Scientific Method

Basic Steps

Definition

- Scientific method: basic steps that scientists follow in order to investigate a natural occurrence.

Steps of Scientific Method

- State the problem or ask a question
- Gather information through observations or research and develop a hypothesis
- Perform an experiment to see whether the suggested answer makes sense
- Record and analyzing the results of experiments or other observations
- State conclusions
- Share results

Stating the Problem

- Develop a question or problem that can be solved through experimentation.
  - What invisible trail does a rattlesnake follow in tracking down its bitten prey?

Gathering Information

- Make observations and research your topic of interest.
  - A rattlesnakes eyes are only sensitive to visible light
  - A pair of organs located under the eyes detect invisible light in the form of heat
  - A rattler's tongue "smells" certain odors in the air
  - The sight or smell of an unbitten animal does not trigger the rattler's tracking action

Hypothesis

- Predict a possible answer to the problem or question. This should be testable.
  - After the snake wounds its victim, the snake follows the smell of its own venom to locate the animal

Experiment

- Develop and follow a procedure. Include a detailed materials list. The outcome must be measurable (quantifiable).
  - Experiment: Drag a dead mouse that has been struck and poisoned by a rattlesnake along a curved path on the bottom of an empty cage. Place the snake in the cage and observe the snake's behavior.
  - Control: Drag an unbitten dead mouse along the path. Place the snake in the cage and observe the snake's behavior.

Recording and Analyzing Data

- Collect and record the data and analyze results.
  - Modify the procedure if needed.
  - Confirm the results by retesting.
  - Include tables, graphs, and photographs. Do the experiment many times

Conclusion

- Make a statement that accepts or rejects the hypothesis. Make recommendations for further study and possible improvements to the procedure.
  - The scent of venom was the only factor that could cause a rattlesnake to follow its bitten victim.

Communicate the Results

- Compile the data and results of your experiment in a lab report, or some other presentation format.
  - Be prepared to present the project to an audience.
  - Expect questions from the audience.

Factors in an experiment

Controls and variables

Variables in experiments

- Experiments demand control. If more than one variable changes at a time, the cause and effect is unclear.

Experimental Variable

- The variable that you are studying (changing) in and experiment. It is the only variable that should differ from trial to trial.
- This factor is called either the manipulated variable or the independent variable.

Control

- The variables that you control (don't change) in an experiment. The control variables are all other variables than the experimental variable.
  - If you are running multiple trials, you will want to keep all factors the same from trial to trial except for the thing that you are testing.

experimental results

- The change that is caused by the experimental variable is called the dependent variable or the responding variable.

Example

- You want to know how speed affects gas mileage. Speed is the only variable that should change. The car, tires, road, and wind speed should stay the same. If any of these things differ from trial to trial, then you cannot be certain that the speed caused the difference in gas mileage.
  - What is the manipulated variable?

    the speed of the car
  - What is(are) the controlled variables?

    the car, tires, road, and wind speed/direction.
  - What is the responding variable?

    the gas mileage

Graphing Experimental Data

DRY MIX

DRY MIX

D - dependent variable

R - responding variable

Y - y axis

M – manipulated variable

I – independent variable

X – x axis

graphing

- The experimental variable is graphed on the x-axis (the bottom of the graph)
- The responding data is graphed on the y-axis (the vertical axis)

