Physics 11 - Elementary Physics

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

5/21/01 Physics 11, Summer 2001

Introduction

- Course Information:
  – Syllabus, Schedule, Homework Assignments at http://www.uvm.edu/~mmsander/ph11/ph11.html
- Evaluation:
  – Reading quizzes, In-class exercises - 25%
  – Exam 1 (6/4) - 25%
  – Exam 2 (6/18) - 25%
  – Exam 3 (6/29) - 25%

5/21/01 Physics 11, Summer 2001

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)

5/21/01 Physics 11, Summer 2001

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.

Measurement, Dimension, Units

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.

Measurement, Dimension, Units

"***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, mole, Luminous intensity***)

Other measurable things can be derived from these:

Examples: [***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*"

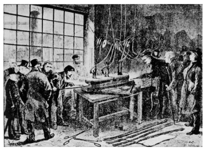
Measurement, Dimension, Units

"***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.

SI Base Units reference: http://physics.nist.gov/cuu/Units/current.html

Each SI Unit is based on a reproducible physics measurement!



Machining the 1876 Platinum-Iridium Standard Meter

5/21/01 Physics 11, Summer 2001

Measurement, Dimension, Units

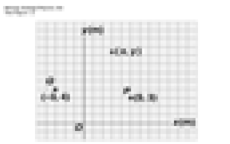
- Converting Units
  - The SI unit of length is the meter
  - Other length units: mile(mi), kilometer (km), centimeter (cm), inch(in), foot (ft), furlong …….
    - 12.0 in = 1.00 ft
    - 2.54 cm = 1.00 in (exact by definition!)
    - 100 cm = 1.00 m
  - Example: How many feet are in 1.00 meter?

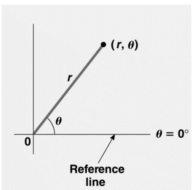
$$1.00\ m = 1.00\ m(\frac{100\ cm}{1.00\ m})(\frac{1.00\ in}{2.54\ cm})(\frac{1.00\ ft}{12.0\ in}) = 3.28\,ft$$

- Other tools to use: http://www.digitaldutch.com/unitconverter/

5/21/01 Physics 11, Summer 2001

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

5/21/01 Physics 11, Summer 2001

Math

***Scientific Notation:** Use of "powers of ten" to express large and small numbers*

Examples:

Large - $6,250,000,000 = 6.25 \times 10^{9}$

Small - $0.0000000002768 = 2.768 \times 10^{-10}$

The exponent is the number of places you have to move the decimal point. (right ward is "-", leftward is "+")

Math

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

6.25×10^{9} ***has 3 significant figures***

6.250000×10^{9} ***has 7 significant figures***

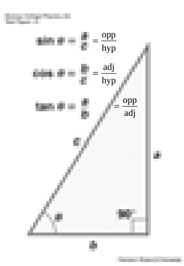
When numbers are divided or multiplied, the result is known only to the # of significant figures of the lesser of the two original numbers:

$$\frac{3.4 \times 10^{2}}{2.782 \times 10^{-3}} = 1.2 \times 10^{5}$$

Math

- ***Math practice Test***
  - ***http://www.uvm.edu/~mmsander/MathTest/P11mathtest.htm***
- ***Know basic Trigonometry***
  - a: opposite side
  - b: adjacent side
  - c: hypotenuse
- ***Know Pythagorean Theorem***

$$a^{2} + b^{2} = c^{2}$$



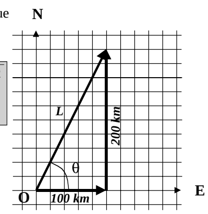
Example Problem

- 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 θ?

$$\vartheta = \tan^{-1}\left(\tfrac{200}{100}\right) = 63.4^{\circ}$$



Note the use of correct # of significant figures!

5/21/01 Physics 11, Summer 2001

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!

5/21/01 Physics 11, Summer 2001