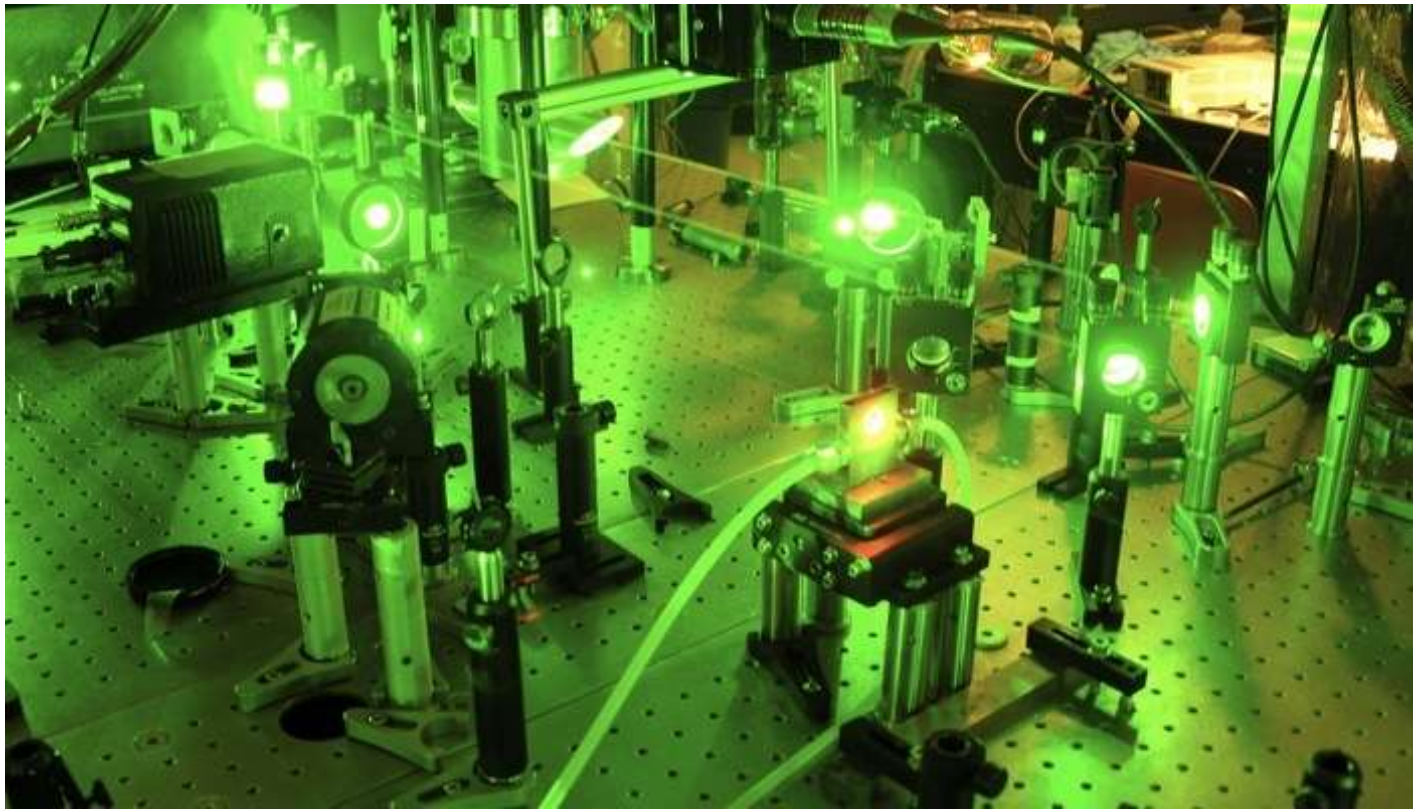
