Acceleration of Gravity on an Inclined Plane

Purpose: 1. To find the acceleration of gravity by studying the motion of a cart on an incline.
2. To gain further experience using the computer for data collection and analysis.

Equipment Needed: windows based computer with Logger Pro software, motion detector, ballistic cart, aluminum track, wood blocks, meterstick, small carpenter level.

Introduction: In this laboratory you will use the computer to collect position (x) vs time (t) data for a cart accelerating on an inclined track. By comparing the acceleration of the cart when moving up and down the track, the effect of friction can be eliminated and the acceleration due to the effect of gravity alone can be found.

Since the force of friction acts with the force of gravity when the cart is going up the track and against the force of gravity when the cart is going down the track, we can average the slightly increased acceleration (when going up) with the slightly decreased acceleration (when going down) to obtain an acceleration that depends only on the force of gravity. If we call **g** the acceleration due to gravity when an object is in free fall, then the component of this acceleration along the track is **g** $\sin\theta$ where θ is the angle of incline for the track. Thus

$$g \sin\theta = \frac{(a_1 + a_2)}{2}$$

where a_1 and a_2 are the accelerations of the cart up and down the incline. In this lab we will measure acceleration by looking at the slope of the v vs t curve for the cart.

Procedure:

1. Connect labpro to computer and motion detector to DIG/SONIC2 port on labpro. Turn on the computer and load the **Logger Pro** software by double clicking on its icon located within the **Physics Apps** folder. A file named graphlab will be used to set up the computer for collecting the data needed for this experiment. To open this file first select **FILE/OPEN** (with the mouse) and then open the **Mechanics** folder by double clicking on its icon. When this folder opens, double click on **graphlab** to open the file.

2. Incline the track slightly by putting the wood friction block under the track support at approximately the 50 cm mark thus raising that end of the track. (The other track support should be near the opposite end of the track.) Use a bubble level to make sure the track is reasonably level from side to side. Adjust the leveling feet if necessary. Determine the inclination angle θ for the track by carefully measuring the vertical and horizontal travel of the track ($\tan\theta = \Delta y/\Delta x$). Make a sketch in your lab report showing your method of measurement of the angle of inclination.

3. Place the detector at the upper end of the track facing down toward the lower end. Start with the cart at the lower end of the track and give the cart a gentle uphill (toward the detector). Be sure to catch the cart when it returns down the track to prevent damage to the cart or track. Take a few practice runs so that the highest point of the cart's path brings it no closer than 50 cm from the motion detector.

4. Start the computer taking data after the cart leaves your hand and observe both the position and velocity graphs simultaneously by having two windows open—one above the other. Select suitable scales for both vertical and horizontal axes to best show the motion. Be sure to properly label the graphs with titles, units, etc. The graphs should yield smooth consistent curves. If not, repeat the trial again. What type of curve do you expect to see for x vs t and v vs t? Explain.

5. Find the accelerations, a_1 and a_2, of the cart by determining the slopes of the v vs t curve for each portion of the motion (up and down). With the mouse, first select a range of times that represents the motion going up the incline. Then choose **ANALYZE/CURVE FIT** and fit this portion of the velocity curve to a **linear** function of time. The slope should be the acceleration a_1. Similarly, repeat the process by selecting a range of times representing the motion down the incline and thus determine a_2. Use the equation given in the introduction above to determine **g**.

6. Repeat at least two more trials for the same inclination. Average your values calculated for **g** and compare your result with the accepted value: 9.80 m/s^2.

7. Repeat the above experiment (steps 2, 5 and 6) for a larger value of θ by using a larger block of wood to increase the angle of inclination of the track.

6. Show a representative set of data from one of your trials by obtaining a printout of the two graphs, x vs t and v vs t. Show on the graph the time intervals used and the slope of the two different velocity curves (up and down).