Acceleration Down an Incline

1 Equipment

- 2 photogates
- 1 PASCO photogates timer
- 1 utility Stand
- 1 cart
- 1 catch box
- 2 mass bars

2 Introduction

The purpose is to study how the acceleration of an object down an incline depends on the angle of the incline and to obtain the acceleration due to gravity.

A cart on an incline will roll down the incline as it is pulled by gravity. The acceleration due to gravity is straight down as shown in Figure 1. The component of gravity which is parallel to the inclined surface is $g \sin\theta$, so this is the theoretical acceleration of the cart if we neglect friction.

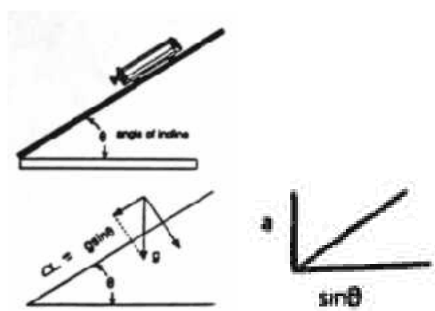

Figure 1: Decomposing g into two components and a plot of a versus $\sin\theta$

To measure the acceleration, the cart will be started from rest and the time (t) it takes for it to travel a certain distance (s) will be measured. Then since $s = \frac{1}{2}at^2$, the acceleration ($a_{measured}$) can be calculated using:

$$a = \frac{2s}{t^2}$$

Since we know $a = g\sin\theta$ in theory, a plot of acceleration versus $\sin\theta$ should give a straight line with a slope equal to the acceleration due to gravity g.

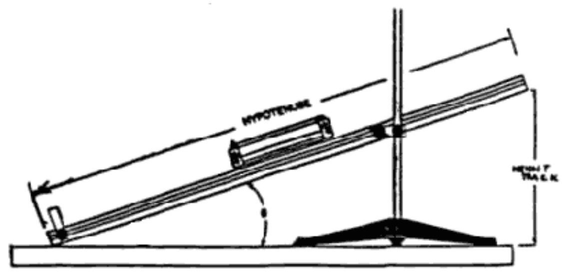

Figure 2: Setup

3 Procedure

1. Set up the track as shown in Figure 2, raising the end of the track to about $H = 10cm$. Place a catch-box at the lower end of the track to prevent damage to the cart as it moves from the incline onto the table. When you measure the height, make sure you measure from the table to the *bottom* of the track.
2. Set the photogate timer to the `PULSE` setting.
3. Have a student hold the cart at the top of the track so that the end of the cart on the top of the end of the track.
4. With the cart in place as described, adjust the photogate close to the cart so that it is just in front of the dark band of the transparent vertical flag. You could see if the photogate is triggered by the red LED on it. Arrange it so that the photogate is NOT triggered until the cart is let go.
5. Record the total length of the track L and the distance between the photogates s. Write all your measurements in m.
6. Press the red rest button on the timer.
7. Let go of the cart at rest and record the time in Table 1.
8. Repeat this measurement one more time.
9. Repeat the experiment for a total of 7 angles by raising and lowering the track to different height. Remeasure s after each adjustment.
10. Complete Table 1.
11. Repeat the above steps with additional mass places on the cart. Complete Table 2.
12. Plot the graph of your measured acceleration versus $\sin\theta$ (NOT versus θ!). Fit a straight line through your points, and calculate the slope of the line. The slope should be close to the the true value of $g = 9.8m/s^2$.
13. Calculate the percentage difference of your measured g with the true value.

4 Questions

- By comparing Table 1 and 2, did the additional mass improve or worsen the experiment? Explain the reasons behind the difference (if any).

Table 1: Acceleration of a cart without additional mass

Height H (m)							
Time (s) [Trial 1]							
Time (s) [Trial 2]							
Average Time t (s)							
$\sin\theta = \frac{H}{L}$							
Distance between photogates, $s(m)$							
$a_{measured} = \frac{2s}{t^2}$ (m/s^2)							
$a_{theory} = g\sin\theta$ (m/s^2)							
Percentage diff of a							

Length of the entire track: $L =$

Slope of the $a_{measured}$ versus $\sin\theta$ graph:

Percentage error of $g_{measured}$:

Table 2: Acceleration of a cart with additional mass

Height H (m)							
Time (s) [Trial 1]							
Time (s) [Trial 2]							
Average Time t (s)							
$\sin\theta = \frac{H}{L}$							
Distance between photogates, $s(m)$							
$a_{measured} = \frac{2s}{t^2}$ (m/s^2)							
$a_{theory} = g\sin\theta$ (m/s^2)							
Percentage diff of a							

Number of mass bars on cart:

Length of the entire track: $L =$

Slope of the $a_{measured}$ versus $\sin\theta$ graph:

Percentage error of $g_{measured}$: