Welcome to
Physics 111.01
General Physics I

(Mechanics, Fluids, Sound, Heat)

Fall 2009

James M. Lockhart

Professor of Physics

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

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Course Web Page:

http://www.physics.sfsu.edu/
~lockhart/courses/phys111.html

From this page you will find the Physics 111.01 syllabus, physics readiness test info, lecture notes, help session times, etc.

Administrative Details (1)

Instructor: James M. Lockhart, lockhart@stars.sfsu.edu

Office: Rm. 520 Thornton Hall, Tel: (415) 338-2451

Office Hours (tentative):

Monday 9:10-10:00, Wed. 1-2, and Friday 1-2 or by appointment.

Laboratory:

Labs start this week. Take the Phys 112 laboratory simultaneously with the lecture unless you already have credit for the lab. If you are not yet enrolled in lab, go to every lab section and try to add. Lab and lecture are separate courses.

Administrative Details (2)

Textbooks:

- James S. Walker, ***Physics, SFSU Custom Edition, Pt. 1,*** Pearson (2009)
  (or Walker, ***Physics,*** **4th ed. (2009) , or 3rd ed. (2007)**
- ***Physics 112/122 Lab Manual.*** Purchase this week (bookstore)

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 will be comprehensive. All exams closed book, but equation sheets provided. NO make-up exams.

Homework:

Homework done on WebAssign system (see below); usually due every lecture day. Assignment #1 is due on Monday, August 31.

Administrative Details (3)
Physics Readiness Test ("Math Test")

To be enrolled in Phys 111 and 112, you must pass a test on algebra and basic trigonometry (see handout or description on web page). ***No calculators may be used.*** Test given **this Friday** (Aug. 28) at regular class time.

- **Registered students - this room**
- **Official Wait List students - Thornton 230**
- **Unofficial Wait List - Thornton 116**

Preparation Workshops: Wed.6-7:30; Thur. 5-6:30;
Register in advance, in person at HSS 346

Administrative Details (4)

WebAssign Information

- The **Physics 111 Class List** of registered and official wait list students has been uploaded to WebAssign. Names of those who add from unofficial wait list will show up later.
- WebAssign is free of cost for first two weeks.After that, you will need to buy a WebAssign access code ($19.95). Available in bundle with textbook, at bookstore, and on-line from WebAssign.
- The WebAssign **URL** is: http://www.webassign.net/login
- **Logging onto WebAssign (see syllabus for more detail):** Your "username" is last name + last 4 digits of SFSU ID; Your initial "password" is last 4 digits of your SFSU student ID .
- Try logging on as soon as possible. Let me know about 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, sensor development, 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

Friday: Math Test !

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)**
- Most physical quantities have ***units***, which must match on both sides of an equation.
- Much ***complexity*** can arise from even relatively simple physical laws.

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

• ampere, mole, candela

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

Unit Conversions

1 in = 2.54 cm	1 cm = 0.3937 in	**English Units (Used only in USA, Liberia, and Myanmar)**
1 mi = 1.609 km	1 km = 0.621 mi	
1 mph = 0.447 m/s	1 m/s = 2.24 mph	

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 fraction of value 1 and arrange to cancel out undesired units

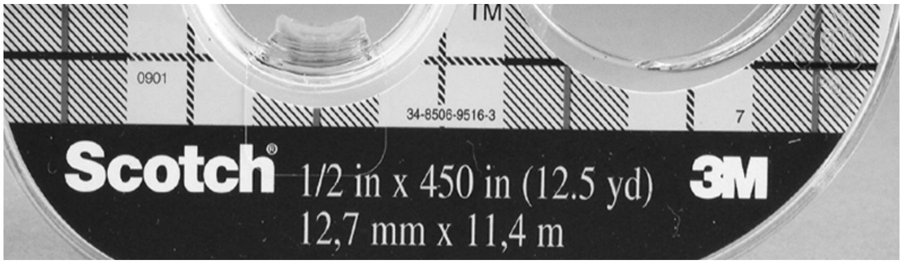
1 mile = 1609 m = 1.609 km
1m = 39.37 in = 3.281 ft

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

$$\frac{1mi}{1.609km} = 1$$

$$\frac{0.0254m}{1inch} = 1$$

Example 1. Scotch tape:



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

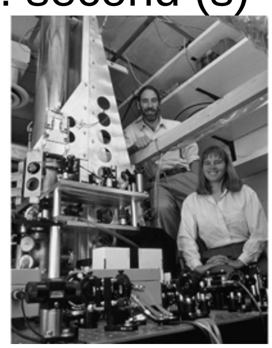
Example 2. Trip to Canada:

Legal freeway speed limit in Canada is 100 km/h.
What is it 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. This definition can be used and checked in any laboratory to great precision.

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.

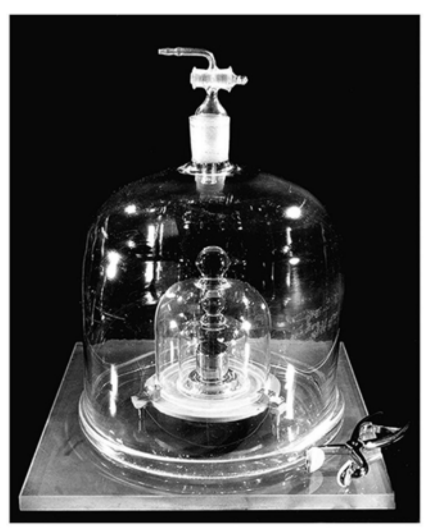
Currently, 1 meter defined as distance traveled by light in 1/299,792,458 of a second

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

Dimensional Analysis (1)

Any valid physical equation must be dimensionally consistent – each side must have the *same* dimensions.

TABLE 1–5 Dimensions of Some Common Physical Quantities

Quantity	Dimension
Distance	[L]
Area	$[L^2]$
Volume	$[L^3]$
Velocity	[L]/[T]
Acceleration	$[L]/[T^2]$
Energy	$[M][L^2]/[T^2]$

From the Table:

Distance = velocity × time

Velocity = acceleration × time

Energy = mass × $(\text{velocity})^2$

Dimensional Analysis (2)

Example:

The period P ([T]) of a swinging pendulum depends only on the length of the pendulum d ([L]) and the acceleration of gravity g ($[L]/[T]^2$).

Which of the following formulas for P *could* be correct ?

(a) $P = 2\pi(dg)^2$ (b) $P = 2\pi\frac{d}{g}$ (c) $P = 2\pi\sqrt{\frac{d}{g}}$

Dimensional Analysis (3)

Remember that P is in units of time [T], d is length [L] and g is acceleration [L]/[T]^2.

The both sides must have the ***same*** units

Try equation (a). Try equation (b). Try equation (c).

$\left(L \cdot \frac{L}{T^2}\right)^2 = \frac{L^4}{T^4} \neq T$

$\frac{L}{\frac{L}{T^2}} = T^2 \neq T$

$\sqrt{\frac{L}{\frac{L}{T^2}}} = \sqrt{T^2} = T$

(a) $P = 2\pi(dg)^2$ **(b)** $P = 2\pi\frac{d}{g}$ **(c)** $P = 2\pi\sqrt{\frac{d}{g}}$

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: 32.8~~5~~ cm^2 → 33 cm^2 ← 2 significant figures

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

[redacted]

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

- Prepare for math test on Friday
- Before Monday lecture, read *Walker*, 2.1 through 2.3.
- Log in to WebAssign; try "Introduction to WebAssign"
- Lecture Homework #1 has been posted on WebAssign system and is due at or before 11:00 PM on Monday, Aug. 31.