Metrics and Measurement

Be sure to look at the helpful links on the unit page on the website if you need extra practice!

Syll. Statements 1.2.1 – 1.2.11

due Monday!

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SI—what is it?

- **SI = Système Internationale d'Unités**
- What we know as the "Metric System"
- Units are standardized and regulated by two organizations:
  - International Bureau of Weights and Measures (in France)
  - National institute of Science and Technology (in Maryland)
- All measurement tools are calibrated using the standards stored at these locations

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Fundamental Units

- A quantity that cannot be measured in a simpler form

OR

- A quantity that has been selected because of its convenience/practicality
- Sometimes also called "base units"

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Table 1: SI Fundamental Units and Symbols

Quantity	SI Unit	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Luminous intensity	Candela	cd
Electric current	Ampere	A
Thermodynamic temperature	Kelvin	K
Amount of substance	Mole	mol

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Standard unit definitions:

- **Meter:**
  - **Has gone through several changes through the years:**
    - **"1/10,000,000 the distance from the north pole to the equator, measured along a line passing through Lyons, France" (1790)**
    - **"Distance between two lines engraved on a platinum-iridium bar" in Paris. (1875)**
    - **"the distance traveled by light in a vacuum during a time interval of 1/299,792,458 s" (1984)**
  - **Length has NOT changed…just how it's defined so that it's now more easily repeated in calibration**

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Standard unit definitions:

- **Second:**
  - old: "1/86,400 of the mean solar day"
  - Better: "the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom"
  - (essentially, the second is based on the vibrations of a cesium-133 atom in an atomic clock ☺)

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Standard unit definitions:

- **Kilogram:**
  - Old: mass of exactly one cubic decimeter of water (1790)
  - NOW: "the mass of the international prototype of the kilogram" (1899)

Photo from: http://physics.nist.gov/cuu/Units/kilogram2.html

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Derived Units

- **Any unit that is formed through the combination of two or more fundamental units**
- Examples:
  - Area: square meter = m^2
  - Velocity: meters per second = $m/s = m \cdot s^{-1}$
  - Energy: Joules = $J = kg \cdot m^2/s^2 = kg \cdot m^2 \cdot s^{-2}$
- A conversion of the fundamental unit into one with a different prefix does NOT create a derived unit…

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Metric Prefixes

Prefix (symbol)	Conversion Factor	Example
Mega- (M)	10^6	1 MW = 10^6 W
kilo- (k)	10^3	1 kg = 10^3g = 1000 g
centi- (c)	10^{-2}	1 cm = 10^{-2} m = 0.01 m
milli- (m)	10^{-3}	1 mL = 10^{-3} L = 0.001 L
micro- (μ)	10^{-6}	1 m s = 10^{-6} s = 0.000001 s

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A desk was measured to be 62.52 cm tall. How many millimeters tall is this desk?

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The world's largest strawberry was measured to be 231 g. How many kilograms is this?

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More on metric prefixes…

- Metric prefixes are used to put numbers into a more usable format….
- For example:
  - 12000 g is better written as 12 kg
  - 0.0000065 m is better written as 6.5 μm
- For ALL of your measurements and calculated answers, make sure that you are using the most logical unit for that measurement!

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Which of the following is NOT a fundamental unit?

A. meter
B. gram
C. candela
D. second

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What is the approximate mass of a 2 L bottle of pop?

A. 0.5 kg
B. 2 kg
C. 5 kg
D. 10 kg

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Factor-Label Method for Conversions

- When converting from one unit to another (i.e. kg → g, or feet → meters), we use **Conversion Factors**
- Conversion factors tell us the equivalent magnitude in the new unit
  - For example:
    - 1 in. = 2.54 cm
    - 1 lb = 454 g
    - 1 kg = 2.2 lb

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Factor-Label Method for Conversions

- When converting, we make fractions (ratios) out of the conversion factors so that the original unit divides out (cancels out) and the new unit remains:
  - Example:
    - 2.75 pounds is equal to how many kilograms?

$$\left(\frac{2.75\ \text{lb}}{}\right)\left(\frac{1\ \text{kg}}{2.2\ \text{lb}}\right)=1.25\ \text{kg}$$

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Factor-Label Practice

- Usain Bolt ran the 100-m race at the Beijing Olympics in a world record time of 9.69 seconds. His average speed was 10.3 m/s. How fast was he running in miles per hour?

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A cheetah can run at speeds up to 70.0 miles per hour. How fast is this in meters per second?

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