Welcome to
Physics 101
Conceptual Physics
(Mechanics, Fluids, Sound, Heat, Electricity, Light, Atomic, Nuclear)
Fall 2010

James M. Lockhart
Professor of Physics

Pick up two handouts; return filled-out enrollment sheet to me at end of class

Course Web Page:
http://www.physics.sfsu.edu/~lockhart/courses/phys101.html

From this page you will find the Physics 101 syllabus, lecture notes, help session times, etc.

Administrative Details (1)

Instructor: James M. Lockhart

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Tel: (415) 338-2451

Office Hours (tentative):

Monday 10:10-11:00, Wed. 1-2, and Friday 10:10-11:00 or by appointment.

Physics 102 Lab

- Physics 102 is an optional 1-unit laboratory course associated with Physics 101.
- *Not* required *unless* you need a lower-division science lab for GE requirements.
- Must be enrolled in lecture (or have credit for it) to take lab
- Can take lecture first and lab in later semester (but not recommended).

Administrative Details (3)

Textbooks:

- Paul Hewitt, ***Conceptual Physics, 11th Ed. (***Pearson/Addison-Wesley, 2010) (or Hewitt, ***Conceptual Physics, 10*^th^ **ed.)**
- WebAssign access code

Lectures:

Lectures will be given using a combination of PowerPoint and blackboard. Lecture pdf files available on class web page.

Help Sessions:

Instructors available for help sessions several hours each week. Help session schedule will be posted on course web page.

Exams: Two 50-min. midterms + 2.5-hour final. Final is comprehensive. All exams closed book, but equation sheets provided. NO make-up exams. You must take final as scheduled.

Homework:

Homework done on WebAssign system; due every lecture day.

Administrative Details (4)

WebAssign Information

- **Physics 101 Class List** of registered and official wait list students will be uploaded to WebAssign by Friday. Names of those who add from unofficial wait list will show up later.
- WebAssign is free of cost for first 10 days. After that, you will need to buy a WebAssign access code ($22.95). Available in bundle with textbook, at bookstore, and on-line from WebAssign.
- WebAssign **URL**: http://webassign.net/login
- **Logging onto WebAssign (see syllabus for more detail):** Your "username" is last name + last 4 digits of SFSU ID; Initial "password" is last 4 digits of your SFSU student ID .
- Try logging on Friday afternoon. Let me know of problems.

About Prof. James M. Lockhart

I'm a Professor of Physics, and I've taught at SFSU since 1983. Previously taught at Stanford.

I do research in superconducting devices and medical physics (MRI and radiation-based cancer treatment). I'm also involved in a satellite-based test of Einstein's theory of General Relativity.

Outside interests include music (guitar and saxophone), audio recording, hiking/climbing.

Agenda for this week:

Today: Intro, units, dimensions, scientific notation

Friday: Newton's First Law, Forces

Lecture 1:
Units, Dimensions, Scientific Notation

Some illustrations courtesy of Prof. J.G. Cramer, U of Washington

Physics and the Laws of Nature

Physics: the study of the fundamental laws of nature. Foundation of all physical science

- These laws can be expressed as mathematical ***equations***. **(e.g., F = m a)** that relate physical quantities
- Most physical quantities have ***units***, which must match on both sides of an equation.

Units

With a few exceptions, all physical quantities have units. Examples:

Mass	-	kilograms (kg)
Speed	-	meters per second (m/s)
Pressure	-	pascals (P)
Energy	-	joules (J)
Temperature	-	kelvins (K)

The units of almost ***all*** physical quantities can be expressed as combinations of ***only*** the units for ***mass***, ***length***, and ***time***, i.e., kilograms, meters, and seconds. A few physical quantities are pure numbers that have no associated units.

Systems of Measurement

- Standardized systems
  - agreed upon by some authority, usually a governmental body
- SI -- Systéme International
  - agreed to in 1960 by an international committee
  - main system used in this course, and in all science
  - also called mks for the first letters in the units of the fundamental quantities

Standard International Units

Standard International (SI) Base Units

• **Length:**	meter	m
• **Mass**:	kilogram	kg
• **Time:**	second	s
• **Temperature**	kelvins	K
• **Current**	**Ampere**	**A**
Light level	**candela**	**cd**

Units for almost all other physical quantities can be constructed from the base units of mass, length, and time.

inches, feet, miles	miles/hour	**English Units (Used only in USA, Liberia, and Myanmar)**
pounds	Fahrenheit degrees	

Note: English *pound* unit is a measure of *force or weight*, **not** mass. A kilogram has a *weight* of 2.20 pounds at standard gravity.

