Acceleration Along An Incline Plane (1/6/2017) (1 Lab Period)

Learning Goals

-Observer the magnitude and direction of the acceleration on an inclined plane.
-Build scatter plots using PASCO Capstone software
-linearize data to reveal mathematical relationships between variables
-Extract information via fit parameters from experimental data

Provided Equipment

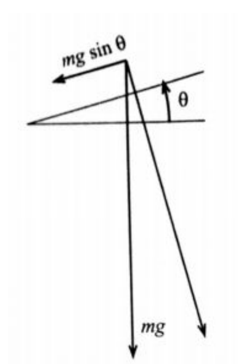
Support Rod and PASCO pivot clamp
2.2 meter PASCO Dynamics Track
Angle Indicator
PASCO SMART Cart and 250-gram mass bar
Interface/Capstone Software
Dynamics Track End Stop

Purpose

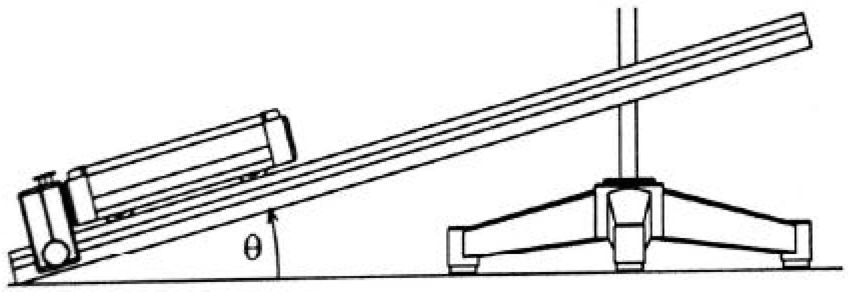
In this experiment, you will investigate a) the magnitude and direction of the acceleration along an inclined plane and b) how the acceleration of a cart rolling down an inclined track depends on the angle of the incline. From your data, you will calculate the acceleration of an object free-falling in the Earth's gravity field.

Theory

A cart of mass m on an incline rolls up and down the incline as is pulled by gravity. The force of gravity (mg) is down (towards the Earth) as shown in the above figure. The component (part) of that is parallel to the inclined plane is a fraction of (mg), the gravitational force, mg sin θ.



To determine the acceleration at any point along the inclined plane, you will place the cart at the bottom of the ramp, gently nudge the cart such that when released, it will move up the ramp, momentarily stop, and begin moving down the inclined plane. Carts moving in gravity fields will experience variable motion which can be observed using data collected with the PASCO SMART Cart. If position and velocity graphs are created using PASCO Capstone, where the slope of the position vs. time graph represents the velocity of the cart and the slope of the velocity vs. time graph represents the acceleration. You will use your knowledge of motion graphs to observe the nature of acceleration as the cart moves up the ramp, momentarily stops, and then moves down the ramp.



Procedure

Prelab
1)Set up the track as shown in the above figure. (Track End Stop installed at the bottom)
2)Connect the SMART Cart to PASCO Capstone.
3)Create two graphs by dragging and dropping two graphs from the display tab.
4)Select position vs. time measurement for one graph and velocity vs. time from the other.

Preliminary observations
6) Adjust the ramp to a 10-20 degree angle and practice sending the car up and down the ramp .
7) Describe the acceleration of the car as it a) moves up the ramp, b) stops, and moves down the ramp. This description will serve as a prediction before collecting experimental data. Record your description in the qualitative data section.
8) Sketch the position vs. time and velocity vs. time graphs in the quantitative data section.
9) Measure the slope of the velocity vs. time graph at points in the data when the cart moves up, stops, and moves down the ramp.
10) Annotate your graph sketches with the magnitude and sign (direction) of the acceleration at each point.
11) Compare the predictions for the accelerations from question 7 (predictions) and question 9 (measurement). Did they predictions agree? If not, how are they different?

Acceleration on the Incline Observations

12)Measure and record the acceleration the dynamics cart experiences while moving along the inclined plane at several (minimum of 5-7 different angles). Determine accelerations from the slope of the velocity vs. time graph. Determined the angles from the angle indicator.

13)Create a data table with the Capstone software, tabulate the acceleration as a function of the sine of the angle.

14)Create an acceleration vs. sin θ and observe the shape of the graph. Sketch or print the graph for your lab write up.

15)Perform a linear curve fit and recording the slope, and R^2 value.

16)What is the physical meaning of the slope? Compare the slope to the expected value.

17)What is the meaning of the R^2 value? How could you improve the experiment to increase the reliability of the curve fit?

18)Repeat the experiment (steps 12 -17) after doubling the mass of the car (place a 250 g mass bar in the car). Before conducting the experiment predict the impact on acceleration after increasing the mass of the car.