Lab #02: Kinematics #1 “Kinematics With Constant Acceleration”

Goal: In this lab we will investigate kinematics for the case of constant acceleration.

1. Introduction:

We will simply tilt the air tracks so that gravity can provide the constant acceleration. The PASCO motion detectors will record position versus time data which we will analyze using MS Excel. When we run the curve fitting routine in Excel, we should get a second order polynomial or quadratic function to fit our data. Recall that:

\[ x(t) - x_o = v_o t + \frac{1}{2} a t^2 \]

Here, \( x(t) - x_o \) is simply the displacement we’ve been calling \( x \) in class. This alternate notation covers the case in which the motion does not start from \( x = 0 \).

Excel will generate a fit that will have the form:

\[ X(t) = At^2 + Bt + C. \]

Our constant acceleration can then be found from the coefficient of the squared term \( A \):

\[ a = 2A. \]

2. Procedure:

(1) Make a table in your lab book to enter your results.

(2) Adjust the motion detector so that your slider is detected on the sloping air track.

(3) Place a book under the track supports on one end of your air track.
   a. Measure the height above the table of each end of your air track.
   b. The tracks are 2 m in length. Determine the incline angle.
   c. Start the slider from rest and let it bounce two or three times to record a couple curves for you to choose your data set from.
   d. Paste data into Excel
   e. Graph one parabolic section of the data.
   f. Create a second order polynomial fit to your data.
   g. Calculate the slider’s acceleration and record the result in your lab book.

(4) Repeat the procedure for two additional incline angles (use the provided books).
(5) Plot all three curves with appropriate titles and axis labels. Be sure to include the curve fitting equation.

**Some suggestions:** For better performance of the motion detector, high data quality and help you understanding, please do the following:
- Set your motion detector's sampling rate to 50 Hz (more points can improve the accuracy of fitting the data).
- Select data generated after the first bounce of the slider.

3. **Questions to be answered with the data in your experiment:**
- For all three accelerations measured divide the result by \( \sin \theta \). Do the results look familiar?
- Why should these results be equal to the acceleration due to the gravity? Please provide a quantitative argument.