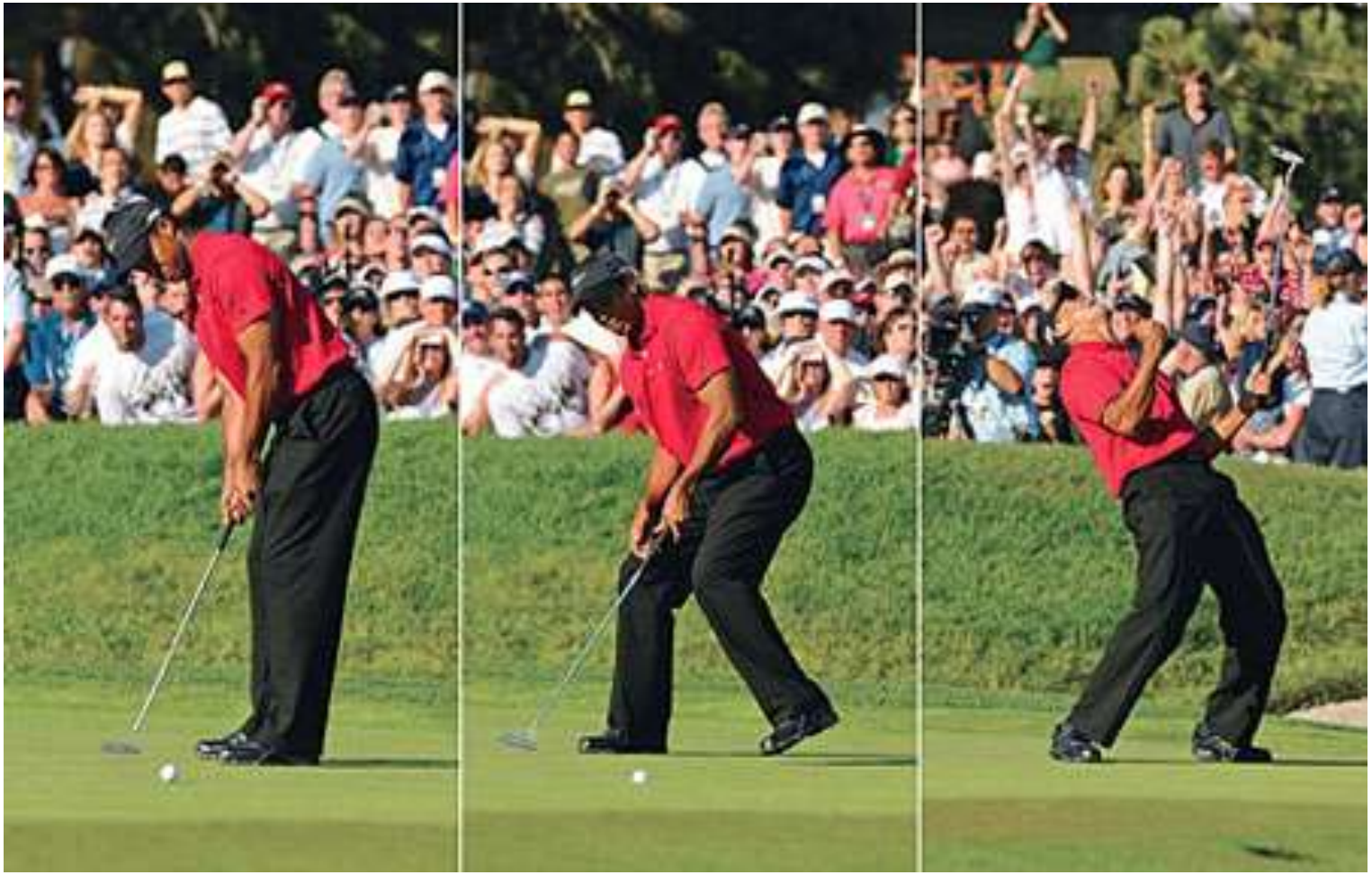
Pre-AP Chemistry