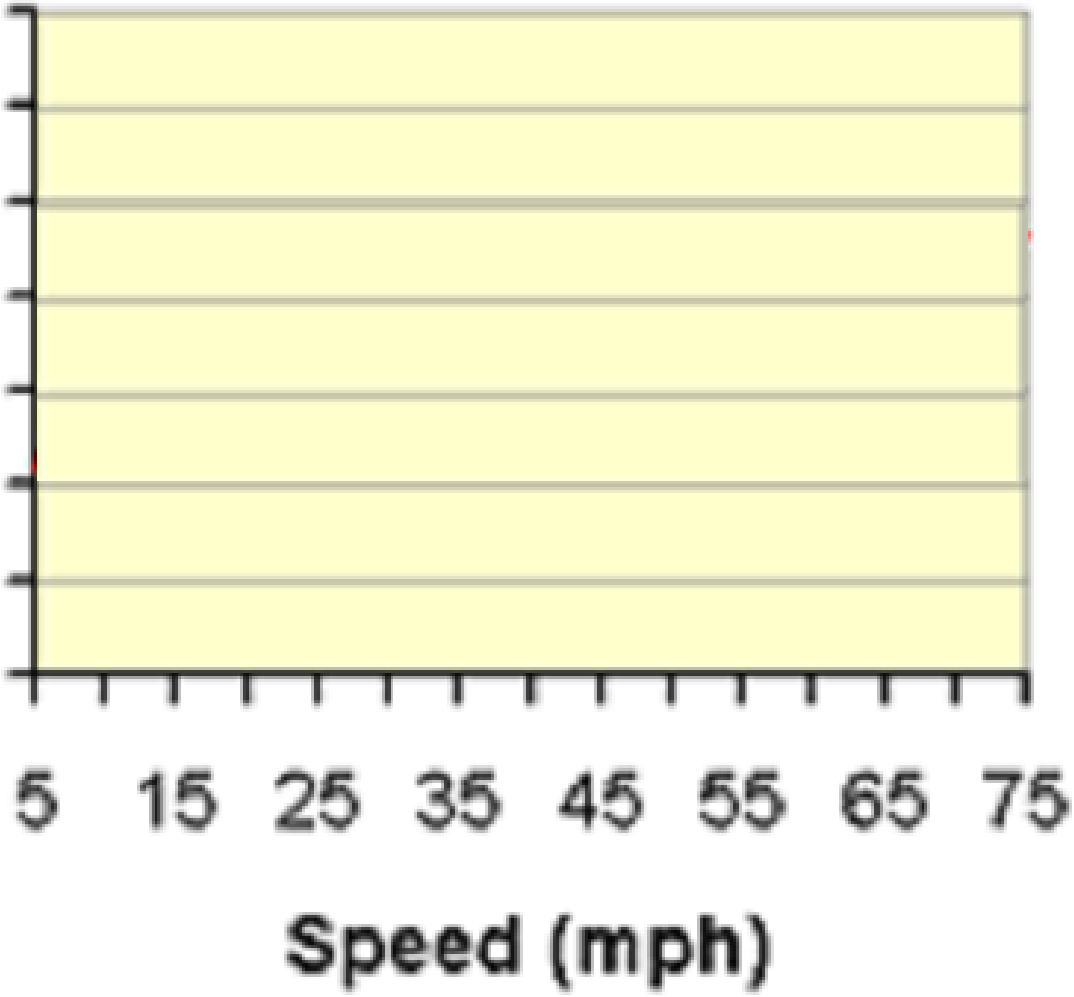
Example

Car speed	Fuel efficiency
5	10 mpg
15	23 mpg
25	28 mpg
35	29 mpg
45	30 mpg
55	31 mpg
65	28 mpg
75	24 mpg

