Equations of Motion for Constant Acceleration

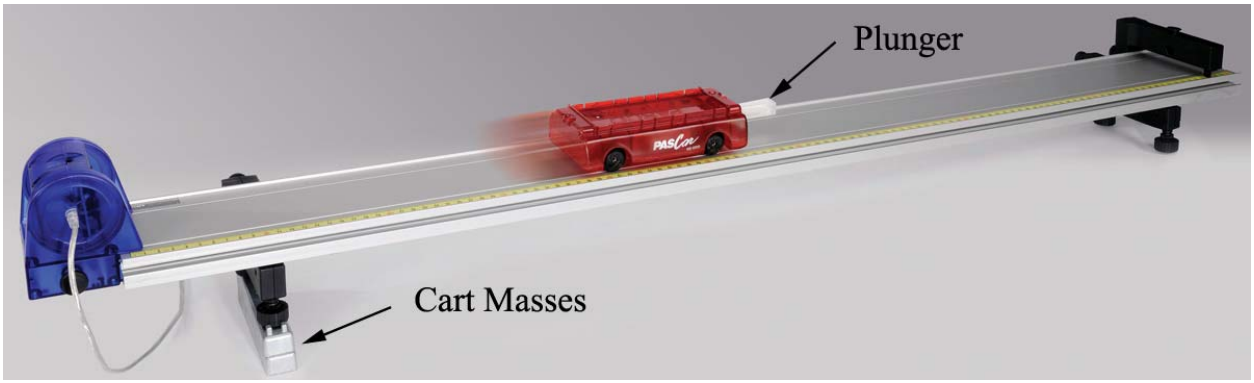

Figure 1: Cart on Incline

Introduction

The motion of a cart as it accelerates down an incline is measured by a motion sensor. Graphs of position and velocity are studied and comparisons are made to the standard equations of motion using User Defined Curve Fits.

Equipment

Qty	Items	Part Number
1	Motion Sensor	PS-2103A
1	Dynamics System	ME-6955

Set-up

1. Set up the track as shown in Figure 1, including feet and endstops. Note that the Motion Sensor is on the end of the track that is the zero point for the yellow rule.
2. Plug the Motion Sensor into the interface, and set the range switch to the "Cart" icon.
3. Make sure the plunger on the cart is on the side towards the endstop.
4. Use the two Cart Masses to incline the track.
5. In PASCO Capstone, create a graph of Position vs. Time.

Procedure

1. Position the back of the cart (closest to the Motion Sensor) at the 16 cm mark as shown in Figure 2. This is the starting position for the cart.

2. Click on Record, and then release the cart. Data collection will NOT start until the cart reaches a position of 18 cm, due to an initial starting condition. This will give you better looking data.

3. You can stop recording at any time, but there is an automatic stop condition that stops the recording when the cart reaches 80 cm.

4. You can delete unwanted runs using the Delete Run feature in the Experiment Control Bar.

5. Get a single good run of position vs. time data.

Figure 2: Starting Position

Position Equation

6. Select a User Defined Curve Fit from the Curve Fit list on the graph toolbar.

7. If the curve fit parameters do not appear in the editor window (at left) click on the curve fit annotation (on the graph) to make it active. Then open the Curve Fit Editor at the left of the screen.

8. The equation for the user curve fit in the editor window will initially be:

   y=A*t +B

   Edit this to read:

   $x_o + v_o*t + (1/2)*a*t\text{^}2$

   To make the subscripted zero, you can right-click and select the subscript.

9. Click on Apply.

10. Record the initial position, x_o, the initial velocity, v_o, and the acceleration, a.

Velocity Equation

11. Create a graph of Velocity vs. Time.

12. Select a User Defined Curve Fit from the graph tool palette.

13. If the curve fit parameters do not appear in the editor window (at left) click on the curve fit annotation (on the graph) to make it active.

14. Edit the equation (in the Curve Fit Editor at left), and change it to

    $y = v_o + a*t$

15. Click on Apply

16. Record the initial velocity, v_o, and the acceleration, a.

Analysis

1. What is the initial position, x_o? Remember that the Start Condition (when data was recorded) was when the cart reached 18 cm. How does it compare?

2. How does your value for v_o from the position graph compare to your value for v_o from the velocity graph?

3. How does your value for "a" from the position graph compare to your value for "a" from the velocity graph?

4. Click on the position graph to make that graph active, then select the Slope tool from the graph tool palette.

5. Move the Slope tool to 0.4 seconds. What is the slope at this point (including units)? How does this compare to the speed on the velocity graph for this same time?

6. Repeat for 0.8 s and 1.2 s.