Acceleration Due to Gravity

Introduction

The purpose of this lab is to measure the acceleration of a cart moving down an incline, and compare the measured value to the theoretical.

A cart on an incline will roll down the incline as it is pulled by gravity. The direction of the force of gravity is straight down, but the component of the acceleration due to gravity that is parallel to the inclined surface is only a fraction of the total accleration due to gravity:

$$a = g \sin\theta$$

where θ is the angle of incline.

Equipment

Qty	Items	Part Number
1	Motion Sensor	PS-2103A
1	Dynamics System	ME-6955
1	Large Rod Base	ME-8735
1	Rod, 45-cm	ME-8736
Required but not included:		
1	Meter Stick	SE-8695

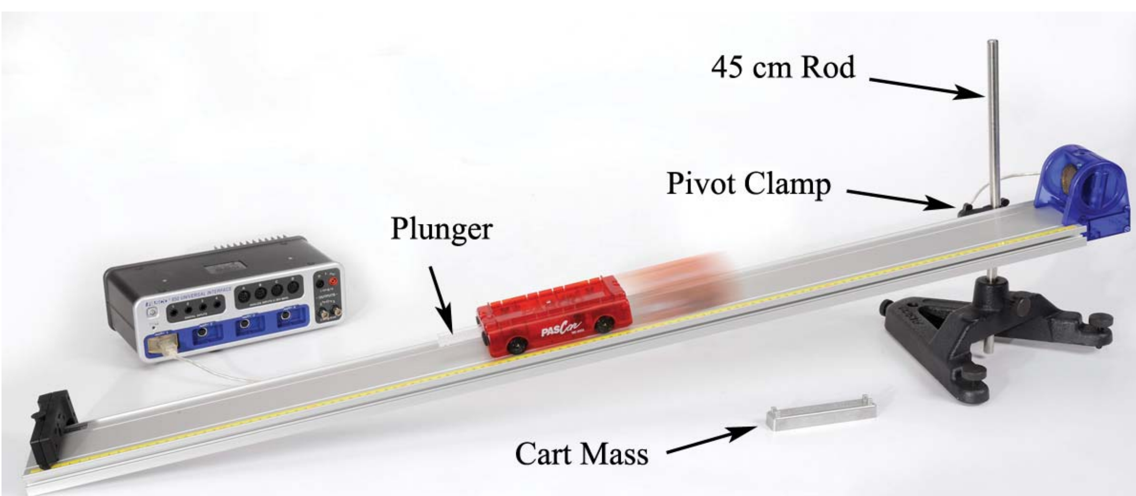

Figure 1: Measuring Acceleration of the Cart Down the Incline

Set-up

1. Set up the track as shown in Figure 1 using the rod base and 45-cm rod. Note that the lower end of the track rests directly on the table, and that the normal track feet are NOT used in this experiment. The square nut on the Pivot Clamp slides into the T-Slot on the track, and allows the track to be secured at various angles.

2. Attach the Motion Sensor to the track and then connect the sensor to the interface. Make sure the range switch on the motion sensor is set to the "cart" icon.

3. The PAScar should be oriented so the plunger hits the Endstop at the bottom of the incline.

4. The Motion Sensor sample rate should be 20 Hz.

5. In PASCO Capstone, make a graph of velocity vs. time.

6. Set a Start Condition based on the Position measurement, is above 0.20 m.

7. Set a Stop Condition based on the Position measurement, is above 0.60 m.

Procedure – Predicting Acceleration

1. Carefully measure the length of the track and record the value below.

2. Adjust the height of the end of the track to about 20 cm.

3. Carefully measure this height and record the value below. The height should be measured to the underside of the track as shown in Figure 2.

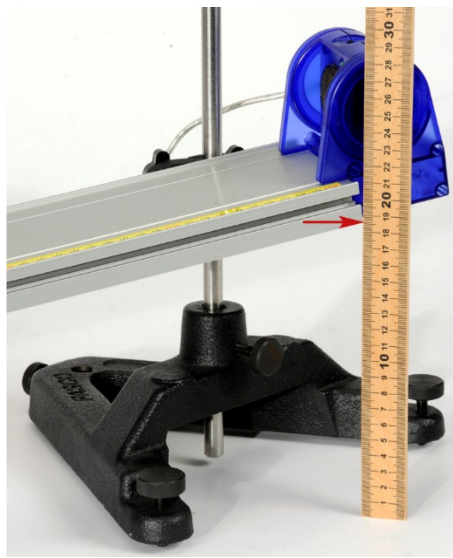

Figure 2: Height of Track

4. Calculate the angle, θ, of the track using the height, h, and the length of the track. See Figure 3. Record the value.

5. Using the accepted value for the acceleration due to gravity, calculate the predicted acceleration of the cart down the incline. Record the value below.

6. There is a start condition so that when the cart is released, data does NOT start recording unless the cart is more than 20 cm away from the Motion Sensor. Click on Recording Conditions in the lower Control Bar.

7. There is also a stop condition so that when the cart reaches 60 cm, data collection automatically stops. This makes it easier to take the data, and you can change these values to suit your experiment.

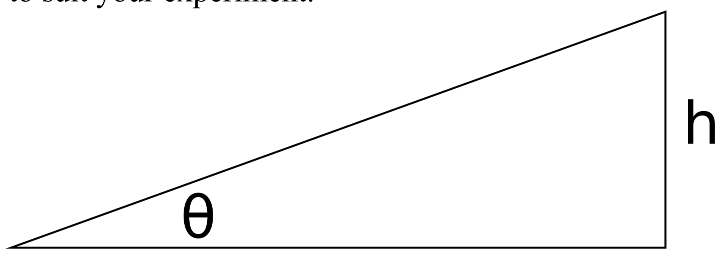

Figure 3: Finding the Angle

Measuring Acceleration

8. Position the cart at the top of the incline, about 15 cm from the Motion Sensor. The cart should be oriented so the plunger hits the Endstop at the bottom of the incline.

9. Start recording data and release the cart. Data will be shown in the graph at right. You can delete unwanted runs using the Delete feature in the lower Control Bar.

10. Select a Linear Curve Fit from the graph tool palette. What is the physical meaning of the slope? Does it have units? What is the uncertainty in your value?

11. Compare to the accepted (theory) value using the % error calculation.

$$\%error = \frac{Measured - Accepted}{Accepted} x100$$

12. Was your measured (actual) value high or low? What might account for this?

Further Study

13. Predict how the acceleration of the cart might change if it's mass was doubled.

14. Add the mass bar to the cart and measure its new acceleration. How does this compare to your prediction?

15. Change the height of the track by about 5 cm and repeat the experiment for a different angle.