September 13-15, 2011

2. Scientific Measurements



Matter or Non-Matter?



Simple Questions

- How many spunkles are in a tollan?

Simple Questions

- How many spunkles are in a tollan?

- Have you ever run 15 gadapoozles?

Simple Questions

- How many spunkles are in a tollan?

- Have you ever run 15 gadapoozles?

- How many Justin Bieber’s big is this room?

Outline

- Measurements and Units
- Numbers in Science
- Dimensional Analysis

- Measurements and Units
  - Length, Mass, Time, Temperature
  - Volume, Density, Speed
- Numbers in Science
  - Scientific Notation
  - Significant Figures
- Dimensional Analysis

Outline

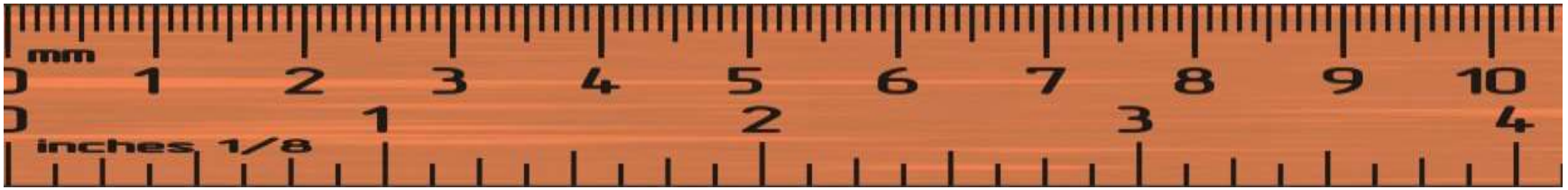
- Measurements and Units
- Numbers in Science
- Dimensional Analysis

- Measurements and Units
  - Length, Mass, Time, Temperature
  - Volume, Density, Speed
- Numbers in Science
  - Scientific Notation
  - Significant Figures
- Dimensional Analysis

Length

- The physical extent of an object
- Fundamental Unit: **meter** (m)

$3*10^{-15}m$ $1*10^{-4}m$ $2*10^{0}m$ $2*10^{7}m$



Mass

- The quantity of matter in an object
- Fundamental Unit: **kilogram** (kg)

$9*10^{-31}$kg

$2*10^{2}$kg

$6*10^{24}$kg

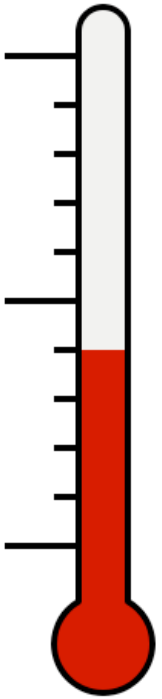
Time

- The duration of an event
- Fundamental Unit: **second** (s)

Temperature

- Measures the *average* kinetic energy of a substance
- Fundamental Unit: Kelvin (K)

- $T(K) = T(C) + 273.15$
- $T(F) = (9/5)*T(C) + 32$



Temperature

$T(K) = T(C) + 273.15$

$T(F) = (9/5)*T(C) + 32$

273.15 K
0 C
32 F

298.15 K
25 C
77 F

373.15 K
100 C
212 F

Mini Quiz

- Fill in the blanks:

- The standard unit of mass is the _____.
- The meter is the standard unit of _____.

- Ice cream tastes best when the temperature outside is 90 F. At what temperature does ice taste best in C? In K?

Mini Quiz

- Fill in the blanks:

- The standard unit of mass is the **kilogram**.
- The meter is the standard unit of **length**.

- Ice cream tastes best when the temperature outside is 90 F. At what temperature does ice taste best in C? In K?

$T(C) = (5/9)*[T(F) - 32]$

$T(C) = (5/9)*[90 - 32]$

$T(C) = 32.2$

$T(K) = T(C) + 273.15$

$T(K) = 32.2 + 273.15$

$T(K) = 305.35$

Outline

- Measurements and Units
- Numbers in Science
- Dimensional Analysis

- Measurements and Units
  - Length, Mass, Time, Temperature
  - Volume, Density, Speed
- Numbers in Science
  - Scientific Notation
  - Significant Figures
- Dimensional Analysis

Volume

- The space occupied by an object
- Derived Unit: **liter** (L) = 0.001 m^3

2 L

1,300,000,000,000,000,000,000 L

Density

- Mass per unit volume
- Derived Unit: **kilograms per liter** (kg/L)

- What weighs more, a kilogram of feathers or a kilogram of bricks?

