PHY180F 2004 ASSIGNMENT 1
Due: Thursday, September 23
(In the first 5 minutes of your tutorial)

1) Download DataStudio from http://www.pasco.com onto your personal computer. Let us assume that you have downloaded DataStudio.
If you are using Microsoft Explorer: Click on the link, Assignment1Problem1 on the Assignments page or on the News page (http://faraday.physics.utoronto.ca/PHY180F/Assignment1Problem1.ds) and the DataStudio session will start.
If you are using Netscape: Right click on the link and save (depending on your version of Netscape you will get a message like "Save Link Target as …") the DataStudio file on your computer. Start a DataStudio session and open the activity (file) that you have just saved.

When you start DataStudio it wants to know which interface was used to create the data in the laboratory. Choose the 750 interface. Note that you don't actually need an interface because you will not be taking data but only modifying data.
The data is for a mass executing slightly damped simple harmonic motion on the end of a spring.
   a) How many pulses of ultrasound is the sensor emitting per second?
   b) Expand the graph for the section of the graph between 0.75 s and 1.00 s. Assume that the graph is linear (which it isn't). Perform a linear fit and find the average speed of the mass between 0.75 s and 1.00 s.
   c) Print the graph for the data between 0.75 s and 1.00 s with your results for the linear fit making sure that **nothing** is covering the data points.
   d) Assume that the data can be described by $y = y_0 + A\sin(\omega t + \phi)$. Determine a value for ω without using the fitting routines of DataStudio.
   e) Determine a value for ϕ without using the fitting routines. (Hint: What is y when t = 0?)
   f) In the *Fit* menu click on *Sine Fit*. The best Sine fit to all the data will appear. Note that since the amplitude of the data is decreasing, an 'average' amplitude is chosen. What DataStudio calls the *Phase* (coefficient C) in not actually the phase angle. To see how it is defined, click on *Curve Fit* on the main toolbar. Using this definition of C, calculate ϕ. [It should be close to the value you found in (e) but not exactly the same since DataStudio fits to all the data but you were concentrating on the data near t = 0.]

2) Have your picture taken in the Engineering Science office. Do this immediately since there may be a lineup when this assignment is due.

3) You are responsible for learning error analysis for use in the laboratory on your own. All the information that you need, (and there is a lot of it), is on the web site:
http://www.upscale.utoronto.ca/PVB/Harrison/ErrorAnalysis/
Study this information and answer this question which was actually generated by ERRTST.

You have repeated the measurement of the time for a metal hoop to swing through 20 oscillations 9 times. The average value of your measurements is 39.60 seconds. The standard deviation of the sample is 0.23 seconds which is larger than the reading error of the clock. What is the error, in seconds, in the average value of your trials?

4) If you take two parallel metallic grounded plates of area A and separate them by a distance d you would suspect that there should be no force between them since they are both grounded. However, because of the effect of the plates on the vacuum fluctuations of the electromagnetic field there is an attractive force F given by $\frac{F}{A} = \frac{\pi^2}{240}\frac{\hbar^n c^m}{d^p}$ where c is the speed of light, $\hbar = \frac{h}{2\pi}$ where h is Planck's constant and n, m and p are numbers. This is known as the Casimir effect and is interpreted as direct evidence for quantum effects in the vacuum. Using dimensional analysis, determine the numbers n, m and p. A **proof** is required and not just a guess.

5) Dimensional analysis is useful for resolving the discrepancy in the notation used in Physics and Civil Engineering. For example, both Physics and Civ use the term "moment of inertia" with the same symbol I even though the meaning is different.
   a) In Physics, if a torque τ (Serway p. 306) is applied to an object and it experiences an angular acceleration α (Serway p. 295) then
   $$\tau = \mathrm{I}\,\alpha$$
   where I, the moment of inertia, is that property of a body which measures its resistance to angular acceleration. This means that the larger the moment of inertia the less will be the angular acceleration of the object. Use dimensional analysis to determine the dimensions for moment of inertia in Physics?
   b) In Civ, when a beam is loaded there will be a bending moment τ_{M} and the beam will experience a tensile stress σ (Serway p. 373) [Although you probably will use the symbol M for the bending moment in Civ., I will use τ_{M} to emphasize the fact that a bending moment is really an internal torque and I wish to draw a comparison to the formula in (a)]. The Flexure Formula in Civ. says that for a symmetric beam of thickness y but of unspecified shape, the maximum bending stress σ at some point along the beam is related to the bending moment at that point by
   $$\tau_{\mathrm{M}} = \left(\frac{2}{\mathrm{y}}\right)\mathrm{I}\,\sigma$$
   where I, the moment of inertia, is that property of a body which measures its resistance to bending (or to stress and hence to strain). This means that the larger the moment of inertia (which depends on the shape) the less the beam will bend. Use dimensional analysis to determine the dimensions for moment of inertia in Civil Engineering?
   c) Although moment of inertia has a similar meaning in Physics and Civ. there is a difference. Keeping in mind what we learned from dimensional analysis in (a) and (b) if I wanted to be nice to PHY180F students, instead of saying "moment of inertia" I should say "mass moment of inertia" and the civil engineers should say "_____ moment of inertia". What is the word that replaces the blank?

If you wish to be called by a name which is different from the one that appears on ROSI then please email me (john.pitre@utoronto.ca) so that I can change the class lists (I won't change ROSI). Examples:

My name appears as:	**I wish to be addressed as:**
Robert	**Bob**
Nicollette	**Nicole**
Jun Min	**Frank**
Charles Chin Kei	**Chin Kei**