Massachusetts Institute of Technology - Physics Department

Physics - 8.01 **Assignment #1** September 8, 1999.

It is strongly recommended *that you read about a subject* ***before*** *it is covered in lectures.*

Lecture Date	Material Covered	Reading from Ohanian
#1 Wed 9/8	Powers of Ten - Units - Dimensions	Prelude, page 1–18
	Measurements - Uncertainties	Ch. 1, page 1–20
	Dimensional Analysis - Scaling Arguments	*Take Notes*
#2 Fri 9/10	1D Kinematics - Speed - Velocity - Acceleration	Page 25–43
#3 Mon 9/13	Vectors - Dot Products - Cross Products	Page 53–68
	3D Kinematics	Page 74–81
	Watch videos on *PIVoT* (e.g. keywords: *vector multiplication*,*dot product*, etc. and look at the Simulation)	
#4 Wed 9/15	3D Kinematics	Page 74–84
	Falling Reference Frames	Page 86–90

Due Wednesday, Sept 15, before 4 PM in 4-339B. Solutions will be available on Sept 17.

1.1 *Estimates and Uncertainties* – Ohanian page 21, question 1.

1.2 *Fundamental Units* – page 21, question 14.

1.3 *How to measure the thickness of one sheet of paper to a high degree of accuracy?*

a) With a ruler, measure as accurately as you can the thickness (in mm) of your temporary five-chapter copy of Ohanian (excluding the yellow front and back cover).

b) What is the approximate uncertainty (often called error) in your measurement (in mm)?

c) What is the percentage uncertainty (often called relative uncertainty or relative error) in your measurement under a)?

d) Deduce from your answer under a) the thickness of one sheet of paper (in microns).

e) What is the uncertainty in the thickness of one sheet of paper (in microns)?

f) What is the percentage uncertainty in your result of the thickness of one sheet?

g) Different students may find very different values for the thickness (even if we take the uncertainty in their measurements into account). Why is that expected?

1.4 *Relative Uncertainties*
There is a very large difference in the relative uncertainties of the measurements of (i) the length of the student measured in lectures on 9/8, and (ii) the thickness of the femurs shown in lectures (see the data on the 8.01 Home Page). What is the relative uncertainty (in %) for the student's length, and what for a typical value of the thickness of the bones? Why are the two so very different?

1.5 *Distant Quasar* – page 22, problem 8.
http://dir.yahoo.com/Science/Astronomy/Astrophysics/Stellar_Phenomena/Quasars/

1.6 *Distances on Earth* – page 22, problem 10.

1.7 *Atoms in your Body* – page 23, problem 26.

1.8 *Astronomical Distances* – page 23, problem 29.
http://einstein.stcloudstate.edu/Dome/clicks/au.html

1.9 *Mean Density of Stars* - page 24, problems 37 and 38.
http://search.yahoo.com/bin/search?p=neutron+stars

1.10 *Position, Velocity, Speed, and Acceleration.*
The position, x (in m), of an object that moves along a straight line is changing with time, t (in sec), as follows:

$$x = +16 - 12t + 2t^2$$

a) Make a plot of the position x vs. time from $t = 0$ to $t = +6$.

b) Make a plot of the velocity, v (in m/sec), vs. time from $t = 0$ to $t = +6$.

c) Make a plot of the acceleration, a (in m/sec^2), vs. time from $t = 0$ to $t = +6$.

d) What is the velocity at $t = 0$, $+2$, and $+4$?

e) What is the acceleration at $t = 0$, $+2$, and $+4$?

f) When is the velocity zero, and what then is the x position of the object?

g) What is the average velocity between $t = -1$ and $t = +3$?

h) What is the average velocity between $t = 0$ and $t = +6$?

i) What is the average speed between $t = 0$ and $t = +6$?

j) At what time does the object reverses its direction?

1.11 *Car Crash and Seat Belts* – page 49, problem 35.

1.12 *Brain Teaser - Returning to the same Point on Earth.*
A person starts walking at point A on earth. She walks 10 km to the south, stops, then walks 10 km to the east, stops, then 10 km to the north, and she is back at point A where she started. Find all points on the surface of the earth that will meet this condition. Don't miss any, there are an infinite number of them!

1.13 *Human Femur.*
Look at http://www.wcape.school.za/subject/biology/skeleton/femur.htm. You will see a human femur on a scale roughly 2:1.

a) What is the ratio d/l as defined in class (look at our plot on the 8.01 home page)? The ratio d/l is independent of the scale. You will not be able to measure the average value of d as defined in class. This, however would make a difference of at most 10%.

b) What is the average value of d/l of the data in our plot? This value is substantially higher than the value under a).

c) Can you come up with reasons why that may be the case. Frankly, I am somewhat at a loss. Since humans walk on two legs, I had expected the value of d/l for humans, if anything, to be *higher*, not lower, than the average value for the mammals in our plot as they walk on four legs.

REMEMBER!

8.01 Home Page http://www.mit.edu/~8.01/Fall99/
There are 26 recitation sections. If you want to change, for whatever reason, please go to the physics education office (4-352).