Conversions

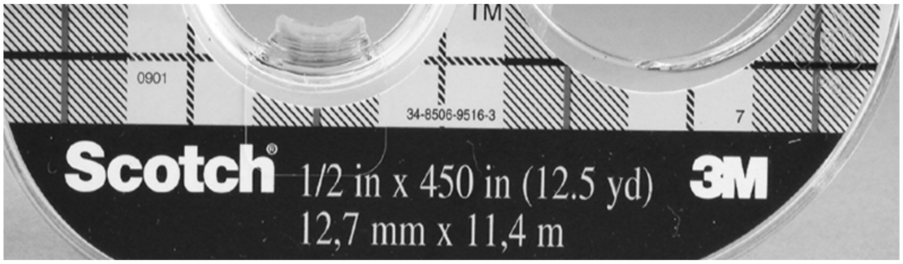
- When units are not consistent or are not given in SI, you may need to convert to appropriate ones
- Units can be treated like algebraic quantities that can cancel each other out
- Write conversion factors as a <u>fraction of value 1</u> and arrange to cancel out undesired units

1 mile = 1609 m = 1.609 km
1m = 39.37 in = 3.281 ft

1 ft = 0.3048 m = 30.48 cm
1 in = 0.0254 m = 2.54 cm

$$\frac{1mi}{1.609km} = 1 \qquad \frac{0.0254m}{1inch} = 1$$

Example 1. Scotch tape:



$$450\,inch \bullet \frac{0.0254m}{1\,inch} = 11.4m$$

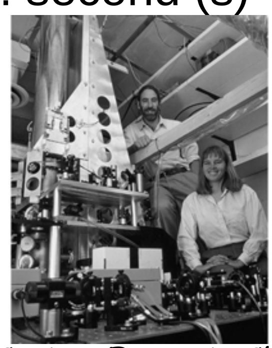
Example 2. Trip to Canada:

Freeway speed limit in Canada is 100 km/h. In miles/h?

$$100\frac{km}{h} = 100\frac{km}{h}\cdot\frac{1\,mile}{1.609\,km} \approx 62\frac{miles}{h}$$

The SI Time Unit: second (s)

13th Century Water Clock



Cesium Fountain Clock

The ***second*** was originally defined as (1/60)(1/60)(1/24) of a mean solar day. Currently, second is defined as time for 9,192,631,770 oscillations of the radio waves absorbed by a vapor of cesium-133 atoms.

The SI Length Unit: meter (m)

Meter originally defined as 1/10,000,000 of distance from Earth's equator to North pole on line of longitude passing through Paris. Later defined as distance between two scratches on a particular platinum-iridium bar.

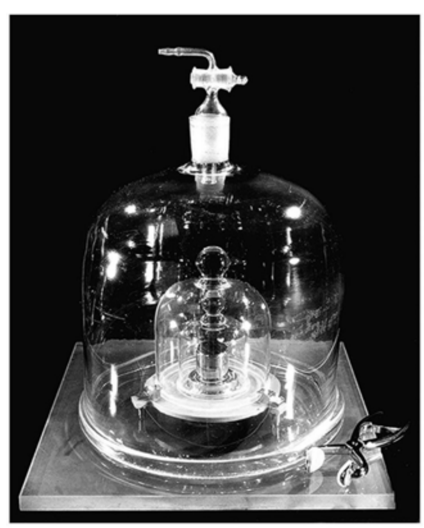
Currently, 1 meter defined as distance traveled by light in 1/299,792,458 of a second

The SI Mass Unit: kilogram (kg)

The ***kilogram*** was originally defined as the mass of 1 liter of water at 4°C.

Currently, 1 kilogram is the mass of the international standard kilogram, a polished platinum-iridium cylinder stored in Sèveres, France. (It is currently the ***only*** SI unit defined by a manufactured object.)

Why the glass domes??



Multiple	Prefix	Abbreviation
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Dimensional Analysis

- Dimension denotes the physical nature of a quantity (length, time, length/time, ...)
- Dimensional Analysis - Technique to check the correctness of an equation
- Dimensions ([L] length, [M] mass, [T] time, & combinations) can be treated as algebraic quantities
  - add, subtract, multiply, divide
  - quantities added/subtracted only if have same units
- Both sides of an equation must have the same dimensions

Significant Figures & Sci. Notation

- A significant figure is one that is reliably known
- All non-zero digits are significant
- Zeros are significant when
  - between other non-zero digits
  - after the decimal point and another significant figure
- can be clarified by using ***scientific notation***

$17400 = 1.74 \times 10^4$ **3 significant figures**

$17400. = 1.7400 \times 10^4$ **5 significant figures**

$17400.0 = 1.74000 \times 10^4$ **6 significant figures**

Operations with Significant Figures

- Precision -- number of significant figures
- When multiplying or dividing, round the result to the same precision as the least precise measurement

Example: rectangular plate: 4.5 *cm* by 7.3 *cm*
area: 32.85 cm^2 33 cm^2 ← 2 significant figs.

- When adding or subtracting, round the result to the smallest number of decimal places of any term in the sum

Example: 135 m + 6.213 m = 141 m

Key Points of Lecture 1

- SI System of units; base (m, kg, s, K) and derived units
- Treat units as algebraic quantities; convert with “unity fractions”
- Both sides of equation need same dimensions; so do things added or subtracted
- Scientific Notation: Write numbers as a set of significant figures multiplied by a power or 10.

Before Friday lecture, read *Hewitt*, first half of Chap. 2