Chapter 2.2
Measurement

- Standard: an exact quantity that people use to make measurements
  - Good Example: a meter stick (everyone one knows the length of a meter)
  - Bad Example: Ms. Pluchino's foot (everyone does not know how big my foot is—not a good comparison)

- Unit: a standard of measurement

- Accuracy of Measurement: how close your measured value is to the actual measurement

- Precision : refers to how closely individual measurements agree with the actual measurement.

- **Metric System** (or International System of Units (SI)): (or International System of Units (SI)): the modern system agreed upon around the world. Founded in 1795.

- Some Common Metric Prefixes:
- kilo- (k) = 1000 (to measure: very large objects)
- deci- (d) = 0.1 or 1/10
- centi- (c) = 0.01 or 1/100 (small objects)
- milli- (m) = 0.001 or 1/1000 (tiny objects)

- significant figures: used to determine how many numbers are important in your measurements.

- Why use significant figures?
  - It is important to be honest when reporting a measurement, so that it does not appear to be more accurate than the equipment used to make the measurement allows. We can achieve this by controlling the number of digits, or **significant figures**, used to report the measurement.

- If I quickly measure the width of a piece of notebook paper, I might get 220 mm (2 significant figures).

- If I am more precise, I might get 216 mm (3 significant figures).

- An even more precise measurement would be 215.6 mm (4 significant figures).

Rules for Working with Significant Figures:

- **Leading zeros** are never significant. **Captive zeros (**zeros that fall *between* nonzero digits) are always significant.

- **Trailing zeros (**at the *right end* of the number or to the right of a nonzero digit) are significant only if the decimal point is specified.

  Hint: Change the number to scientific notation. It is easier to see.

- ex. 0.0**53** has 2 sig.fig.
  50.037 has 5
  5000.0 has 5
  10.01 has 4
  72.60 has 4
  0.698 has 3
  0.00590 has 3

- ex. 7200 has 2
  10 has 1
  2040 has 3
  506 has 3
  4000 has 1
  25 has 2

- When calculating with significant figures you must round off to the LEAST number of significant figures.

- **For Multiplication and Division**: the number of significant figures in the result is the same as that in the measurement with the *smallest number* of significant figures. We say this measurement is *limiting,* because it limits the number of significant figures in the result. For example, consider this calculation:

- 4.56 X 1.4 = 6.384 is rounded off to 6.4 because 1.4 has two sig figs so your answer is limited to 2 sig figs.

- **For Addition or Subtraction**, the limiting term is the one with the smallest number of decimal places. For example, consider the following sum:

- 12.11 + 18.0 + 1.013 = 31.123 which is rounded off to 31.1 because it is limited to one decimal place because 18.0 has only one decimal place.

- Consider another example:
- 0.6875 – 0.1 = 0.5875 which you round off to 0.6 because 0.1 is the limiting term as it has only one decimal place.

- ex. What is the area of a rectangle whose length is 1.23 cm and width is 5.1cm?

- # of significant figures:
  - L = 1.23➔ ___
  - w = 5.1 ➔ ___

Formula:	Equation:	Raw Answer:	Rounded with Sig Figs:

- The number of significant figures can only be 2 due to the width only having 2 sig. fig.

- **length**: measures distance.
- SI unit: **meter** (m)
- 1m = 100cm = 1000mm 1m = 39.4 inches
- 1km = 1000m
- instrument: ruler/meter stick
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- **Light-year**: the distance light travels in one year = 300,000 km per second or
- = 9.5 trillion km.

- **time**: interval between two events.
- SI unit: **seconds** (s)
- instrument: stop watch or clock

- **weight**: the amount of attraction between 2 objects due to gravity.
- SI unit: _____ (N)
- (1N = 1 medium apple)
- instrument: scale

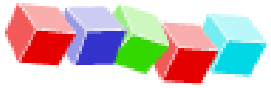
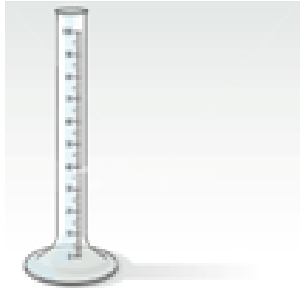
- **mass**: the amount of matter in an object.
  - SI unit: **kilogram** (kg)
  - 1kg = 2.205 lbs.
  - 1kg = 1000g
  - 1g = 1000mg

- instrument: **balance**

- (p. 800 in text, label parts of balance, copy 5 steps into notes.)

	1.
	2.
	3.
	4.
	5.

- **volume**: amount of space an object takes up.
  - SI unit: liter (L)
  - 1L = 1000mL = 1000cm^3
  - instrument: graduated cylinder or ruler

Object	Instrument used	Unit
Regular solid 	ruler V = L * w * h	cm^3
liquid and irregular shaped objects 	graduated cylinder (g.c.) 	mL

Water displacement

Follow steps on next page

- **Regular solid volume**: calculate by multiplying
- $V = L \bullet w \bullet h$ or put in water and measure the displacement.
-
- **liquid & irregular solid volume**: measure using water displacement and a graduated cylinder (g.c.).
- Steps:
- Put enough water in g.c. to cover the object.
- Record amount of water by reading the meniscus.
- Tilt g.c. slightly and gently slide object in g.c.
- Record amount of water and object by reading the meniscus.
- Subtract the first reading from the second to get the volume of the object.

- **meniscus**: curved surface of a liquid. To read the proper amount of the liquid, you must read the bottom of the curve if curved down.

- **temperature**: measure of energy.
  - SI units: **Celsius (°C) or kelvin (K)**; we use Celsius because it's based on the freezing and boiling points of water.
  - instrument: thermometer

Measurement	Fahrenheit Scale	Celsius Scale
Boling Water 	212°F	100°C
Freezing Water 	32°F	0°C

- **density**: a relationship between an object's mass and volume
-
- formula: $d = \frac{m}{v}$

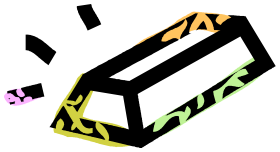
  units for a solid: g/cm^3

  units for a solid: g/mL

  (Remember: $1mL = 1cm^3$)

- The density of a material does not depend on how much of it you have. Depends on what it's made out of.

Aluminum



Gold

- Ex: A liquid has a **mass of 55 grams** and a **volume of 5 mL**. What is the density of the object?

Formula:	Equation (substitution):	Answer with units:
$D = \frac{m}{v}$	$D = \frac{55g}{5mL}$	$D = 11g/mL$

- **dimensional analysis** (also known as the factor-label method): a method used to convert from one unit of measurement to another

- conversion factor : used in dimensional analysis to convert one unit into another (fraction – derived from expression)

$$1\text{m} = 100\text{cm}$$

$$\frac{1\text{m}}{100\text{ cm}} \qquad \frac{100\text{ cm}}{1\text{m}}$$