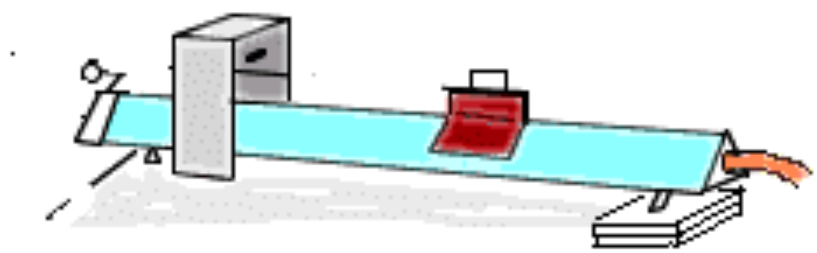
PHY 241
Lab 5

Conservation of Mechanical Energy

We will investigate the principle of the conservation of mechanical energy. Strictly speaking, the mechanical energy of a system of objects is conserved only if there are no external forces. Although we cannot completely eliminate friction, we can greatly reduce friction along one direction using the air tracks in the lab. The carts move along the air track riding on a cushion of air. The V-shape bottoms of the carts perfectly match that of the track. Air is forced up through tiny holes in the track surface, which levitates the carts a fraction of a millimeter above the track.

IMPORTANT!

- **Treat both the track and carts with great care.**
  Dropping the carts even a few inches onto the table or track can ruin them.
- **Never slide the carts on the track unless the air supply is on.**



Objective

We will investigate conservation of mechanical energy for a cart riding along the air track along an incline or on the level and attached to a weight hanging freely over a pulley. You will do four trials at each of four angles or four hanger masses. In each case you will release the cart from rest and measure the velocity of the cart at the end of the run.

Procedure

1. The track needs to first be leveled so that the force of gravity has no component along the track. This is done by turning on the air source, placing the cart on the track and adjusting the leveling screw until the cart remains stationary when placed on the track. The track may not be perfectly straight. Consequently, the cart will "fall" into the low spots. It will be necessary to place the cart at three or four locations along the track, adjusting the leveling screw such that the track is level "on average". Your instructor will help you with the technique.

2. Find the mass of the cart using the triple beam balance. The cart will have a trigger flag that should be included with the mass. Be careful with the carts when placing them on the balance pan.

3. A photogate towards the end of the track will record the time required for the flag on top of the cart to pass by. Knowing the width of the flag, the velocity with which the cart passed through the photogate can be determined. Measuring the distance the cart travels will also provide the height through which the hanging weight travels.

Performing the Experiment

1. The cart will be released from a fixed position near the end of the track opposite the photogate. One group member should should be ready to gently stop the cart just before it hits the end of the track, but not before it passes entirely through the photogate. This will prevent the cart from bouncing back and possible causing damage. Practice this until you can smoothly release and catch the cart. You may adjust the position of the photogate if necessary.

2. Determine the width of the the flag by slowly moving the cart into the gate, stopping just as the flag blocks the photo eye and the timer starts. Record the position of the *back end* of the cart from the track scale. Now continue to move the cart just until the photo eye is unblocked and the timer stops. Record this position. The *difference* in the two positions will be the width of the cart. You will also need to calculated the average position, as you will need that value to find the distance the cart travels.

3. Place one of the spacers under the adjustment screw. This will now put the air track on an incline. Measure the width of the spacer and the distance from the adjustment screw to the fixed support on the other end to determine the angle the track now makes with the horizontal. Choose a position near the high end of the track. Record that position and start the *back end* of the cart there for all trials. Reset the timer on the photogate. Release the cart from rest and record the time from the timer mechanism after the cart has passed through the photogate. The velocity is calculated by dividing the flag width by the photogate time. The cart will have traveled a distance equal to the difference between the starting position and the *average* of the photogate positions found in the previous step. You will calculate the vertical height through which the cart has fallen from this distance and the angle you calculated in #3 above.
4. Repeat the procedure 3 more times. (You will have 4 velocity values for each vertical height.)

5. Add another spacer and repeat procedures #3 and #4. You should keep the starting point and hence the total distance the cart moves the same, but you will need to calculate the new angle. Repeat for 3 and for 4 spacers. When finished, you should have a total of 4 sets of data with 4 recorded times each.

Report

Calculate the velocity from each time and the flag width. Find the average velocity, and determine the uncertainty in your velocity from this data. Calculate the total change in KE and the total change in PE. Find the % difference between |ΔKE| and |ΔPE| for each of the 4 experiments. Is the % difference small enough for you to conclude that mechanical energy is conserved? Be sure to include your uncertainty in the KE and PE values in your conclusion. Do you see any trend in among the 4 experiments? If so, provide a possible explanation.