PHY131 Laboratory

Scaling and Motion Diagrams

May 15, 2008

[Based on materials being planned for the *U of T Physics Practicals*, to be launched in Fall 2008]
Last revision: May 15, 2008 by JJBH

Purpose

To investigate the nature of scaling, units, and the use of motion diagrams.

Teamwork Basics

You will be working in a Team with about three other students. The Team will have a Notebook, to which you are all expected to contribute. Do not write your names on the front of your notebook; write your team name! (YOUR names should go inside the book by Experiment Title.) The first thing your team should do is choose a name. The name should be something unique but not specific you the people in your team, as you will be switching teams later in the semester. You should preface your team with your group code. For example, if your group is 1F and your team name is Wolves, beside STUDENT'S NAME, write: 1F: Wolves.
For COURSE NUMBER, write PHY131 / 132 Summer
For DEMOSTRATOR'S NAME write your demonstrator's name!
For LAB SESSION NO. write P5201 (2:00PM) or P5101 (7:00PM)
For LAB GROUP NO. write again your group code (ie, 1F)

Take some time to get to know other members of your team and their strengths. For each lab session, there should be one person elected as the **Note-taker** (in charge of making sure everything gets recorded in the notebook) and another person as the **Facilitator**. The roles of Note-taker and Facilitator should change person *every* lab session. All team members should have a chance to be both this semester.

Responsibilities of the Facilitator: the facilitator is the person who keeps the group progressing in the right direction (i.e., toward productivity). Therefore, the facilitator should:

- Focus the team on the task (both short term and long term)
- Get participation from all team members
- Keep the team to its agreed-upon time frame (both short term and long term)
- Suggest alternative procedures when the team is stalled
- Help team members confront problems
- Summarize and clarify the team's decisions

Equipment List

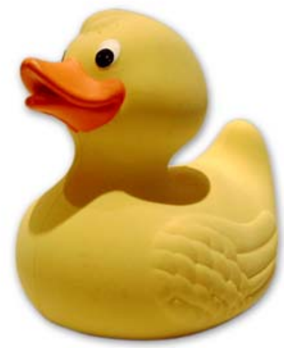
Item	Qty	Item	Qty
2.2 meter Track, Pasco ME-9453	1	Metal rod, 60 cm long, 1/2" diameter	1
Collision Cart, Pasco ME-9454	1	Cart Launcher, Pasco ME-9488	1
PASCO Large Table Clamp, ME-9472	1	End Stop, Pasco ME-9808	1

Setup Notes:

The track should be mounted with the ruler side toward where students sit. The bumper on the top that is closest to the end of the table should be removed and put into storage. The pivoting rod-clamp should go where the bumper normally goes. The rod clamp, large table clamp and aluminum rod can be used to secure one end of the track to the table. This allows that end to be raised.

Activity 1: Scaling

A sculptor is making a statute of a duck. She first creates a model.



A. To make the model requires exactly 2 kg of bronze. The final statue will be 5 times the size of the model in all three dimensions. How much bronze, in kg, will she require to cast the final statue?
B. When the sculptor finished making her model of the duck statue, she gave it 2 coats of varnish. This took exactly one can of varnish. How many cans of varnish will she need to give the final statue 2 coats of varnish?

The ancient Greeks built a temple to Apollo on the island of Delos. It was 11 m wide, 24 m long, and 10 m high. In 427 B.C. a plague ravaged Athens, and the Athenians consulted the oracle on Delos, who demanded that they double the size of the temple.

C. What is the original volume of the temple?
D. The Athenians re-built the temple by doubling the size of each dimension of the temple. What was the volume of the new temple?
E. The Athenians consulted to oracle again, who said "You have not doubled the size of god's temple, as he demanded of you." Assuming that the oracle meant they should double the volume, not the linear dimensions, what would be the dimensions of the temple that the oracle wanted the Greeks to build?

Activity 2: Units

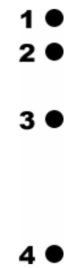
Mort the politician has a not-so bright idea that we could save money by simplifying the standards for units. Instead of having a unit of length be fundamental, the politician suggests having a unit of volume as fundamental. Of course this unit of volume would be called a mort. Then, instead of an expensive separate standard for length we could define the volume of the standard kilogram to be exactly 1 mort.

