Welcome to PHY106
Science for the 21st Century

Course Website:
http://www.phy.syr.edu/courses/PHY106/

❑ Pick up "A, B, C, D Card" and please drop it back in the box when you leave.

Course Overview

❑Aim is to introduce you to some of the ideas of modern physics, including:

Relativity, Cosmology and Particle Physics

❑ Before embarking on those topics, we'll first need to understand forces, energy and light.

❑ This course is meant to use **as little math as possible**. Using some basic high school level math will be necessary though. **I will devote some time to the math we'll need for this course**.

Course Information I

❑ There will be **3 exams plus a comprehensive final**. The **tentative dates** are:

Feb 16, Mar. 24, and April 26

(I tried to stay away from Holidays! Make sure you are here !!!)

❑ If these dates change, you will be given at least 2 weeks notice.

❑ There are **NO MAKEUP EXAMS**. **If you miss an exam for any reason, it's a 0.**

❑ BUT, **you get to drop your lowest exam score** (of the 4 exams).

❑ This is **NOT an invitation to skip an exam**. It is in your best interest to take all 4, and drop the lowest. If you are happy with the results of your first 3 exams, no need to take the final !!!

Course Information II

❑ **Homework:**

Homework will be assigned weekly. Late HW's will lose credit, as specified by the TA.

I encourage you to work together and share ideas. **DO NOT COPY**. After you have discussed the problem, you should write up the answer by yourself. **Copying the work of others will be dealt with harshly**.

❑ **Time:**

Most students should expect to spend about 4-6 hours per week on this course (outside of class time).

❑ **Succeeding in PHY106:**

The most important factors which will determine your grade are: **SLEEP, ATTENDANCE** and **doing HW**.

Course **Information** III

- **Class Time:**

  Please do not chatter during class. Sounds travels well in Stolkin, and it disrupts your peers.

  You are encouraged to ask questions during class. This will help you, me, and your classmates!

- **Getting help:**

  Do NOT fall behind in this course. Ideas presented early in the course will be used later on. So if you feel confused, DON'T WAIT !!! You should immediately get help from your TA or me…

Grading

- **Grading Breakdown:**

Exams:	70% of your grade
Homeworks & Labs:	30% of your grade

- I do strive to make the tests fair. In all my previous courses, the average exam score was typically 75%.

- Your final grade will be determined using a curve. I will not determine a letter grade for each exam, but I will provide you with the distribution of scores.

Education

I have occasionally heard from students in the past:

"Why do I need to learn this? I just want to learn about my major."

Please… do not underestimate the importance of *breadth of knowledge*.

If you learn something that your friends have no knowledge of, you should feel proud.

Because this is an elective for most of you, you should just have fun with this course. Try your best and enjoy learning something new!

Web Site

I have put together a web site for this course at:

http://www.phy.syr.edu/courses/PHY106/

This is where you can access exam scores, HW assignments, labs, etc.

You should familiarize yourself with it, and if you have questions about it, please let me know…

Reading assignments in text are posted under the "Schedule" link.

Sizes and Powers of 10

- **In describing nature, objects vary dramatically in size.**
- **The solar system is about 10,000,000,000,000,000,000,000 times larger than an atom, for example ➔ Scientific notation !**
- **You should become comfortable with seeing scientific notation, in the context of relative sizes of objects.**
- **Useful Web Sites which allow you to step through the powers of 10 are at:**

http://cern.web.cern.ch/CERN/Microcosm/P10/english/P0.html
http://www.wordwizz.com/pwrsof10.htm
http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/

Powers of 10

Positive Powers

$$10 = 10^1$$

$$100 = 10 x 10 = 10^1 x 10^1 = 10^2$$

$$1000 = 10 x 10 x 10 = 10^1 x 10^1 x 10^1 = 10^3$$

Negative Powers

$$0.1 = \frac{1}{10} = \frac{1}{10^1} = 10^{-1}$$

$$0.01 = \frac{1}{100} = \frac{1}{10} x \frac{1}{10} = \frac{1}{10^2} = 10^{-2}$$

$$0.001 = \frac{1}{1000} = \frac{1}{10} x \frac{1}{10} x \frac{1}{10} = \frac{1}{10^3} = 10^{-3}$$

0 Power

$10^0 = 1$

Scientific Notation

Express 12,500 in scientific notation.

$1.25 \times 10^{?}$ **12500.0** Move decimal 4 places to **right**

$12500 = 1.25 \times 10000 = 1.25 \times (10 \times 10 \times 10 \times 10) = 1.25 \times 10^{4}$

Express 0.00367 in scientific notation.

$3.67 \times 10^{?}$ **0.00367** Move decimal 3 places to **left**

$0.00367 = 3.67 \times 0.001 = 3.67 \times (.1 \times .1 \times .1) = 3.67 \times 10^{-3}$

A few examples

The earth has a circumference of about 25,000 miles. How is this number expressed in scientific notation?

A) 2.5×10^{3} B) 25×10^{4} C) 2.5×10^{4} D) None of these

The sun has a radius of 695 million meters. How is this number expressed in scientific notation?

A) 695×10^{5} B) 6.95×10^{8} C) 6.95×10^{9} D) 6.95×10^{6}

An atom has a radius of about 0.0000000002 cm? How is this number expressed in scientific notation?