Speed

- Distance per unit time
- Derived Unit: **meters per second** (m/s)

0.5 km / hr

37.58 km / hr

322 km / hr

Properties and Units

Property	Units		Property	Units
Length	meter (m)		Volume	liter (L)
Mass	kilogram (kg)		Density	kilogram per liter (kg / L)
Time	second (s)		Speed	meters per second (m / s)
Temperature	kelvin (K)			

Outline

- Measurements and Units
- Numbers in Science
- Dimensional Analysis

- Measurements and Units
  - Length, Mass, Time, Temperature
  - Volume, Density, Speed
- Numbers in Science
  - Scientific Notation
  - Significant Figures
- Dimensional Analysis

Scientific Notation

- Used to simplify expression of very large or very small numbers
- Write every number as a coefficient between 1 and 10 and a base as a power of 10.

12,340,000. = 1.234 x 10^{7} = 1.234E+7

7 6 5 4 3 2 1

coefficient base

0.0000725 = 7.25 x 10^{-5} = 7.25E-5

1 2 3 4 5

coefficient base

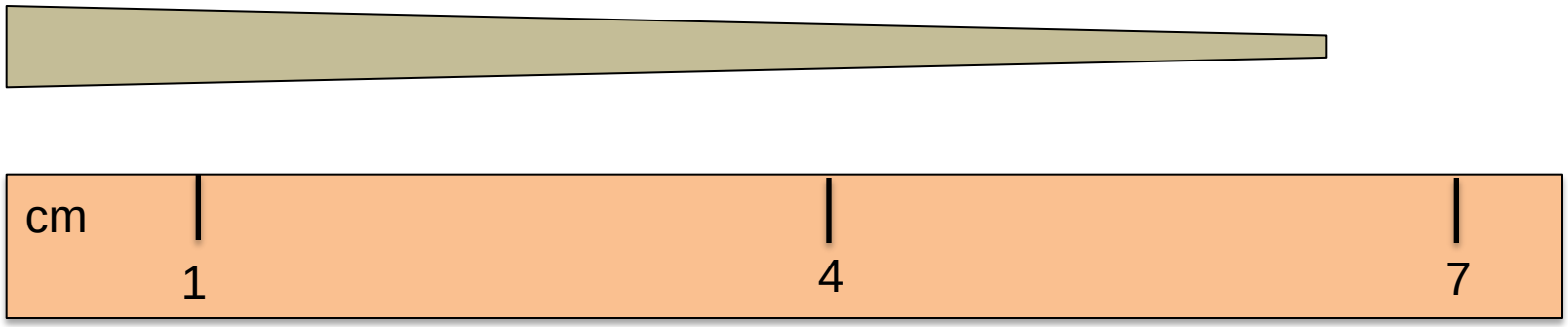
Outline

- Measurements and Units
- Numbers in Science
- Dimensional Analysis

- Measurements and Units
  - Length, Mass, Time, Temperature
  - Volume, Density, Speed
- Numbers in Science
  - Scientific Notation
  - Significant Figures
- Dimensional Analysis

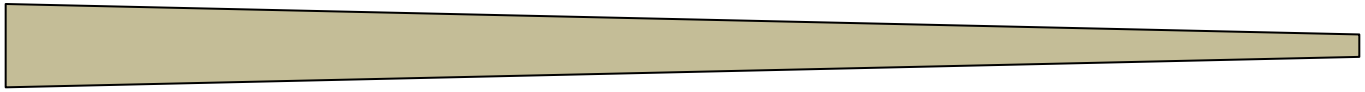
Significant Figures

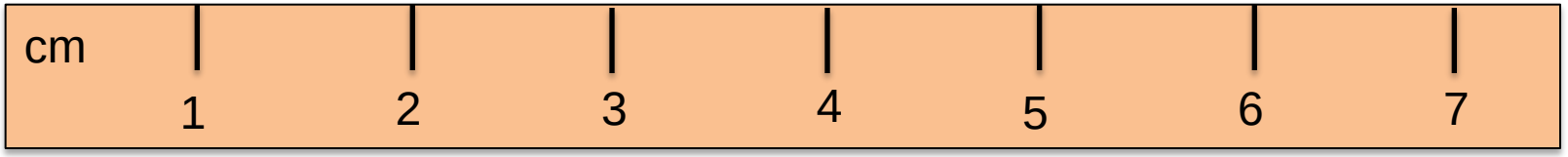
- How long is this chopstick?

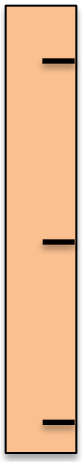


Significant Figures

- What about now?