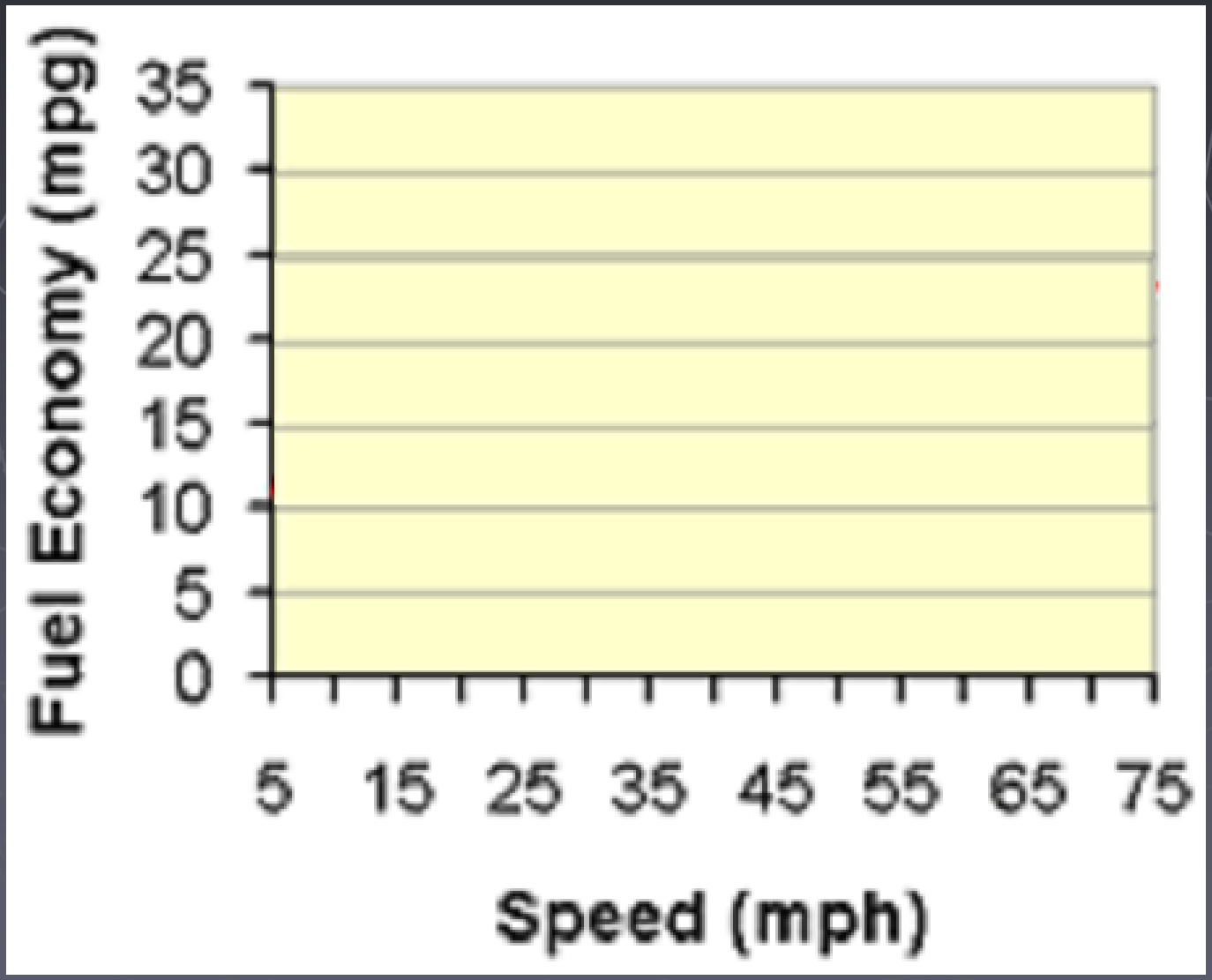
What goes where?

- Remember DRY MIX
- What is your Manipulated Variable?
- Where should you graph it?
- What is your Responding Variable?
- Where should you graph it?

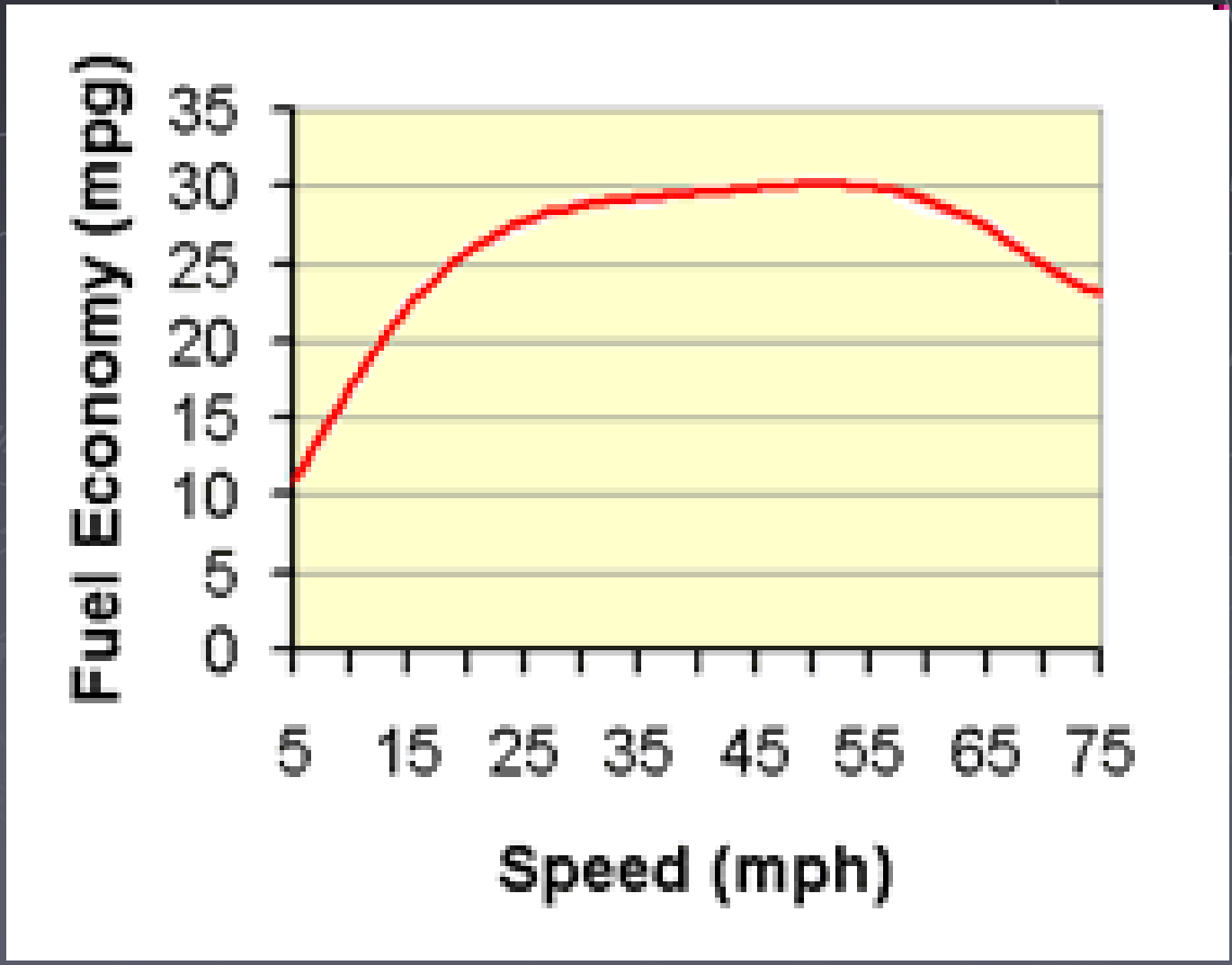
What is your Manipulated Variable? Where should you graph it?



