PHYSICS 125 EXPERIMENT NO. 6
THE CONSERVATION OF ENERGY

For an isolated system, the total energy must be conserved. In this experiment, we will examine the law of energy conservation by observing the transfer of gravitational potential energy to kinetic energy, using a glider on an air track. The apparatus is fairly sophisticated. Your instructor will tell you how to use it. It is called an air track because an air "cushion" reduces the friction. The position of the cart as a function of time can be accurately recorded by means of a photo gate device.

DO NOT USE THE APPARATUS UNTIL YOU HAVE READ THE APPENDIX!

Equipment:

One air track, one glider with photogate, one light sensor, one interface box, one computer with timing program, and one 20 gram weight.

Method:

A battery powered photogate is mounted on the glider. When activated with the small push button on the side of the glider, the photogate turns on a bright, light emitting diode (LED) whenever the picket fence over the air track blocks the photogate. A light sensor at the end of the air track receives the LED signals and the timing program in the computer measures and records the time intervals between successive lighting of the LED.

In the experiment a small mass is attached to the glider via recording tape on a level air track. By dropping the small mass, the change in height of the small mass can be measured, as well as the velocity of the glider/mass system. This will allow the computation of the sum of kinetic and potential energy before and after the change and verify (or dismiss) the law of conservation of energy as a useful concept.

Procedure:

1. Level the air track by carefully adjusting the single leveling screw at one end of the track. When the track is level, the glider should remain nearly stationary at any point on the track. Be sure to tighten the wing nut on the leveling screw when the track is level.
2. Attach a 20 gram mass to the glider with a piece of audio tape and rest the tape on the "air pulley" at the end of the air track so that the mass hangs over the edge of the table and can fall unobstructed.
3. Set the computer up to take data in the *MOTION TIMER* mode. When you are ready to begin a run, push the small button on the side of the glider (This will activate the photogate for about one minute, after which it will turn itself off automatically to save the batteries). Hold the glider in a position where the photogate is *not* blocked (LED off). Push the *SET* button on the grey interface box, then push *ENTER* on the keyboard. After you let the glider go, data will start recording when the photogate is first blocked

Push the *STOP* button on the interface box before the glider rebounds from the end of the air track.

4. As in the previous lab the distances from one "picket" to the next must be measured and entered in the computer. Make two plots in your lab book of velocity vs. time and displacement vs. time in such a way that you can read the velocity and displacement of the glider at the same moment; i.e., one above the other. Take the velocity and displacement of the glider at 6 different time points on the graphs and compute the difference in kinetic and potential energy of the glider/mass system between adjacent points. Note that the horizontal displacement of the glider is the same as that of the small mass' vertical displacement, and the mass and glider are moving at the same speed. Discuss your calculations.

5. This experiment can also be viewed as a test of Newton's second law, $F=ma$. Compare the acceleration of the glider with the theoretical expression that you should derive,

$$a = g\frac{m}{m+M},$$

where a is the acceleration of the glider, m is the small mass, and M is the mass of the glider which the TA will provide.

Appendix
HOW to use the Air Track

CAUTION: DO NOT DROP THE GLIDERS OR ANYTHING ELSE FROM A HEIGHT OF EVEN A FEW INCHES ABOVE THE TRACK. DO NOT SLIDE TI~ GLIDERS ON THE TRACK WHEN THE AIR SUPPLY IS OFF. Always treat this very delicate, expensive equipment like delicate, expensive equipment.

You will not get good results from the air track unless you plan carefully what you will do.

It is easy to level the air track. Simply place a glider on it and raise or lower the end which has only a single screw by turning that screw until the glider will sit at rest for a few seconds at any position along the track.

Keep all the surfaces of the air tracks and gliders clean. If they get gummed up, ask your TA to have them cleaned with alcohol. The data can be very good if you perform the measurements with enough care.