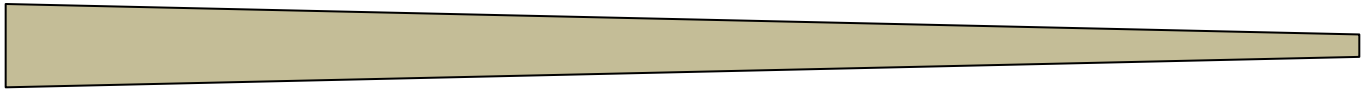


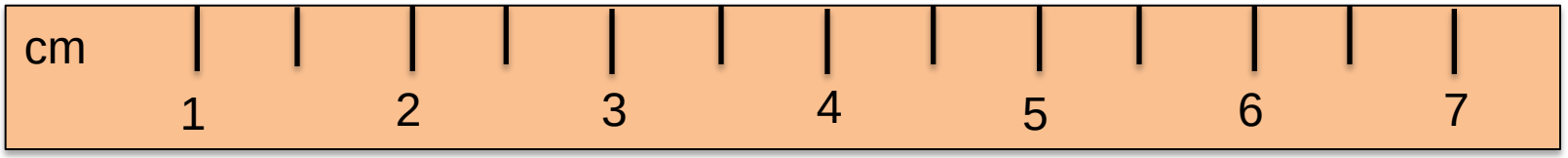


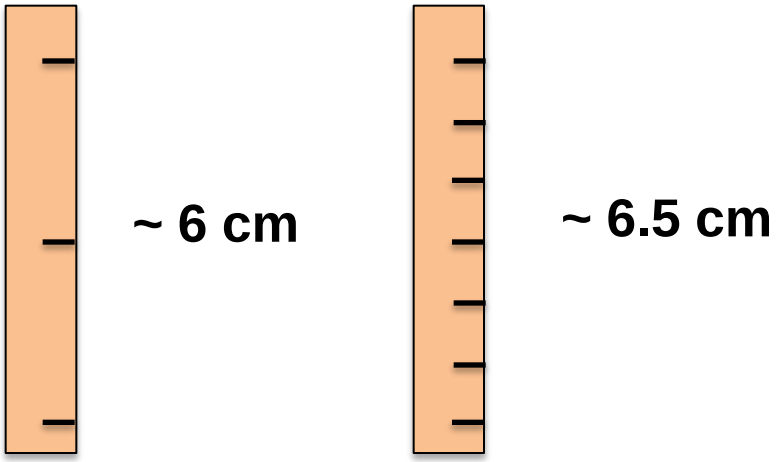
~ 6 cm

Significant Figures

- What about now?





