s)
Step 3: Start with what you know

How many centimeters are in 5 m?

      Larger   **Smaller**
Step 1:   5 m   =   ? cm

Step 2: Indicate Ratio
     1 m = 100 cm

   (1 m)   or   (100cm)
  (100 cm)   (1 m)

Step 3: Start with what you know

Prefix	Factor	Abbr	Ratio example
kilo	1,000	K	1Kg = 1000 g
hecto	100	h	1 hg=100g
deka	10	da	1 dag = 10 g
suffix or base = 1			meter, liter, gram
deci	.1	d	1 g = 10 dg
centi	.01	c	1 g = 100 cg
milli	.001	m	1 g = 1000 mg

$$\frac{(5m)}{1} \quad \frac{(100cm)}{(1m)} = 500cm$$

SI Measurement: Length

- Base unit - Meter
- Instrument (tool) – meter stick or ruler
- Unit used in labs - centimeters
- Steps for using a meter stick
  1. Write down the whole number that the object stretches up to or past
  2. If the object does not end exactly on a whole number, write a decimal point after the whole number
  3. Count the number of little lines the object stretches past the whole number and record this after the decimal point
  4. If the object ends between two lines add a 5
 5. Always label your answers in centimeters

SI measurement: Volume

- Base unit:
  - Liquids: Liter (L)
  - Solids: cm^3
    - Volume = length x width x height

- Instrument (tool):
  - Liquids: Graduated cylinder
    - Read at eye level
    - Read Bottom of meniscus
  - Solids: meter stick or ruler

- Unit used in labs
  - Liquids: mL
  - Solids: cm^3

Meniscus
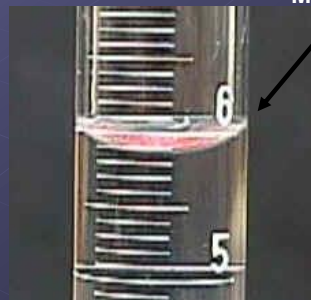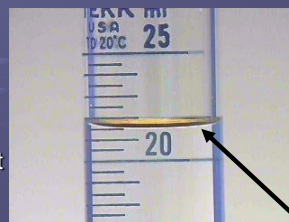
SI measurement: Density

- Base unit:
    - Liquids: g/mL
    - Solids: g/cm^3

- Instrument (tool):
    - Scale, metric ruler or graduate cylinder
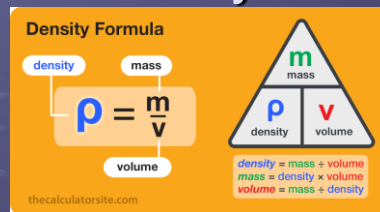
Calculating Density

1. Measure the mass of object in grams (g) on a scale
2. Measure the volume of object
    - Liquids - use a graduated cylinder (mL)
    - Solid - use a metric ruler (cm^3) (Volume = length x width x height)
    - Irregular solids – water displacement method
3. Solve for density by diving the mass by the volume and label your answer in either g/cm^3 for solids or g/mL for liquids

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Density: Water Displacement method

- Since both irregular shaped objects and water have the same volume, we can immerse objects in water and the water will rise an amount equal to the volume of the object. This happens because two materials which have volume cannot occupy the same space.

    Example: When a person jumps into a bathtub full of water, the water overflows the edges of the tub.

Steps for Water Displacement Method

1. Fill a graduate with enough water to cover the object. (Write down this measurement in mL)
2. Tilt the graduate and slide the object into the cylinder to avoid breakage.
3. The water level will rise (Record this new water level in mL)
4. Subtract the original water level from the final water level and record.
5. Change this number's units from mL to cm^3 since the object is solid

$$1 \text{ mL} = 1 \text{ cm}^3$$