PHY151H1F – Practical 4: Digital Measurements, Force and Acceleration

Don't forget:

- Write your **Pod Number** clearly on the front of the booklet, and fill in "1" for the *book no*. – If you require more than one booklet during today's practical, ask your TA and fill out the book number and *total number of books used* on each booklet.
- List the **Names** of all participants on the cover of the booklet. You do not need to write your student numbers. Note if any participants arrived late or left early.
- Fill in the **Date** on the front page of the booklet.

Note that the activities below have numbers which refer to numbers in the Physics Practicals Modules at http://faraday.physics.utoronto.ca/Practicals/ .

First Hour: Complete the "Uncertainty in Physical Measurements Module 2 - Digital Instruments" which is available online at:
http://www.upscale.utoronto.ca/PVB/Harrison/GUM/02_DigitalInstruments/02_DigitalInstruments.pdf
Answer all 9 questions, and measure the diameter of the coin.

Mechanics Module 2, Activity 14

In this Activity you will use a *Fan Accessory*. The fan accessory clamps to the collision cart and produces an approximately constant force upon it.

- **Avoid a runaway Cart falling off the Track.**

Level the Track and leave the Motion Sensor mounted on one end. Warm up the bearings of the wheels of the Cart by rolling it up and down the Track a few times. Set the fan angle at zero degrees.

A. Put 4 AA batteries in the Fan Accessory. Carefully clip the fan accessory to the top of the collision cart, avoiding putting too much pressure on the wheels of the cart. Place the Cart on the Track close to the Motion Sensor but at least 0.15 m away from it. You will want the direction of the air from the fan to blow towards the Motion Sensor. Turn the fan on and use the Motion Sensor to measure the acceleration of the Cart.
B. Sketch a multiple-flash photographic sequence (taken at approximately equal time intervals) of the Cart.
C. Consider the Cart, motor, fan and the housing for the fan as the system under consideration. Sketch a Free Body Diagram of all the force acting on the system when the Cart was accelerating in Part A.
D. Use the spring-scale to measure the horizontal force acting on the system by the fan when it is not moving. You may wish to loop a length of string over the small metal pin in the cart in order to attach the spring-scale. Is this the force acting on the system when it is moving?
E. Repeat Parts A – D with two batteries swapped out for aluminum dummies. Note that the small screwdriver is supplied to help you pry out the batteries. This will halve the voltage provided to

the fan motor, decreasing the fan speed and decreasing the force on the system. Put the real batteries back where the dummies were so that the mass of the system remains the same.

F. Sketch a graph of acceleration versus force, with the force on the horizontal axis. Be sure to include the origin on the graph. Although you only have two data points, what do you think the shape of the graph is for an arbitrary number of data points?
G. Is there a "free" third data point that you can include in your graph? Hint: what is the acceleration of the Fan Cart when the fan is off?
H. Sketch a straight line that "fits" the two data points. Should the line go through the origin?
I. How much can you vary the slope of the line and still more-or-less "fit" the data?
J. From the slope of this line, make a prediction of the mass of the cart+fan system. Find a scale in the room and directly measure the mass of the cart+fan system. Is your slope reasonable?

Mechanics Module 2, Activity 15 (If You Have Time)

A key aspect of the scientific method is that often when a physical system has many variables we can keep all but two of the variables constant, and can investigate how those two variables relate to each other. In Activity 14 you varied the force applied to the Cart and saw how different forces cause different accelerations of the Cart. In this Activity you will apply the same constant force to the Cart but will vary its mass.

A. Measure the mass of the Fan Accessory, the Cart, and the two available masses.
B. The Fan Accessory snaps on top of the cart. In addition, some supplied metal masses can be placed on the Cart. How many possible values of the total mass are possible with and without the extra masses?
C. Using the 4-battery maximum force from the fan, measure the acceleration three different values of the mass.
D. Sketch a graph of acceleration versus total mass, with the mass on the horizontal axis. What is the shape of the graph?
E. Sketch a graph of acceleration versus one over the mass, with one over the mass on the horizontal axis. Include the origin in the graph. Is this graph simpler than the one in Part D?
F. For the graph of Part E, draw a straight line that "fits" the data. Should the line go through the origin? Why?
G. From the slope of this line, make a prediction of the force of the fan. Recall from Activity 15 what you actually measured for the force of the fan. Is your slope reasonable?

The Mechanics Module 2 Guide was written in July 2007 by David M. Harrison, Dept. of Physics, Univ. of Toronto. Some parts are based on Priscilla W. Laws et al, **Workshop Physics Activity Guide** (John Wiley, 2004) Unit 5.
Last update by Jason Harlow Oct. 6, 2015