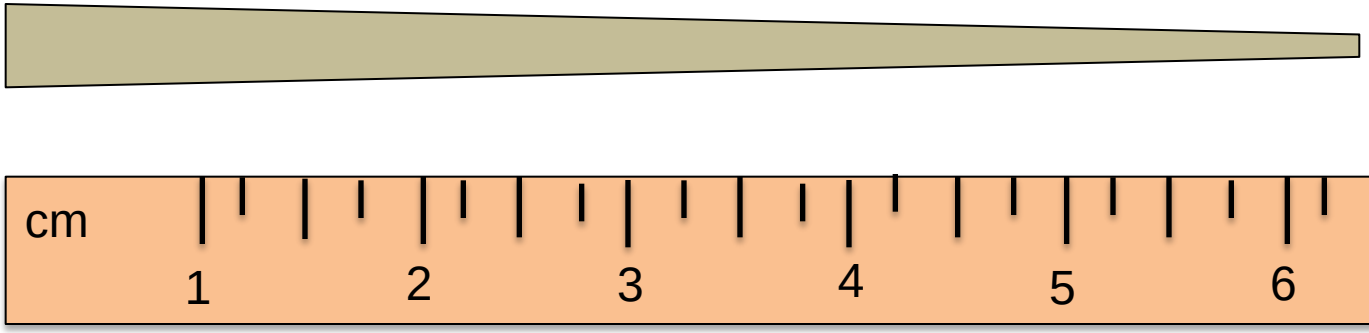


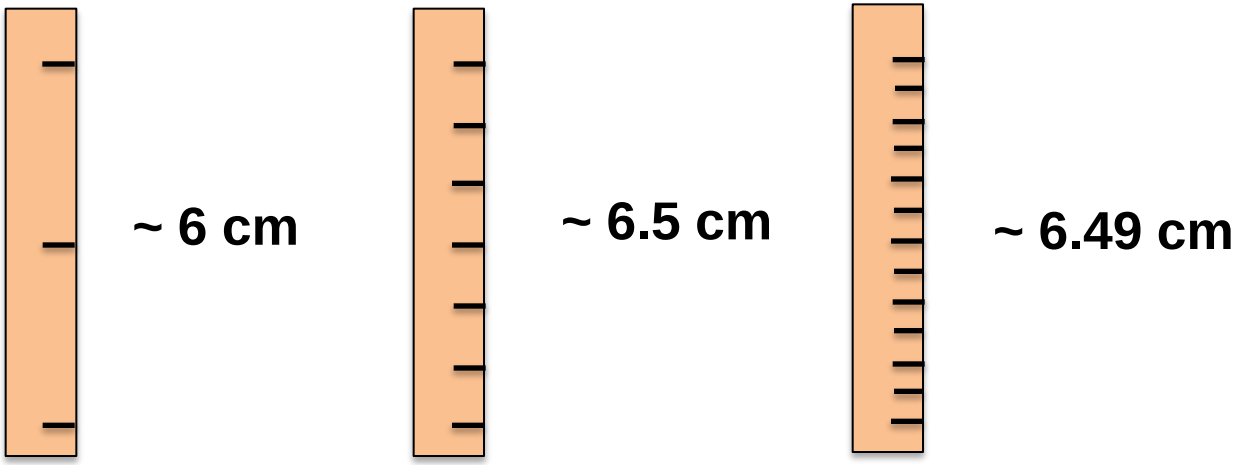
~ 6 cm

~ 6.5 cm

Significant Figures

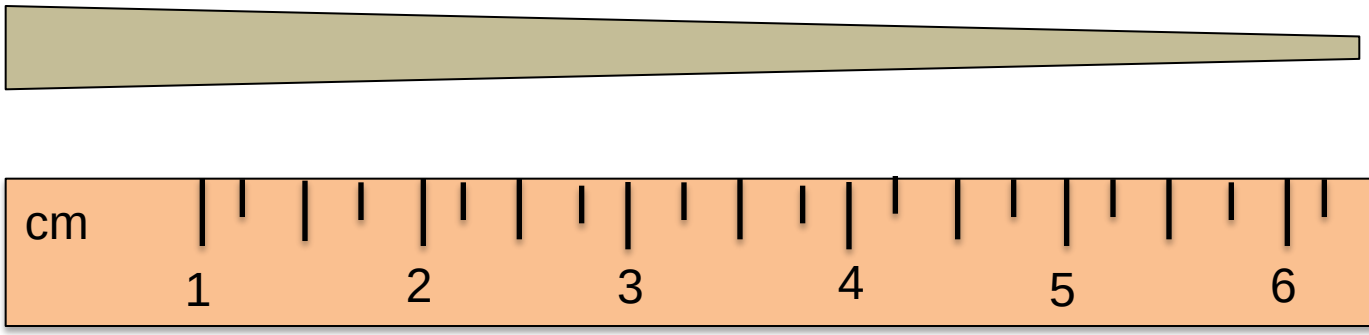
- What about now?

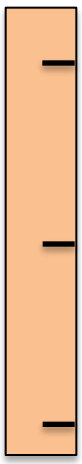




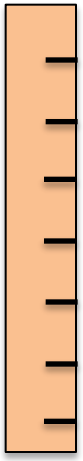
Significant Figures

- What about now?

