**Physics 11 - Elementary Physics**

- Introduction
- Course Goals
- Measurement, Dimensions, & Units
- Math
- Estimation
- Introduction to motion

**Introduction**

- Course Information:
- Evaluation:
  - Reading quizzes, In-class exercises - 25%
  - Exam 1 (6/4) - 25%
  - Exam 2 (6/18) - 25%
  - Exam 3 (6/29) - 25%

**Course Goals**

- Learn and understand the basic definitions, terms and concepts relevant to
  - Newtonian mechanics
  - Properties of Fluids
  - Elasticity, Vibrations and Waves
  - Heat, Temperature and Thermodynamics
- Learn reasoning and problem solving strategies for applying these concepts to a wide range of problems, both qualitatively (words, pictures) and quantitatively (math, geometry)
Measurement, Dimension, Units

All science in general, (and physics in particular) is based on making measurements and drawing conclusions from them about how the world works.

All scientific theories must be testable by an experiment based upon making measurements.

Heard on NPR (BP sponsorship blurb last year) …

"Energy, it’s more than a force. It’s a power!"

To a physicist, this is nonsense. It’s like saying...

"Apples, they’re more than pears. They’re oranges!"

Hopefully, you’ll soon know what’s wrong with this picture.

"Dimension" refers to the basic nature of a thing we can measure.

Basic Physics dimensions are:

- Mass \((M)\)
- Length \((L)\)
- Time \((T)\)

(Also: Electrical current, Temperature, mass, Luminous intensity)

Other measurable things can be derived from these:

- Speed \(= L / T\)
- Energy \(= (M L^2 / T^2)\)
- Force \(= (M L) / T^2\)
- Power \(= (M L^2 / T^3)\)
- Area \(= L^2\)
- Volume \(= L^3\)

Notation: \([something]\) means “dimensions of something”
Measurement, Dimension, Units

“Units” are standardized quantities we use to compare our measurements against. In physics we use a special set of units, called the SI (Systeme Internationale) units, informally known as the metric system.


Each SI Unit is based on a reproducible physics measurement!

Machining the 1876 Platinum-Iridium Standard Meter

- Converting Units
  - The SI unit of length is the meter
  - Other length units: mile (mi), kilometer (km), centimeter (cm), inch (in), foot (ft), furlong ……
    - 12.0 in = 1.00 ft
    - 2.54 cm = 1.00 in (exact by definition!)
    - 100 cm = 1.00 m
  - Example: How many feet are in 1.00 meter?

\[
1.00 \text{ m} = 1.00 \text{ m} \left( \frac{100 \text{ cm}}{1.00 \text{ m}} \right) \left( \frac{1.00 \text{ in}}{2.54 \text{ cm}} \right) = 3.28 \text{ ft}
\]

- Other tools to use: [http://www.digitaldutch.com/unitconverter/](http://www.digitaldutch.com/unitconverter/)

Frames of Reference

- Rectangular Coordinates
  - Locate position by (x, y) coordinates on a rectangular grid, fixed in space
  - Origin at (0,0)

- Polar Coordinates
  - Locate position by (r,θ) coordinates
  - r is distance from origin; θ is angle from reference line
Math

Scientific Notation: Use of “powers of ten” to express large and small numbers

Examples:

Large - \[6.25 \times 10^9\]

Small - \[0.000000002768 = 2.768 \times 10^{-9}\]

The exponent is the number of places you have to move the decimal point. (rightward is “+”, leftward is “-”)

Math

Significant Figures: Number of meaningful digits in a numerical quantity.

- \(6.25 \times 10^9\) has 3 significant figures
- \(6.25000 \times 10^9\) has 7 significant figures

When numbers are divided or multiplied, the result is known only to the # of significant figures of the lesser of the two original numbers:

\[
\frac{3.4 \times 10^2}{2.782 \times 10^{-3}} = 1.2 \times 10^2
\]

Math

- Math practice Test
  - http://www.uvm.edu/~mmssander/MathTest/11MathTest.htm
- Know basic Trigonometry
  - a: opposite side
  - b: adjacent side
  - c: hypotenuse
- Know Pythagorean Theorem
  \[a^2 + b^2 = c^2\]
Example Problem

- A plane starts at the origin and flies 100 km due east, then turns and flies 200 km due north.
  - How far from the origin does it end up?
  \[ L = \sqrt{(100 \text{ km})^2 + (200 \text{ km})^2} \]
  \[ = 224 \text{ km} \]
  - What is the angle \( \theta \)?
  \[ \theta = \tan^{-1} \left( \frac{200}{100} \right) = 63.4^\circ \]
  
  Note the use of correct # of significant figures!

Estimation

- Enrico Fermi was a famous Italian physicist who did a lot of ground breaking work in the field of Nuclear Physics. He was known to be a very smart fellow and the procedure of making an order-of-magnitude estimate of an unknown quantity based on reasonable assumptions has come to be called a 'Fermi Problem.' Some examples might be...
  - How many molecules of oxygen are in this room?
  - How many full-time barbers are employed in Vermont?
  - How much energy is required to sustain 10,000,000,000 people for one year?
  - How far can a wild goose fly?

Moral: You should always have a ballpark idea of the answer before you do the calculation!