What is your Responding Variable?
Where should you graph it?



Plot the data



The Metric System

SI units

Metric history

Before the eighteenth century, there were many units of measurement. The lack of common standards led to a lot of confusion and significant inefficiencies in trade between countries.

- Example: length could be measured in feet, inches, miles, spans, cubits, hands, furlongs, palms, rods, chains, leagues, and more

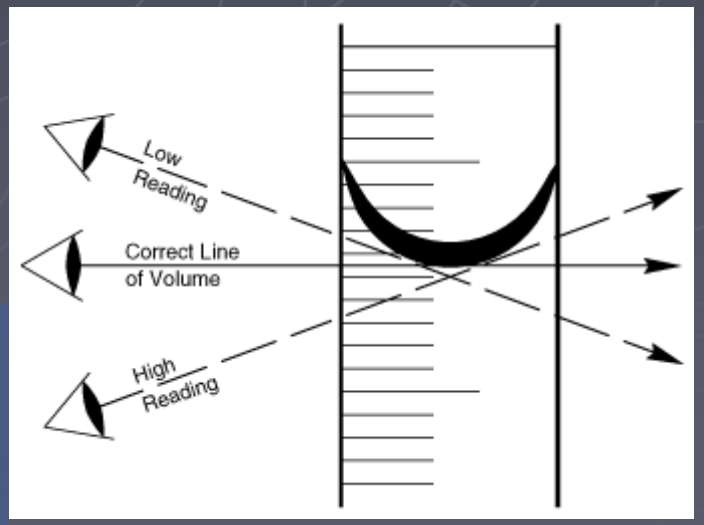
- The metric system, also known as the Système International d'Unités (SI), was developed in the late 1700s to standardize units of measurement in Europe.
- The metric system is almost always used in scientific measurement.

Metric System Units

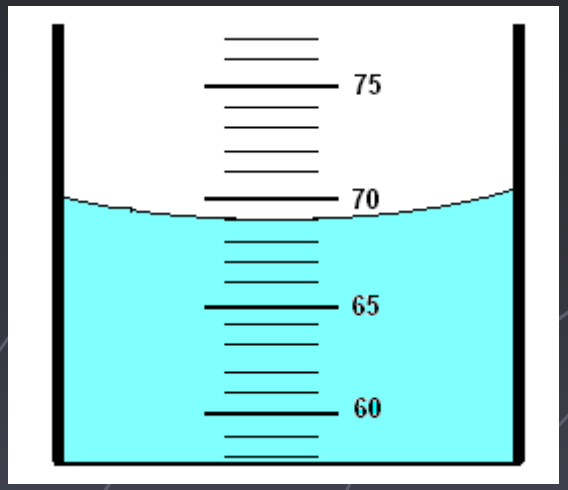
- There is only one unit of measurement (or base unit) for each type of measurement.
- The three base units in the metric system are:
  - Length – meter
  - Volume - liter
  - Mass – gram

