PHYSICS 125 EXPERIMENT NO. 4
NEWTON'S SECOND LAW

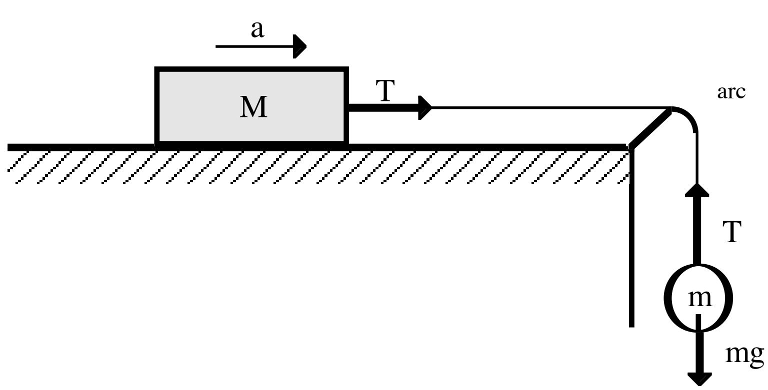
A mass is accelerated along an air track by the weight of another "hanging" mass. The acceleration is measured and compared with that predicted by using Newton's second law of motion.

A. Equipment

1 Air Track with Pulley, 1 Set of Calibrated Slotted Masses, 1 Motion Timer

B. Method

A glider of mass M is accelerated along a horizontal air track by a tension T. The tension is provided by a length of thread which is attached over a pulley to another mass m. The gravitational force acting upon m gives both masses an acceleration a along their respective lines of motion. Newton's law applied to each mass allows the value of a to be calculated in terms of M, m, and g. This value is compared to the "measured" value of a.



C. Procedure

1. Level the air track using the glider without the hanging mass attached. The air track can be considered to be level when the glider is able to remain stationary for several seconds.

2. Measure and record the mass of your glider.

3. The motion of the glider will be recorded using the motion timer software and hardware in your IBM PC. Refer back to your lab notebook

and lab handout for experiment #1 for a review of the correct procedure.

Your glider and air track system is equipped with remote motion sensing equipment. Along the top of the air track is a stationary “picket fence” which acts as a light block. A “U” shaped post is mounted to the top of the glider. Light is sent from one arm of the “U” to the other. As the glider slides along the track, the light path across the “U” is repeatedly blocked by the picket fence. When this occurs, a bright LED on the front face of the “U” flashes. The flashing of this LED is sensed by a fixed telescope mounted to one end of the air track. The times of the light flashes (as sensed by the telescope) are recorder by the computer.

4. Boot the computer and place the glider on the air track. The power to the glider sensor comes from an internal battery. To preserve the life of the battery, the glider sensor is activated for only one minute by pressing the small red button on the side of the glider. Press the button on the side of the glider to activate it.

5. Test the sensor system by moving the glider gently along the air track. As the picket fence blocks the light path you should notice that: i) The bright LED on the front face of the glider flashes as the glider moves along the track; ii) The small LED on the back end of the telescope flashes in unison with the glider. If the sensor system is not working properly, request assistance from your TA.

6. Attach one end of a piece of thread to the glider. Run the thread over the pulley and attach the other end to a 10 g hanging mass.

7. Use the motion timer mode of the computer to record the acceleration of the glider as it is released from rest. Copy the table of velocities to your lab notebook and make a plot of velocity vs. time. Determine the acceleration of the system from your graph.

8. Repeat the measurement of acceleration for m=20 g and m=30 g. In this case, the graph of velocity vs. time is not necessary; you may record the acceleration value as calculated from the statistics package in the motion timing program.

9. Use the theoretical formula, $a = g\left(\frac{m}{m + M}\right)$, to compare with your measured values.

Q1. *Derive the equation given in part 9.*

Q2. *Does the theoretical value match your measurement within error? If not, comment on possible sources of error in the measurement.*

Q3. *What does the theoretical formula predict for the acceleration in the limit as $M \rightarrow 0$? Justify why this result is sensible.*

Q4. *What does the theoretical formula predict for the acceleration in the limit as $m \rightarrow 0$? Justify why this result is sensible.*

Q5. *Is the tension in the thread less than, greater than, or equal to the weight of the hanging mass. Derive the value of the tension to justify your conclusion.*