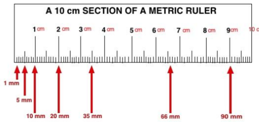
Scientific Measurements & Conversions

Length, Mass, Volume, Density, Temperature, and Time

Length

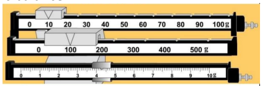
- Length measures the distance from end to end on an object; height and width are variations on length.
- **<u>Standard (S.I.) Unit</u>**: **meter (m)**
- Common units for this course: **centimeter (cm)**
- Tool: ruler, meter stick
- How to read a metric ruler:



The arrows indicate specific mm locations.

Mass

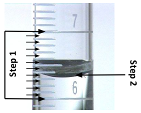
- Mass measures the amount of matter (particles) in an object. It is similar to weight but does not change as gravity changes. For example, if you go to the moon, you will weigh less but your mass is that same (you didn't lose any body parts!).
- **<u>Standard (S.I.) Unit:</u> kilogram (kg)**
- Common units for this course: **gram (g)**
- Tool: triple beam balance, electronic balance



➢ **Mass = 100 + 10 + 4.3 = <u>114.3</u>**

Volume of a Liquid

- Volume measures the amount of space an object occupies.
- **<u>Standard (S.I.) Unit</u>**: **liter (L)**
- Common units for this course: **milliliter (mL)**
- Tool: graduated cylinder
- How to read a graduated cylinder:



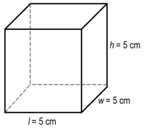
Step 1: Determine the scale of the cylinder

- Subtract the values of any two labelled graduations and divide by the number of intervals between them. Here subtract 6 from 7 (answer = 1) and count that there 10 graduations between the 6 and 7 labelled graduations. One graduation therefore = 1/10 mL, or simply 0.1 mL.

Step 2: Determine the volume of liquid in the cylinder

- Get eye-level with the bottom of the meniscus (curve) of the liquid. Then use the scale to determine the volume, much like using a ruler. Here the meniscus is at 6.3 mL.

Volume of a Regular Solid



- Volume measures the amount of space an object occupies.
- **<u>Standard (S.I.) Unit</u>**: **cubic meter** (m^3)
- Common units for this course: **cubic centimeter** (cm^3)
- Tool: ruler and calculator
- How to calculate the volume of a regular solid:

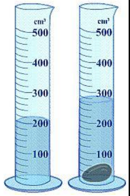
Volume (V) = 5cm × 5cm × 5cm = 125 cm^3

Step 1: Measure the length, width, and height of the regular solid using the same unit for all three (cm, m, etc.) .

Step 2: Use the following formula: L x W x H = Volume

Step 3: Check the units—it must be written as the cube of the same unit as the length, width, and height (cm^3, m^3, etc.).

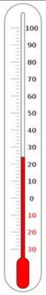
Volume of an Irregular Solid



- Volume measures the amount of space an object occupies. Irregular solids do not have a rectangular shape, so a ruler cannot be used. The technique used instead is called **<u>Water Displacement.</u>**
- **<u>Standard (S.I.) Unit</u>**: **cubic meter** (m^3)
- Common units for this course: **cubic centimeter** (cm^3)
- Tool: graduated cylinder and calculator
- How to use Water Displacement

Add the object to a graduated cylinder of water. Calculate the rise in the water level. The units should be cm^3 since the object is a solid (1 mL = 1 cm^3).

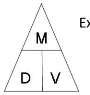
Temperature



- Temperature measures the energy contained within a substance.
- **<u>Standard (S.I.) Unit</u>: Kelvin** Abbreviation: **K**
- Common units for this course: **Degrees Celcius** Abbreviation: **°C**
- Tool: thermometer
- How to read a thermometer:
- Step 1: Determine the scale of the thermometer
  - Subtract the values of any two labelled graduations and divide by the number of intervals between them. Here 60 - 50 = 10 then divided by 5 = 2. So each mark is worth 2°C.
- Step 2: Determine the level of the thermometer fluid, much like reading a ruler. (Here it is 24°C)

Density

- Density measures the ratio of mass to volume for an object. Density must be calculated; it cannot be measured directly; density is the same for all parts of a single object.
- **<u>Liquid Standard (S.I.) Unit</u>: grams per milliliter** Abbreviation: **g/mL**
- **<u>Solid Standard (S.I.) Unit</u>: grams per cubic centimeter** Abbreviation: **g/cm^3**
- Tool: calculator
- How to calculate density: **Density = mass ÷ volume** **or** **$D = \frac{m}{V}$**



Example: If a block has a mass of 5 g and a volume of 10 cm^3, then density is 5 g ÷ 10 cm^3 or 0.5 g/cm^3.

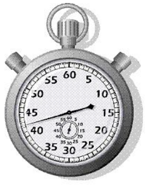
Density Problems

1. What is the density of a piece of wood that has a mass of 25.0 grams and a volume of 29.4 cm^3?

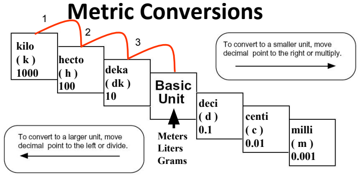
2. Mercury metal is poured into a graduated cylinder that holds exactly 22.5 mL of the liquid. The mercury used to fill the cylinder weighs 306.0 g. From this information, calculate the density of mercury.

Time

- **<u>Standard (S.I.) Unit</u>: second** Abbreviation: **s** or **sec**
- Tool: clock, stop watch



Metric Conversions



How do you use the "ladder" method?

1st – Determine your starting point

2nd – Count the "jumps" to your ending point

3rd – Move decimal same number of jumps in same direction

4 km = _________ m

Starting Point Ending Point

How many jumps does it take?

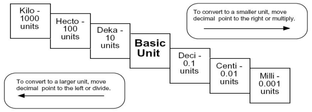
4. _ . _ . _ . km = 4000 m

1 2 3

Conversion Practice

Kangaroos
Hopped
Down
Bumpy
Driveways
Crushing
Millipedes

Kings
Hate
Dragons
Because
Dragons
Cause
Madness



Try these conversions using the "ladder" method

1000 mg = ___ g   1 L = ___ mL   160 cm = ___ mm

14 km = ___ m   109 g = ___ kg   250 m = ___ km

Compare using <, >, or =

56 cm ◯ 6 m   7 g ◯ 698 mg

Metric Conversions w/ Dimensional Analysis

1 Mega = 10^6
1 kilo = 1000
1 hecto = 100
1 deca = 10
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1 deci = .1
1 centi = .01
1 milli = .001
1 micro = 10^{-6}
1 nano = 10^{-9}
1 pico = 10^{-12}

multiply

Given Value	New Unit Equivalent
	Old Unit Equivalent

divide

CONVERSION FACTOR

Conversion Factors allow us to change from one unit to another.

Example: Convert 4000 cm = _______ m

$$\frac{4000\ \cancel{cm}}{} \times \boxed{\frac{.01\ m}{1\ \cancel{cm}}} = 40\ m$$

Conversions Practice

- Convert the following using Dimensional Analysis. SHOW ALL WORK.
- 45 inches = _______ cm = _______ m
- 60,000 sec = _______ min = _______ days
- 120 lbs = ________ kg = _______ g

CONVERSION FACTORS:
1 inch = 2.54 cm
1 kg = 2.2 lbs