Measuring liquids

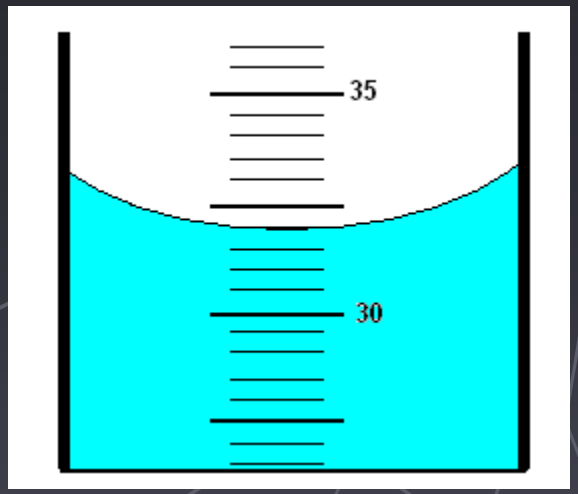
- Liquids cling o the edges of glass containers, causing a curved surface. This curvature is called the meniscus. You measure the level at the horizontal center or inside part of the meniscus



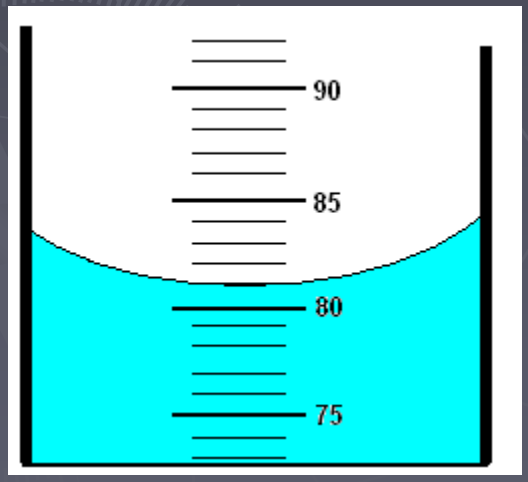
- 1 mL = 20 drops (eyedropper)
- 1 L = ½ of a 2 liter soda
- 1 ml = 1 cm^3



