Chapter 1
PSC1341

Chapter 1 Scientific Method and Measurements

A. Scientific Method
B. Measurements
C. Significant Figures
D. Rounding
E. Metric System of Measure
F. Conversion of English System to Metric System and Vice Versa
G. Math in Science- Factor label method
H. Reporting your answer to the correct Significant Figures
I. Density - Specific Gravity
J. Temperature

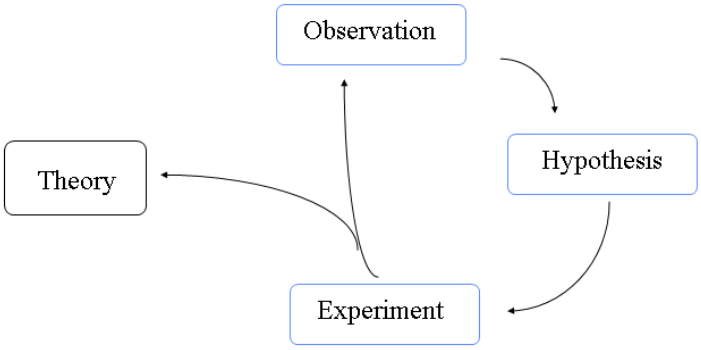
Definitions

Physical Science: any of the natural sciences (as physics, chemistry, and astronomy) that deal primarily with nonliving materials.
Physics: a science that deals with matter and energy and their interactions.
Chemistry: a science that deals with the composition, structure, and properties of substances and with the transformations that they undergo.

Scientific Method

- **Observation**: There are two types of observations, qualitative (the product is blue) or quantitative (the reaction produced 17.0 grams of product. Observations are often the catalyst to formulating a problem. They are also important in our experiments.
- **Hypothesis**: A hypothesis is a possible explanation for an observation.
- **Experiment**: An experiment is something we do to test the hypothesis
- **Theory:** A theory (or model) is a set of tested hypothesis that gives an overall explanation of some part of nature.
- **Law:** A law is a summary of observed behavior.

Scientific Method

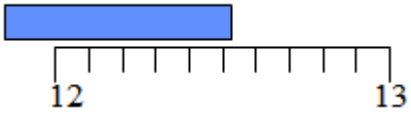


Properties

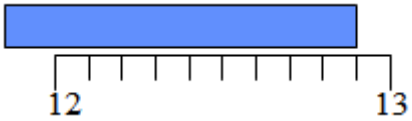
- Extensive: does matter how much you have. Example: mass, volume, length

- Intensive: does not matter how much you have. Example color, temperature, density.

Measurement



- This measurement is 12.54 cm

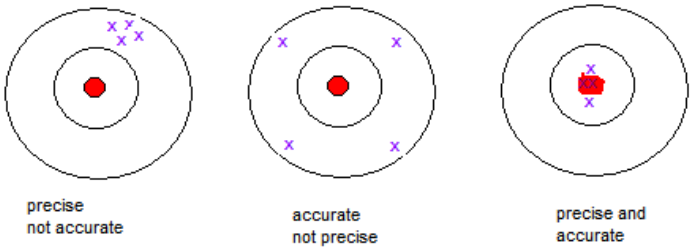


- This measurement is 12.90 cm not 12.9 cm

Precision and Accuracy

- Precision: how closely individual measurements agree with each other. In the case of the eraser they should be within +/- 0.01 cm of each other.
- Accuracy: closeness to correct value.

Usually, precise measurements are also accurate.



Significant figures
An indication of precision

- All non-zero numbers are significant
- Captive zeros are always significant. (203)
- Leading zeros are never significant. (0.032)
- Tailing zeros are significant only if there is a decimal point. (124,000 or 0.3100)

The number of significant figures in a measurement tells something about the instrument that took the measurement.

Sample Problems: How many significant figures in each?

- 203,000,000
- 0.03590
- 127.0
- 300
- 300.

Rounding

- **If the number to the right of the number you are rounding to is 5 or more, you round up, otherwise you do not.**
- **12.5431875 => 12.54** ***with 4 sig. figs***
- **3.14159 => 3.14** ***with 3 sig. figs***
- **453.6 => 454** ***with 3 sig. figs***

Scientific notation
For very large or very small numbers

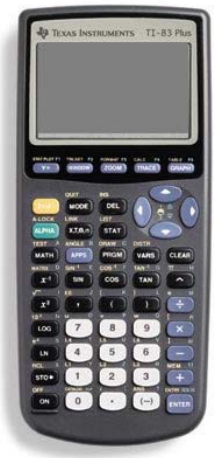
- Form: 1-10 x 10power
- Large numbers: Move decimal point to the left. 275 is 2.75 x 100 which is 2.75 x 102

150000000 miles is 1.5 x 108 miles

- Small numbers: Move decimal point to the left, power of 10 becomes negative.

0.0000007823 cm becomes 7.823 x 10-7 cm

Using your calculator



•Multiply:
6.02×10^{23}
$\underline{\times 2.3 \times 10^{-5}}$

Plug in
6.02 EE 23 X
2.3 EE (-) 5 Enter

The Metric System

•Base Units: Meter (m),
Liter(L), Gram (g)

•The scales of these units are adjusted in powers of ten and are described by prefixes.

- 1000 is kilo (k)
- 1/100 is centi (c)
- 1/1000 is milli (m)

Three metric to English Conversions

o 453.6g = 1 pound
o 1.06 quarts = 1 liter
o 2.54 cm = 1 inch

The Factor Label Method

•Based on the fact if the numerator (top #) and the denominator (bottom #) of a fraction are equal, than the value of the fraction is equal to 1.

