Name: ____________ Physics 1 - Miguel Rocha Date:____________

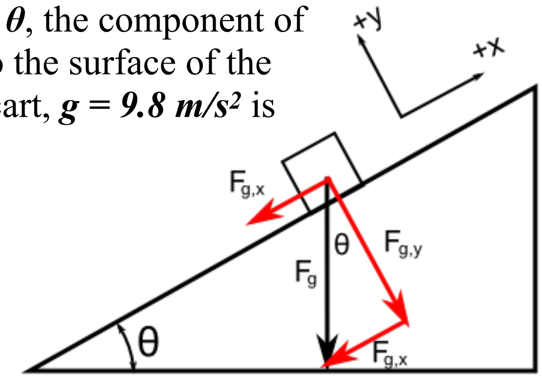
Lab 3: Constant Acceleration

Purpose

The purpose of this lab is to measure the acceleration of a cart moving down an inclined plane and compare the measured acceleration to the theoretical value of ***g** sin **θ***.

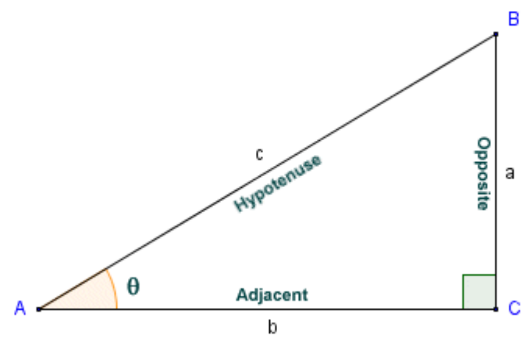
Introduction

If a cart moves on a plane that is inclined at an angle θ, the component of the force acting on the cart in the direction parallel to the surface of the plane is $F_{g,x} = mg \sin\theta$, where m is the mass of the cart, $g = 9.8\ m/s^2$ is the acceleration due to gravity and



$$\sin\theta = \frac{\text{Hypotenuse}}{\text{Opposite}} = \frac{\text{lenght of track}}{\text{height}} = \frac{F_{g,x}}{F_g}.$$

From Newton's second law ($F = ma$) we can then tell that the acceleration of the cart as it moves down the inclined plane is



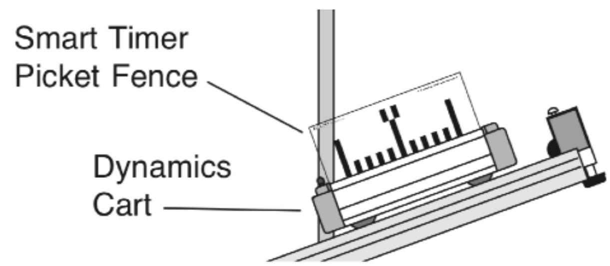
$$a_{\text{theory}} = \frac{F_{g,x}}{m} = \frac{mg\sin\theta}{m} = g\sin\theta\,. \quad \textbf{Eq. 1}$$

In this lab we will compare this theoretical prediction with a measured acceleration. We will measure the average acceleration by measuring the time it takes for the cart to travel 1 meter. For this we will use two photo-gates separated by 1 meter (one near each end of the track). Having the time and the distance we can use the equation of motion for the distance traveled in order to find the acceleration, i.e.

$$d = \frac{a}{2}t^2 \quad \Rightarrow \quad a_{\text{measured}} = \frac{2d}{t^2}. \quad \textbf{Eq. 2}$$

Procedure

1. Setup the inclined plane so that the angle meter reads 10°.
2. Place one photo-gate near the top of the track and one near the bottom, separated by 1 meter (100 cm), and leaving at least one cart-length between the photo-gates and the ends of the track.
3. Connect the photo-gates to the Smart Timer. On the Smart Timer press the Select Measurement key (1) to select the time measurement. Then press the Select Mode key (2) to select the two gates mode.
4. Place the Picket Fence on the cart as shown on the picture to the right.



5. When you are ready to drop the cart press the Start/Stop key (3) on the Smart Meter. When the * shows up on the screen the Smart Meter is ready to measure how long it takes for the cart to go across both gates.
6. Drop the cart 5 times and record the times on your data table.
7. Repeat the experiment after increasing the inclination to 15° and then 20° .

Data Collection

$\theta = 10^\circ,\ \sin\theta = 0.17$

Trial	time (s)
1	
2	
3	
4	
5	
Average	

$\theta = 15^\circ,\ \sin\theta = 0.26$

Trial	time (s)
1	
2	
3	
4	
5	
Average	

$\theta = 20^{\circ}, \ \sin\theta = 0.34$

Trial	time (s)
1	
2	
3	
4	
5	
Average	

Analysis

1. Using **Eq. 1** calculate the predicted acceleration a_{theory} for the 3 different inclinations.

2. Then use **Eq. 2** and the average of your measured times to find the experimental acceleration a_{measured} for the 3 different inclinations

3. Now compute the percent error between the predicted accelerations and the ones you measured. Do this for the 3 different inclinations.

$$\%\ \text{error} = \frac{|a_{\text{theory}} - a_{\text{measured}}|}{a_{\text{theory}}} \times 100$$

4. Is there a trend between your percent error and the inclination? Does your percent error increases, decreases or stays the same as the inclination increases? If there is a trend, that would indicate that the sources of error are inclination dependent, can you think of a source of error that would be inclination dependent?