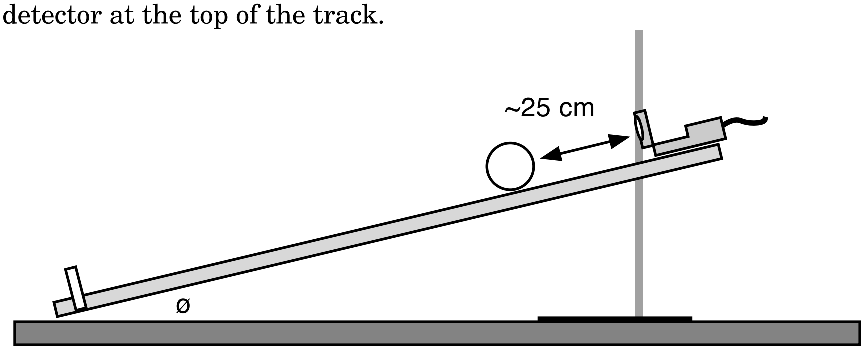
Lab 11-x: Rolling Down a Hill

Purpose: 1. To determine the relationships between the acceleration of different objects down a hill to the angle of inclination of a hill.
2. To compare the accelerations of rolling objects down a hill to sliding down a hill.

Materials: track, clamp & stand, cart, wooden disc, pvc ring, angle indicator, motion detector

Procedure:

1. Attach the track to the stand with the clamp and make the angle of inclination 3º. Place the motion detector at the top of the track.



2. Start up Logger Pro and open up the "02 Cart" file that we typically use.
3. For each of the given angles of inclination, determine the acceleration of each of the objects down the track by calculating the slope of the velocity vs time graph. Make sure the velocity vs time graph is a nice straight line. Try and stop each object before it slams into the bottom of the track.

Data:

Angle	*Wooden Disc (m/s^2)*	*PVC Ring (m/s^2)*	*"Frictionless" Cart (m/s^2)*
3º			
6º			
9º			
12º			
15º			
18º			
21º			
24º			
27º			
30º			

Graph:
Make a graph of Acceleration vs Angle for each of the objects. (You can do them all on the same graph if you like.) Even though they may look linear, they are not. Linearize the graphs by playing with the angle, and then determine the resulting slopes for each of the objects. (See question 1 for a hint.)

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Questions:

1. We are assuming that the cart is frictionless. Derive the theoretical acceleration as a function of the angle of inclination.

2. From your linearized data, what are the three equations that relate the acceleration of each object to the angle of the track?

   a_{cart} = a_{disc} = a_{ring} =

3. Theoretically, what should have been the slope of the cart? How close was your result?

4. The acceleration of each rolling object was a fraction of the acceleration of the cart. What were those fractions? (This means divide the slopes by the slope from the cart.)

   Lab Results: a_{disc} = _______ a_{car} a_{ring} = _______ a_{car}

5. In the packet, the acceleration of an object that rolls without slipping down a hill is shown to be $a = \frac{mr^2 g \sin\theta}{I_{cm} + mr^2}$. Notice that it is a fraction times *gsinø*, which is the acceleration of the cart. Determine the theoretical fractions for the disc and the ring.

   Theoretical: a_{disc} = _______ a_{car} a_{ring} = _______ a_{car}

6. How close were your measured results to the theoretical values?

7. Why didn't we have you measure the masses or the radii of the rolling objects?

8. Derive the relationship given in question 5. (Try and do it on your own. If you are stuck, look in the packet - but then cover it up and try and do it on your own again.)