1 Introduction

This lab simulates the concept of specific heat

1.1 Tools

To perform this lab, you must go to the website located at:
`https://ophysics.com/f2.html`
Uncheck the "Show free-body diagram" checkbox, and set the "Vector length" to "short".

1.2 Relevant Equations

The basic kinematical equations of motion for a body undergoing uniform acceleration, a, are:

$$v_f = v_i + at \tag{1}$$

$$x_f = x_i + v_i t + \frac{1}{2}at^2 \tag{2}$$

where the object starts its motion at time $t = 0$ at position x_i and with velocity v_i.

2 Procedure

2.1 Part I: Incline at several angles with/without friction

1. Uncheck the "Show free-body diagram" checkbox.
2. Set the "Vector length" to "short".
3. Set the static and kinetic frictional coefficients, μ_s and μ_k, to zero.
4. Set the initial velocity to -10 m/sec (a negative velocity).
5. Set the mass to be 1 kg.
6. Set the angle to be 20°.
7. Press the start button and note the behavior of the block in your lab notebook.
8. Press the Reset button. Then press Start again and then then immediately press the Pause button. Using the Step button, record in your lab notebook every 0.2 seconds the time, displacement, velocity, and acceleration. You can stop measuring when you have an equal number of points for negative and positive displacements.
9. Repeat steps 1-8 with the mass set to be 10 kg instead of 1 kg.
10. Repeat steps 1-8 (1 kg mass) with the static and kinetic frictional coefficients, μ_s and μ_k, set to 0.3 instead of zero.
11. Repeat steps 1-8 (zero friction an 1 kg mass) with the angle set to 10°, and measure every 0.5 seconds instead of every 0.2 seconds.

3 Data Analysis

1. Does changing the mass change the acceleration of the object? Explain using the data you measured in Procedure 8 and 9.

2. Plot, by hand, in your lab notebook the *position verses time* graph for your data. Make certain time is the horizontal axis for your plot. Only plot every other (or every third) data point so that only about 10 data points are plotted. Make certain the axes are properly labeled with the correct units. Make three separate plots for Procedures 8, 10, and 11.

3. Plot, by hand, in your lab notebook the *velocity verses time* graph for your data. Make three separate plots for Procedures 8, 10, and 11.

4. For your *velocity verses time* data, draw the best straight line through your data using a ruler (do this only for Procedure 8 and 11). Determine the slope of this straight line. This gives an experimental (or measured) value of the acceleration. Write these number in your lab notebook for Procedures 8 and 11.

5. The theoretical acceleration, for a frictionless surface, is $a = g \sin\theta$ where $g = 9.8$ m/sec^2 and θ is the inclination angle. Using this formula, does the theoretical acceleration agree with that given by the oPhysics simulation for the two inclination angles of 10° and 20°? Write these values down in your lab notebook and explicitly show your calculations.

6. How does your experimental values of acceleration compare with the theoretical values? In this comparison, compute a *percent error* between your measured (or *experimental*) value of a and the theoretical (or *accepted*) value:

$$\%Error = \left| \frac{Experimental - AcceptedValue}{AcceptedValue} \right| \times 100$$

   Note that percent errors of 0.1% are excellent, $1\% - 5\%$ are very good, $5\% - 15\%$ are fairly good (expected in this lab course), and greater than 15% are poor measurements. Write your answer to this question in your lab notebook.

7. Take careful cell phone pictures of your lab notebook. Make certain that they are clearly readable. Upload your pictures to Blackboard. If your pictures are jpegs, convert them into a single pdf file (you can use Microsoft Word [or a smartphone app] to do this). ***This must be completed before you leave lab***. No further lab writeup is required for this 1st lab.