Lecture 8 - Units of Measurement

February 4, 2019

History of Units

- Measurements of weight and volume were likely the first standardized units. (People have always been obsessed with commerce and shiny rocks/metals!)
- The ancient Greek geometers used ratio to characterize length. They looked for some standardizing element that brought all sides of a shape into unity with one another.
- Pythagoras incorrectly believed that every shape could be characterized by ratios of whole numbers. When a student proved him wrong, the Pythagoreans drowned the wayward student in a well!
- Standardized units of length have existed for at least 5,000 years, with one of the earliest being the cubit.
- A modern carpenter's square actually bears a striking resemblance to the cubit square used in ancient Egypt!

Metric Units and Imperial Units

The Metric System

- All civilized nations, and a few barbarous ones, use the metric system.
- The metric system uses the following base units:

Type	**Name**	**Abbreviation**
Length	meter	m
Mass	gram	g
Volume	liter	l
Temperature	Celsius/Kelvin	°C / °K
Time	second	s

- Under the metric system, all unit conversions are done by powers of ten. Hence, all of the unit prefixes are really just shorthand renderings of scientific notation! The powers of ten and prefixes are shown below:

Value	Name	Prefix	Value	Name	Prefix
10^{-24}	yocta	y	10^{1}	deka	da
10^{-21}	zepto	z	10^{2}	hecto	h
10^{-18}	atto	a	10^{3}	kilo	k
10^{-15}	femto	f	10^{6}	mega	M
10^{-12}	pico	p	10^{9}	giga	G
10^{-9}	nano	n	10^{12}	tera	T
10^{-6}	micro	μ	10^{15}	peta	p
10^{-3}	milli	m	10^{18}	exa	E
10^{-2}	centi	c	10^{21}	zetta	Z
10^{-1}	deci	d	10^{24}	yotta	Y

The Imperial System

- The imperial system is an inconsistent hodgepodge of units currently only used by impoverished and despotic nations.
- See the attached handout for a way to interpret this madness!
- Conversion from the good and wise metric system to the wayward imperial system works as follows:
  - **Length** 1 inch = 2.54 cm
  - **Volume** 1 quart = 0.946353 l
  - **Mass (sort of)** 1 pound = 0.453592 kg

Performing Unit Conversions

- Units behave like numbers and/or variables in calculations.
- Hence $2\text{m} \times 3\text{m} = 6\text{m}^2$
- The most common way to convert units is to write them as a series of fractions and multiply. This is called the "factor label method". For example, converting 3km to miles works as follows

$$3\text{km} \times \frac{1000\text{m}}{1\text{km}} \times \frac{100\text{cm}}{1\text{m}} \times \frac{1\text{in}}{2.54\text{cm}} \times \frac{1\text{ft}}{12\text{in}} \times \frac{1\text{mile}}{5280\text{ft}}$$

$$3\cancel{\text{km}} \times \frac{1000\cancel{\text{m}}}{1\cancel{\text{km}}} \times \frac{100\cancel{\text{cm}}}{1\cancel{\text{m}}} \times \frac{1\cancel{\text{in}}}{2.54\cancel{\text{cm}}} \times \frac{1\cancel{\text{ft}}}{12\cancel{\text{in}}} \times \frac{1\text{mile}}{5280\cancel{\text{ft}}}$$

$$1.86\text{miles}$$

Examples

1. What is the speed of sound in furlongs per fortnight?
2. How many liters are in one butt?