A) 2×10^{-5} B) 2×10^{10} C) 2×10^{-10} D) 2×10^{-8}

Multiplying powers of 10

The circumference of the earth is about $4x10^7$ [m]. If I were to travel around the earth $3x10^2$ times, how many [m] will I have gone?

A) $7.0x10^9$ B) $1.2x10^{10}$ C) $1.0x10^{15}$ D) $7.0x10^{15}$

$(4x10^7)\ x\ (3x10^2) = (4x3)\ x\ (10^7x10^2) = 12x10^{(7+2)} = 12x10^9$

$= (1.2x10)\ x10^9$

$=$ **$1.2x10^{10}$ m**

A bullet takes 10^{-3} seconds to go 1 [m]. How many seconds will it take for it to go 30 [m]?

A) $3.0x10^{-1}$ B) $3.0x10^{-2}$ C) $4.0x10^{-2}$ D) $4.0x10^{-1}$

$(1x10^{-3})\ x\ (3x10^1) = (1x3)\ x\ (10^{-3}x10^1) = 3x10^{(-3+1)} =$ **$3x10^{-2}$ sec**

Dividing Powers of 10

A gas truck contains $4.6x10^3$ gallons of fuel which is to be distributed equally among $2.0x10^4$ cars. How many gallons of fuel does each car get?

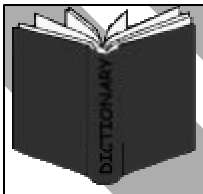
A) $2.3x10^1$ B) $2.3x10^{-1}$ C) 23 D) 2.3

$$\frac{4.6x10^3}{2.0x10^4} = \frac{4.6}{2.0} * \frac{10^3}{10^4} = 2.3x10^{(3-4)} = 2.3x10^{-1}$$

The area of the U.S is about $3.0x10^6$ [sq. mi.], and the population is about $3x10^8$. On average, what is the population density in persons per square mile?

A) $1.0x10^2$ B) $1.0x10^{-1}$ C)$1.2x10^{-2}$ D)$1.0x10^{-2}$

$$\frac{3.0x10^8}{3.0x10^6} = \frac{3.0}{3.0} * \frac{10^8}{10^6} = 1.0x10^{(8-6)} = 1.0x10^2 = 100 \text{ people/sq. mi}$$



Common Prefixes

Commonly used prefixes indicating powers of 10

10^{3} = "kilo" [kHz]
10^{6} = "mega" [Mhz]
10^{9} = "giga" [GHz]
10^{12} = "tera" [THz]

10^{-3} = "milli" [ms]
10^{-6} = "micro" [ms]
10^{-9} = "nano" [ns]
10^{-12} = "pico" [ps]
10^{-15} = "femto" [fs]

How many times larger is a kilometer than a micrometer ?

A) 10^{3} B) 10^{9} C) 10^{6} D) 10^{-9}

➔1 km = 10^{3} m
1 micrometer = 10^{-6} m
➔ $(10^{3}/10^{-6}) = 10^{3-(-6)} = 10^{9}$

How many 100 W bulbs can be kept lit with 100 Tera-Watts?

A) 1.0×10^{7} B) 1.0×10^{9} C) 1.0×10^{12} D) 1.0×10^{13}

➔100 Tera-watts = 10^{14} Watts
➔ $(10^{14}/10^{2}) = 10^{14-2} = 10^{12}$

Common Conversions

Length: 2.54 [cm] = 1 [inch]
Mass: 1 [kg] = 2.2 [lbs]
Speed: 1 [m/sec] = 2.25 [mi/hr]

How many meters are there in a centimeter?
A) 100 B) 0.01 C) 1000 D) 0.001

How many inches in 1 kg ?
A) 2.54 B) 25.4 C) less than 25 D) None of these

Units

- **All physical quantities have units, and they must be used.**
- **One exception is if you are talking only about a *pure number*.**
  For example: How many seats are in this classroom?
- **I will often use *brackets* to indicate units:**
  1 kilogram == 1 [kg]

Be careful when multiplying numbers with units. You have to be consistent!

If a car is going at 50 mi/hr, how far will it have gone in 1 min?

Distance = speed * time = $50\left[\frac{mi}{\cancel{hr}}\right] \times 0.01667[\cancel{hr}] = 0.083$ [mi]

➔ Units must be the same if you want them to cancel out !

Converting Units

Example:
How do I convert the time, say 2 years into seconds ?

This is the way I do it…

$$2\ \cancel{\text{year}}\left(\frac{365\ \cancel{\text{days}}}{1\ \cancel{\text{year}}}\right)\left(\frac{24\ \cancel{\text{hrs}}}{1\ \cancel{\text{day}}}\right)\left(\frac{60\ \cancel{\text{min}}}{1\ \cancel{\text{hr}}}\right)\left(\frac{60\ \cancel{\text{sec}}}{1\ \cancel{\text{min}}}\right) = 3.15\text{x}10^7\ \text{s}$$

$=1 \qquad =1 \qquad =1 \qquad =1$

Notice that we multiply each time by the number one in such a way that it "converts" the units…

Variables/Symbols

- It is often more convenient to represent a number using a letter. For example, the speed of light is $3x10^8$ [m/sec]. To avoid having to write this out every time, we simply use the letter "***c***" which represents this value. That is $c = 3x10^8$ [m/sec].

- We might use the expression, "the particle is moving at 0.1*c*". This should be interpreted as

  "*The particle is moving at 1/10th of the speed of light.*"

- We will often use letters to represent constants or variables, so you must become comfortable with this.