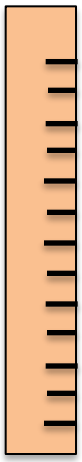




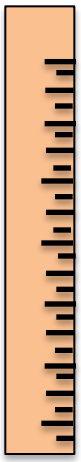
~ 6 cm



~ 6.5 cm



~ 6.49 cm



~ 6.485 cm

Significant Figures

- Used to indicate precision with which measurement was taken
- Three rules
  1. **Not Significant**: Leading zeros
  2. **Not Significant**: Trailing zeros in numbers without a decimal point
  3. **Significant**: All other digits in number

$12{,}340 = 1.234 \times 10^4 = 1.234E{+}4$ ➔ 4 sig figs

$12{,}340. = 1.2340 \times 10^4 = 1.2340E{+}4$ ➔ 5 sig figs

$0.0725 = 7.25 \times 10^{-2} = 7.25E{-}2$ ➔ 3 sig figs

$0.07250 = 7.250 \times 10^{-2} = 7.250E{-}2$ ➔ 4 sig figs

Mini Quiz

- For the following numbers
  - Write the number in scientific notation
  - Determine the number of significant figures

120	**2,001**
1.200	**1.002**
0.0021	**21.**
21.0	**2.1010**

Significant Figures

- Addition / Subtraction
  - Result has as many digits after decimal point as number entering calculation with fewest number of digits after decimal point
- Multiplication / Division
  - Result has as many sig figs as number entering calculation with fewest number of sig figs

? sig figs	1.25		1200.	? sig figs
? sig figs	+ 3.4	x	31.1	? sig figs
? sig figs	4.65		37,320	? sig figs
? sig figs				? sig figs

- What is 5.0 – 3.25? How about 5.0*3.25?

Significant Figures

- Addition / Subtraction
  - Result has as many digits after decimal point as number entering calculation with fewest number of digits after decimal point
- Multiplication / Division
  - Result has as many sig figs as number entering calculation with fewest number of sig figs

3 sig figs	1.25		1200.	4 sig figs
2 sig figs	+ 3.4	x	31.1	3 sig figs
3 sig figs	4.65		37,320	4 sig figs
2 sig figs	4.7		37,300	3 sig figs

- What is 5.0 – 3.25? How about 5.0*3.25?

Significant Figures

- Addition / Subtraction
  - Result has as many digits after decimal point as number entering calculation with fewest number of digits after decimal point
- Multiplication / Division
  - Result has as many sig figs as number entering calculation with fewest number of sig figs

2 sig figs	5.0			5.0	2 sig figs
3 sig figs	- 3.25		x	3.25	3 sig figs
3 sig figs	1.75			16.25	4 sig figs
2 sig figs	1.8			16	2 sig figs

- What is 5.0 – 3.25? How about 5.0*3.25?

Outline

- Measurements and Units
- Numbers in Science
- Dimensional Analysis

- Measurements and Units
  - Length, Mass, Time, Temperature
  - Volume, Density, Speed
- Numbers in Science
  - Scientific Notation
  - Significant Figures
- Dimensional Analysis

Dimensional Analysis

- Method of converting between units and checking for physical consistency in calculated units

- How many cm are in 5 km?

5 km = ? cm

Dimensional Analysis

- Method of converting between units and checking for physical consistency in calculated units

- How many cm are in 5 km?

