CONSERVATION OF ENERGY

OBJECTIVE:

To investigate energy transfer in a dynamical system.

APPARATUS:

Track, Cart, Hanging masses, Leveler, Photogate, Computer and "DataStudio".

THEORY and EXAMPLES:

In this lab, you will consider different forms of mechanical energy and the transfer of energy from one form to another. To begin with, we review several definitions.

1. Whenever an object is moving, it has kinetic energy. When a mass, m, moves with velocity, v, its kinetic energy is $\frac{1}{2}mv^2$.
2. Whenever an object is acted on by the gravitational force, mg, it has gravitational potential energy. Its gravitational potential energy increases when it moves further from the earth and decreases when it moves closer to the earth. It is common to measure the gravitational potential energy from some fixed reference level. If we chose the lab floor as our reference level, then gravitational potential energy of an object of mass, m, is

$$\text{Potential Energy} = mgh$$

   where h is the height of the object above the floor.

3. The law of conservation of energy states that **the total energy is neither increased nor decreased in any process. Energy can be transformed from one form to another, and transferred from one body to another, but the total amount of energy in the Universe remains constant.**

METHOD:

In this experiment, you'll measure the velocity and distance traveled by a cart, which is accelerated by a hanging mass. Then you'll use these measurements to calculate the change in potential energy and compare this to the change kinetic energy. In this way you can examine a system to see if the mechanical energy is conserved. You'll measure the velocity of the cart using a 2 cm Band Spacing Fence on the picket fence that interrupts a photogate. The DataStudio will calculate the velocity.

SUGGESTED PROCEDURE:

1. Start the DataStudio program. Drag the “Photogate & Picket Fence” from Sensor List to Digital Channel 1. Double click the icon “Photogate & Picket Fence” to open “Sensor Properties” window. Click Tab “Constant” and then type 0.02 m for Band Spacing. Click OK to return to Experiment Setup window.

2. Level the track by placing leveler on the track and adjusting the feet at one end of the track. Connect the cart on the track to a mass hanger using a piece of string. The string is to pass over the pulley at the end of the track as shown in the diagram below.

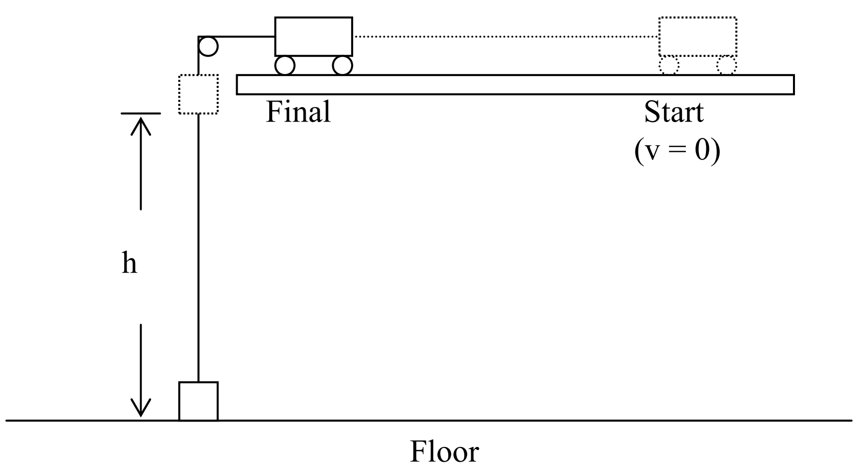
3. Position the cart so that the hanging mass just touches the floor. It is as your ending point. The photogate should be positioned just past the ending point to be able to measure the final velocity of the cart.

4. Now pull the cart back to the end of track. It is as your starting point. Measure the distance from floor to bottom of hanging mass that is the height, h.

5. Practice with a small mass on the hanger, say 25 grams. Click Start button and release the cart at the precise starting point you’ve selected and measure the velocity just past the stopping point you selected. To measure the velocity, use the 2 cm band spacing fence to interrupt the photogate. After cart past the photogate click the Stop button and use Table display to show the recorded data. The mean value is the velocity, V. Repeat several times and find the average value.

6. Now repeat the above measurements with masses of 30 g, and 35 g or as directed by your instructor.

7. Finally, you’ll need to know the masses of the cart and picket in order to calculate the kinetic energy.



QUESTIONS:

1. At the beginning of each experimental run, the velocities of both the cart and the hanging mass were zero.
   a. What was the kinetic energy of the cart?
   b. What was the kinetic energy of the hanging mass?

2. Consider the first measurement that you made with only 25 grams attached to the string.
   a. What was the velocity of the cart after it moved a distance h?
   b. When the cart/hanging mass system was moving with this velocity, what was the kinetic energy of the cart?
   c. What was the kinetic energy of the hanging mass (hanger plus attached mass)?
   d. What was the change in the kinetic energy of cart/hanging mass system during this process?

3. Where did this energy come from? ____ *Energy is never created or destroyed, but just transferred from one form to another or from one body to another*.

4. Let's consider the gravitational potential energy.
   a. Did the gravitational potential energy of the cart change during the experimental run considered above? ____ (Did its height above the floor change?)
   b. Did the gravitational potential energy of the hanging mass change?
   c. By how much did it change? ____ (*Note that its height above the floor had to change by the same amount that the cart moved because they are tied together. This is the distance that you measured!*)

5. Now if all of the gravitational potential energy lost by the hanging mass was transferred to the kinetic energy of the cart/hanging mass system, we would expect that these two quantities should be the same. Are they close?

6. Now look at the measurements that you took with different masses attached to the string? Was energy approximately conserved in each case?

7. You probably found that the change in kinetic energy did not exactly equal the change in potential energy. Discuss several reasons why small differences might occur. If you found large differences, repeat the experiment or see your instructor.

DATA ORGANIZATION SHEET
EXP CONSERVATION OF ENERGY

Cart and Picket M = _______ kg

hanging mass m (kg)	h (m)	$E_p = mgh$ (J)	V (m/s)	$E_k = \frac{1}{2}(M+m)v^2$ (J)	ΔE_k (J)	ΔE_p (J)	Percent difference