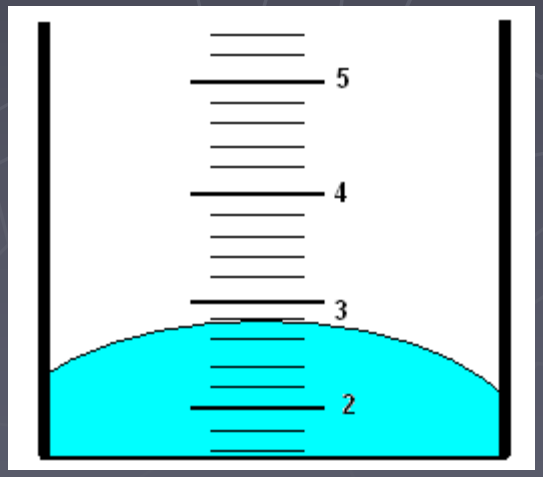
67 mL



32.0 mL



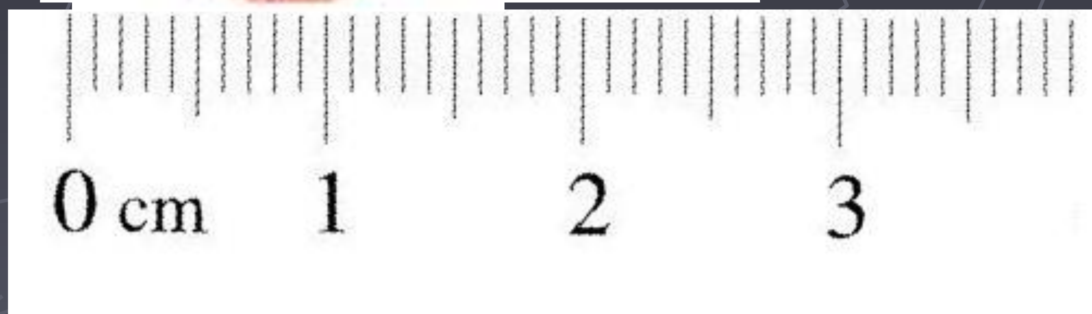
81mL



2.8 mL

Measuring length

- Metric rulers are easy to read. They deal with centimeters and millimeters only so You wont have figure out fractions.
- The larger lines with numbers are centimeters, and the smaller lines are millimeters. Since millimeters are 1/10th of a centimeter, if you measure 7 marks after a centimeter, it is 1.7 centimeters long.
- Be sure that you begin measuring from the beginning of the ruler markings.



1.7cm

23mm

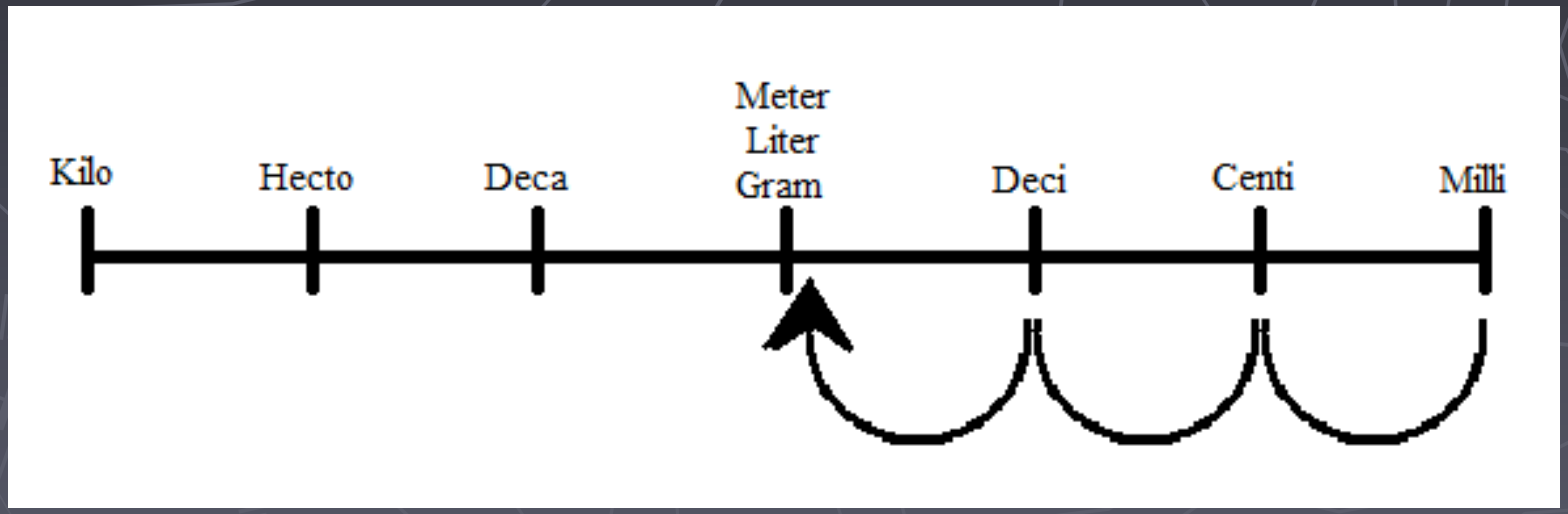
Metric sub-units

- The metric system is a decimal-based system based on multiples of ten.
- The subunits are used when measuring very large or very small things.
- Any measurement given in one metric unit can be converted to another metric unit simply by moving the decimal place.

Converting Metric Units

- If you are converting from a smaller to a larger unit, move the decimal place to the left in the number you are converting.
- If you are converting from a larger to a smaller unit, move the decimal to the right.
- The number of places you move the decimal corresponds to the number of rows you are crossing in the table.

- Example: someone says that that you have to walk 8,939.0 millimeters to get to the grocery store. Is this a long walk?



8939.0 mm = 8.939 m

Quick Assessment

- What is the basic unit of mass? grams
- What is the basic unit of volume? liters
- What is the basic unit of length? meters
- The metric systems is based on units of: ten
- Measurements can be converted from one unit to another by:

moving the decimal the appropriate number of spaces to the right or left