A. In this system of units, what is the unit of density?
B. What is the density of the standard kilogram in kg/mort?
C. The density of the standard kilogram is about 21,500 kg/m^3. The density of water is 1000 kg/m^3. What is the density of water in kg/mort?
D. In this system of units length is now a derived quantity. What is its relation to the mort?
E. You have an object of unknown material which you would like to compare to a mort. How might one actually measure the volume of this object?

Activity 3: Motion Diagrams

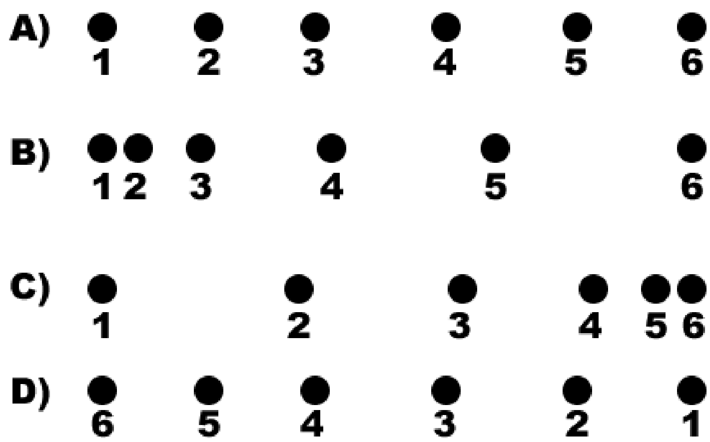
A useful visualization technique in studying motion is called a motion diagram. We will be using these diagrams frequently in this course.

For example, consider an apple that is dropped from rest at some height above the ground.



For many objects in translational motion we can ignore the details of the object itself and model the object as an ideal particle and draw it as a simple dot. We number each dot to show the order in which the apple was at the positions indicated. The same amount of time elapses between each dot and the next one. The figure to the right shows the motion diagram for the apple in free fall.

Four motion diagrams are shown below. One is of a car moving to the right at constant speed, one is of a car moving to the left at constant speed, one is a car accelerating to the right away from a stop light that has just turned green, and one is a car moving to the right and slowing down as it approaches a stop sign. Which motion diagram corresponds to which case?



Activity 4: Cart on a Track

This Activity will involve a Track and Collision Cart.   Please do not adjust the positions where the feet are mounted on the Track. Note that although the Carts have low friction, the fact that they do slow down and stop means the friction is not zero.

A Cart Launcher is mounted on one end of the Track. Raise the other end of the Track by raising the feet 3 cm. The Launcher may be cocked by pulling back the horizontal rod until the disc mounted on it latches to the “finger” on the base. Cock the Launcher and place the Cart against it. Fire the launcher.

You want the Cart to travel almost but not quite all the way up the Track. You want the highest position to be at least a few cm away from the magnetic bumper mounted on the far end of the Track, so the cart does not interact with the bumper. You may need to adjust the Launcher to achieve this. There is a disc mounted on the rod that pushes the Cart whose position can be adjusted to get the desired force.

A. Sketch a motion diagram of the movement of the Cart up the Track It should have some resemblance to one of the motion diagrams of Activity 3; which one does it resemble?
B. Roughly, what is the time between each successive dot of Part A?

Remember that best laboratory practice is to record everything. The Launcher includes a scale the reads how far the spring has been compressed when it is cocked. You should record this value.

Note and record the position of the Cart as measured by the scale on the Track when it is resting against the Launcher when it is not cocked.

C. Launch the Cart and note the position on the scale of the Track where the Cart is at its maximum distance. Repeat a few times, recording each position. Are the values exactly the same for each launch?
D. What are all the reasons you can think of to explain why the positions are not exactly repeatable? The manufacturer of the Launcher says it will launch the cart "with the same force each time." Is this statement correct?
E. How can you quantitatively characterize the spread in values of the positions that you measured?
F. Is it possible to have an apparatus similar to this one for which the positions would be exactly the same each time?
G. What is the mean, i.e. average, value of the positions you measured? What is the mean value of the total distance the Cart travels up the Track between launch and momentarily coming to rest at the top of the Track?