•Based on the fact that multiplying a measurement by one will not change the value of that measurement.

How many eggs are there in three dozen?

- 12 eggs = 1 dozen

$$3 \text{ dozen} \times \frac{12 \text{ eggs}}{\text{dozen}} = 36 \text{ eggs}$$

Conversion factors

- Each equality can be used in to ways:
- 12 inches = 1 ft
- To convert inches to ft

$$\mathbf{1 = \frac{1 \text{ foot}}{12 \text{ inches}}}$$

- Or to convert ft to inches

$$\mathbf{1 = \frac{12 \text{ inches}}{1 \text{ foot}}}$$

Convert 72.0 inches to feet using the Factor Label method.
The steps:
•Find the starting point **72.0 inches = ? feet**

• Collect your conversions.
•Come up with a plan
•Apply your plan.

$$\mathbf{72.0 \text{ inches x } \frac{1 \text{ foot}}{12 \text{ inches}} = 6.00 \text{ feet}}$$

Sample Problem: A newborn baby is measured at 0.470 m long. How many inches is she?

Reporting your Answer to the Correct Number of Significant Figures

- When multiplying or dividing, report your answer to the number of significant figures of the least precise measurement.
- When adding or subtracting, report your answer to the decimal place of the least precise measurement.
- Some numbers have an infinite number of significant figures and so just do not play a role. Counted numbers or defined numbers are such numbers.

A train is traveling at 45.0 miles/hour and has to make a trip of 100 miles. How many minutes will it take to get there?

Density

$$\mathbf{D = \frac{mass}{volume} = \frac{M}{V}}$$

•D=M/V

•Density is a conversion factor that inter-converts mass and volume.

•The density of water is 1.00 g/ml

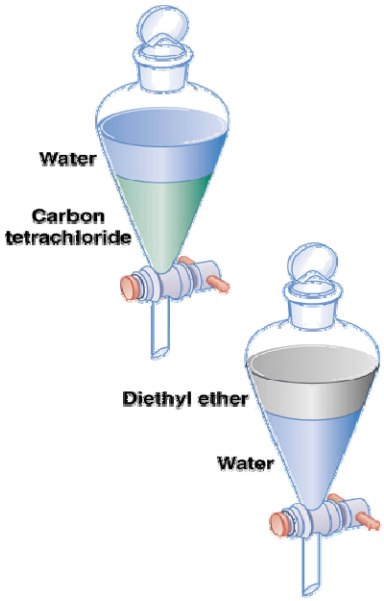
Densities of some things

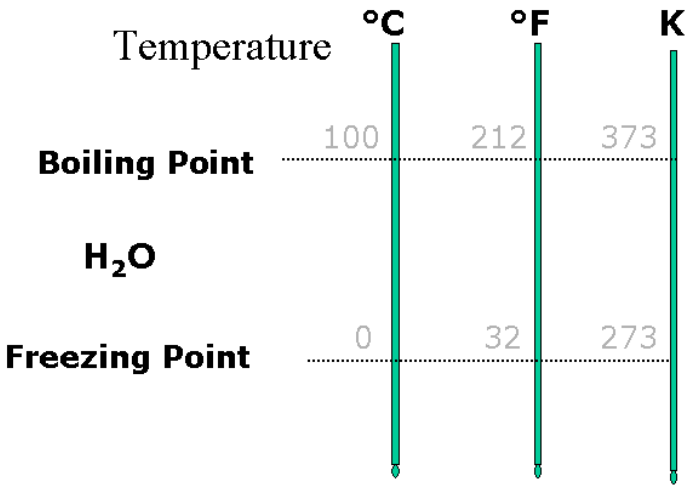
Gasoline	0.66 g/ml
Oil	0.92 g/ml
water	1.00 g/ml
Aluminum	2.70 g/ml
Lead	11.3 g/ml
Mercury	13.6 g/ml

Sample Problem: What is the weight in pounds of 356 mL of mercury?

Density

•Rank water, ether and carbon tetrachloride in terms of density.





Temperature Conversions

$F = \frac{9}{5}C + 32$ K=C+273

If body temperature is 98.6°F, what is my temperature in ºC? How about K?

Sample problems:

1. $(2.15 \times 10^4) \times (3.33 \times 10^3)$=
2. $(2.15 \times 10^4) \div (3.33 \times 10^3)$=
3. What is your height in cm? What is your height in m?
4. What is your weight in kg?
5. What is the weight in pounds of 356 mL of gasoline (0.660 g/mL)?
6. What is the volume in mL of 5.00 pounds of Aluminum?
7. What is the temperature in ºC of 75.0 ºF? In K?
8. How many significant figures in the following measurements?
   a. 3.2 cm b. 3.20 cm c. 0.0320 m
9. Please put the following numbers in scientific notation.
   a. 360,000,000 meters
   b. 0.00000000032 meters
10. The density of mercury is 13.6 g/mL. How many pounds of mercury are in 301 mL?
11. A calculator answer of 2.3169 must be rounded off to three significant figures. What answer s reported?

1. 7.16×10^{7}
2. 6.46
3. I am 5’ 9” or 69.0 inches. 175 cm or 1.75 m
4. 169 lbs is 76.7 kg
5. 0.518 lbs
6. 840. mL
7. 23.9 ºC, 297 K
8. a 2 b 3 c 3
9. a. 3.6×10^{8} b 3.2×10^{-10}
10. 9.02 lbs
11. 2.32