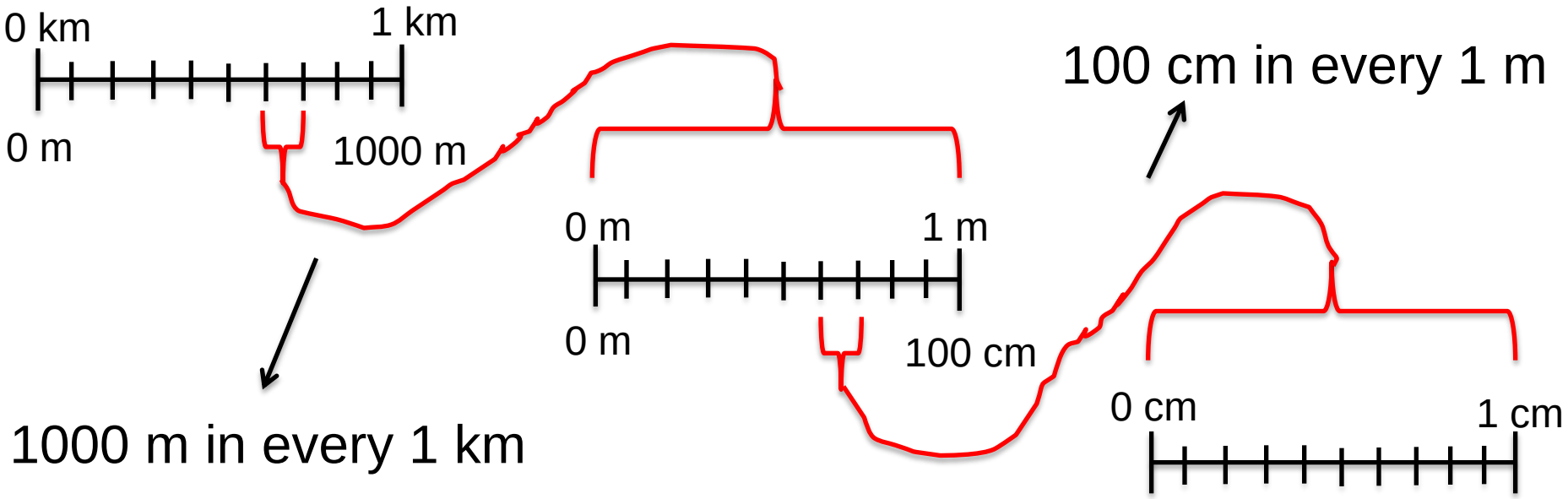
5 km = ? cm

We need **conversion factors** to convert between cm and km

Dimensional Analysis

- Method of converting between units and checking for physical consistency in calculated units

- A **conversion factor** tells you how many of thing A are equal to thing B.



Dimensional Analysis

- Method of converting between units and checking for physical consistency in calculated units

- How many cm are in 5 km?

$$5km \times \frac{1000m}{1km} \times \frac{100cm}{1m} = 5 \times 10^5 cm$$

Conversion factor between m and km

Conversion factor between cm and m

Dimensional Analysis

- Method of converting between units and checking for physical consistency in calculated units

- How many cm are in 5 km?

$$5km \times \frac{1000m}{1km} \times \frac{100cm}{1m} = 5 \times 10^5 cm$$

You can cancel units JUST like you can cancel numbers!

Dimensional Analysis

- Method of converting between units and checking for physical consistency in calculated units

- Express the density of water (1 g / mL) in kg / m3.

Dimensional Analysis

- Method of converting between units and checking for physical consistency in calculated units

- Express the density of water (1 g / mL) in kg / m3.

$$1\frac{\text{g}}{\text{mL}} \times 1\frac{\text{kg}}{1000\text{g}} \times 1\frac{\text{mL}}{\text{cm}^3} \times \frac{(100\text{cm})^3}{(1\text{m})^3} = 1000\ \frac{\text{kg}}{\text{m}^3}$$

$$\frac{1\ \text{g}\ |\ 1\ \text{kg}\ |\ 1\ \text{mL}\ |\ (100\ \text{cm})^3}{1\ \text{mL}\ |\ 1000\ \text{g}\ |\ 1\ \text{cm}^3\ |\ 1\ \text{m}^3} = 1000\ \frac{\text{kg}}{\text{m}^3}$$

Mini Quiz

- Textbooks, p. 51, # 66 (a, c, e, h)

Convert:

a) 5.25 oz to lbs

c) 125 g to oz

e) 125 mL to pints

h) 2.5 mi to cm

453.59 g = 16 oz = 1 lb

1 L = 1.0567 qt

1 qt = 2 pint

1 mi = 1.6093 km

Mini Quiz

Convert:

a) 5.25 oz = 0.328 lbs

c) 125 g = 4.41 oz

e) 125 mL = 0.264 pints

h) 2.5 mi = 4.02325 E+5 cm
= 4.0 E+5 cm

453.59 g = 16 oz = 1 lb

1 L = 1.0567 qt

1 qt = 2 pint

1 mi = 1.6093 km

Summary

- Chemists use a standard set of units in measuring physical properties
- Scientific notation and significant figures give chemists a way to quantify measurements and errors

Homework (Due 9/15)

- Read Ch. 2 (pp. 14 – 22, 24 – 45)
- Problems: pp. 47 – 50

  # 1,5,7,17,37,43,47,49,55;25,27,59
- Study for Quiz (9/17)