Motion and Friction Simulation

Notes:

1. You do not have to come to lab this week, but your TA will be available during the lab period to help with this assignment
2. This lab can be done at home, from a campus computer, or from any other computer with an internet connection.
3. You will produce a lab report and turn it in by 5:00 PM on Friday of week 7.
4. I strongly recommend doing the lab early in the week, rather than waiting until it is almost due. If you have computer trouble, you will want to have plenty of time to fix it before the deadline. No excuses!
5. You may work with your usual lab group or alone, but each student should turn in his or her own lab report.
6. The web site you will be using is very easy, and works with most browsers, operating systems, etc. If you have any trouble, seek help from one another on CN.

OBJECTIVE

In this experiment, you will be exploring friction through an online simulation tool developed at the University of Colorado, Boulder.

EQUIPMENT

Computer with internet connection and web browser.

Excel, Numbers, or other graphing software

Watch with second hand, stopwatch or other timer.

PROCEDURE

PART I – Introduction

In this part, you will explore how the simulation works, and practice measuring acceleration.

1. Open a new document in Word, Pages, or any other word processing program, and create a new document. This will be your lab report. You may use any format you like, but it should be clear to a reader what you did, and why. Of course, please be sure your name is on it!

2. Go to the site https://phet.colorado.edu/en/simulation/forces-and-motion-basics. You can use the simulation there by clicking on the image (it has a triangular play symbol like a video). If you prefer, you may download it by clicking the download link just below the image.

3. The simulation has four parts, “Net Force,” “Motion,” and “Friction,” and “acceleration.” You

are welcome to play around with the Net force portion, but for this lab, we will skip to the Motion section. To change sections, click the icons at the bottom of the screen. Play around with the simulation on your own a bit. The controls are very easy.

4. Check all the boxes in the upper right, and play around with "pushing" the crate. Record your observations about how the simulation works. For instance, does the "speedometer" measure speed or velocity (try getting the cart moving to the left).

5. With all of the boxes in the upper right checked, do this basic "experiment."
   a Click the pause button (two vertical bars), so that you can set a force without starting the motion immediately. It will turn into the play button.
   b Set the applied force to 50 N. Then, click the play button and begin timing. Record the speed at 5, 10, 15, and 20 seconds in your report.
   c Use any other program to make a graph of your data. Copy and paste your graph into your report.
   d Use tools in the program, or any other method you know, to determine the slope of the graph, and thus the acceleration. Write a sentence or two in your report explaining this, and comment on whether Newton's second law is accurately simulated by this program.
   e Now, reset the program, remove the "wooden crate," and replace it with the mystery object that looks like a present.
   f Do the same experiment you did above, and use your results to calculate the mass of the mystery present. Include all relevant data, graphs, and conclusions in your report.

PART II – Measuring Friction

6. Now, move to the third part of the simulation, "Friction." Again, play around with the controls to get familiar, and record your observations of how the simulation works. For instance, try getting the box moving, and watch what happens to the arrows that represent forces as it slides to a stop.

7. Using the methods you practiced in the previous section, measure the coefficient of kinetic friction between the wooden crate and the ground. Do this with the friction set to its original value (centered, you can always hit the reset button to get this).

8. Repeat the experiment above, and measure the coefficient of kinetic friction with the friction slider set to "Lots."

9. Use any means you like to determine the coefficient of static friction between the crate and the ground twice: once with the slider centered and once with it set to "lots."

Summary

In the end, your report should include the following measurements. In each case, include a description of your "experimental method," the data you took, a graph if needed, and the result you calculated:

1. Verification that the "Motion" section accurately simulates Newton's 2nd law.

2. Measurement of the mass of the "present" in the motion section

3. Measurements of the coefficient of kinetic friction between the crate and the ground with the friction slider centered, and at its maximum

4. Measurements of the coefficient of static friction between the crate and the ground.