PHY131 Practicals Day 2 Student Guide

Summer 2009

- REMEMBER: For each Practical session two members of each Team will serve the following roles:

Facilitator: This person is responsible for keeping the Team on track with the Activities.

Recorder: This person takes primary responsibility for recording all work in the lab notebook.

Please choose a different Facilitator and Recorder than last time, and record those roles in the notebook. Everyone should have a chance to be each during these first 5 practicals. (Note that on the 6^{th} practical all the teams will be scrambled.)

- Don't forget the **Error Analysis Assignment** is due this Thursday during practicals. You should hand it to one of your TAs before leaving practicals on Thursday. You may access this assignment at:

https:// www.upscale.utoronto.ca/PVB/Harrison/ErrorAnalysis/index.html

This is a series of online tutorials which must be viewed with a computer. PHY131 students must read through and perform the activities in these tutorials, and write the answers on a paper print-out of the 3-page "Answer Sheet", which is linked as a PDF on the first page of the assignment.

Concepts of this week's Module

- The Scientific Method
- Kinematics: Position, Velocity, Acceleration
- Newton's First Law

Scientific Method Module

"God is subtle but he is not malicious."
-- Einstein

The *Scientific Method* is a set of techniques and assumptions used to try to discover the organizing principles of the physical universe. In this Module, we will explore the method using a "universe" of a set of playing cards.

Here your Instructor will present cards from a deck to you; your task will be to figure out what 'law', if any, controls the pattern by testing hypotheses (i.e. through conjecture and refutation). By “pattern” we mean the order in which the cards are placed in the deck. For example, one pattern is that the cards alternate between red and black.

The basis of the Scientific Method is that one must be prepared to “dare to be wrong.” If we are not prepared to be wrong, then we are not able to increase our understanding.

A. List five different patterns that might be true for the cards in the deck. These should be possible general patterns, not predictions of what the next card might be. For each pattern, list what cards would support the hypothesis and what cards would falsify the hypothesis.
B. It is likely that in Part A you made one or more assumptions about that nature of the “universe” of the deck of cards. These could be:
    - The deck contains four suits: clubs, diamonds, hearts and spades.
    - The deck contains aces, cards numbered between 2 and 10, plus jacks, queens and kings.
    - There are 52 different cards in the deck.
    - Etc.

   Identify as many of those assumptions that you have made as possible.
C. Your Instructor will show you the first three cards of the deck. For the patterns of Part A:
    - Which have been proven to be correct?
    - Which have been proven to be incorrect?
    - Which have not been proven to be either correct or incorrect?

   Have any of your patterns been proven to be correct? What would be necessary for a pattern to be proven to be correct? If all of your patterns have been proven to be incorrect, try to choose two or more patterns that might be true for the cards of the deck based on the three cards that you can see.
D. Your Instructor will show you the next three cards of the deck. For the patterns not proven to be incorrect in Part C:
    - Which have now been proven to be correct?
    - Which have now been proven to be incorrect?
    - Which have not been proven to be either correct or incorrect?
E. Can you now say what the pattern of the cards in the deck is? What would be necessary for you to be 100% sure that you know what the pattern is?

Mechanics Module 2, Activity 9

This Activity uses the Cart and Track that were introduced in Module 1. Remember to:

- Push the Cart and let it run up and down the Track a few times to warm up the bearings in its wheels.
- Check that the Track is level.

Now use the thin blocks to raise the side of the Track closest to the wall a few millimeters.

A. Place the Cart on the Track near the end closest to the wall, place the supplied wooden block on the Cart, and give the Cart a very gentle push. Does it move at a constant speed down the track? If it is slowing down, raise the height a bit more. If it is speeding up, reduce the height. At what height does the Cart move at approximately constant speed? The playing cards are a good way to make small changes in the height.
B. When the Cart is moving at constant speed down the Track, sketch a Motion Diagram of its motion.
C. Treat the Cart plus the block on top of it as a single system. When the Cart is moving at constant speed down the Track, sketch a Free Body Diagram of all the forces acting on the system when it is about half-way down the Track.
D. *[removed due to time constraints]*
E. *[removed due to time constraints]*
F. Place the wooden block in front of the Cart so the cart will push it down the Track. Now there will be more friction. Now what height must you raise the Track to have the Cart moving at approximately constant speed?
G. Again treat the Cart plus the wooden block as the system. Sketch a Free Body Diagram of all the forces acting on the system for Part F.
H. If you could completely eliminate the friction of the Cart and Track, what height would the end of the Track be raised for the Cart to move at constant speed?

Expt *Mechanics Module 2, Activity 10*

For this Activity you will be using a computer-based laboratory system with an ultrasonic motion sensor and motion software. The motion sensor acts like a stupid bat when hooked up with a computer-based laboratory system. It sends out a series of sound pulses that are too high frequency to hear. These pulses reflect from objects in the vicinity of the motion sensor and some of the sound energy returns to the sensor. The computer is able to record the time it takes for the reflected sound waves to return to the sensor and then, by knowing the speed of sound in air, figure out how far away the reflecting object is.

To get the software running:
Double-click: the Labview icon, which should be on your desktop.
Click: File → Open → P:/Labview/motion-sensor
Click: Start Detector
Click: Collect Data

There are a few points to be aware of when using the sensor:

1. The sensor cannot detect distances less than about 0.15 meters because it cannot record reflected pulses than come back too soon after they are sent.
2. The ultrasonic waves spread out in a cone of about 15° as they travel. They will "see" the closest object. Be sure there is a clear path between the object you are tracking and the motion sensor.

Set the detector to collect about 40 samples per second. Set the switch on top of the sensor to the wide beam, which on some sensors is indicated by an icon of a person.

Use the system to take position-time data of one of your Team as he/she walks towards and away from the sensor. Try to glide as smoothly as possible at constant speed.

> Loose clothing like bulky sweaters are good sound absorbers and may not be "seen" very well by the motion sensor.

The software will compute the average velocity and acceleration, just as you did by hand in Activity 8 of Module 1. Use the software to do those computations. Does the plot of average velocity look smooth? If not, why? What about the plot of average acceleration?

If you have time: Mechanics Module 2, Activity 7

[***STOP!*** Please go back and take a second look at what you have recorded in your notebook for the mandatory activities. Is there anything missing? Can anything be improved? Does your TA have advice on what you might be able to do better? Please do not attempt this "If you have time" activity until you feel confident that the other activities are completed to the best of your ability, and you have obtained permission from one of your TAs.]

You can swim at a speed v relative to the water. You are swimming across a river which flows at a speed V relative to the shore. The river is straight and has a constant width.

A. If you wish to swim directly across the river, in what direction should you swim relative to the water in the river?
B. If you wish to get across the river as quickly as possible and don't care where you land on the opposite bank, in what direction should you swim relative to the water?

Normal text last revision: May 15, 2009.
Violet text last revision to this write-up: May 19, 2009.

This Mechanics Module 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. The Scientific Method Module is based on materials developed by Allen Journet, Dept. of Biology, Southeast Missouri State University, http://cstl-csm.semo.edu/journet/BS107/LabManual/BS107-LAB3%20F2008.pdf.