INTRODUCTION
The purpose of this experiment is to give an object (a toy car) a specific amount of potential energy and determine the velocity and kinetic energy associated with this energy. The relationship between velocity, work, and energy will then be explored. These concepts are summarized below.

Work
Work is defined as force times distance. Thus
\[ W = Fd \]
For example, work is done when a box is pushed across a floor.

Potential Energy
Energy is the capacity to do work. Energy that is a property of position is called potential energy. Potential energy due to elevated position is called gravitational potential energy. The gravitational potential energy of a mass at height h is given by
\[ PE = mgh \]
where the force of weight goes as mass times the acceleration due to gravity.

Kinetic Energy
The kinetic energy of a moving body is equal to one half its mass times its velocity squared or
\[ KE = \frac{1}{2}mv^2 \]

The change in kinetic energy is work done in bringing object to rest.
Since work is equal to force times the distance through which it is applied, and if friction provides the force, the relationship above becomes:
\[ \Delta KE = \text{Frictional Force} \times \text{Stopping Distance} \]

This equation relates the energy of a moving car to the stopping distance once brakes are applied. Notice that v is squared. Consequently, the stopping distance is proportional to the square of the velocity. For example, if the velocity is increased by a factor of 2, then the stopping distance increases by a factor of 4!
This lab utilizes a toy car, an inclined racetrack, a section of track to stop the car, and a computer. You will measure the mass of the car, give it a certain potential energy by placing it at some height above the table, release it, and measure the distance it slides before coming to rest. By measuring its time to travel through a known distance you will calculate the velocity the car.
By graphing the data obtained, you can find out whether the stopping distance and height are proportional to the velocity or to the square of the velocity. You will relate the work done in stopping the car to its original velocity and potential and kinetic energies. The primary energy relations examined will be:
\[ \Delta PE \text{ converted to KE then} \]
\[ \Delta KE = \text{Work to Stop} \]
Or
\[ mgh = \frac{1}{2}mv^2 \text{ then} \]
\[ \frac{1}{2}mv^2 = Fd \]
PROCEDURE

1. Measure the mass of your car using the triple beam balance. Record this measurement on the data sheet in kilograms.

2. Note the distance scale along the track. Use this for stopping distance.

3. Set a photogate at the bottom of the track before the cork portion begins to measure the velocity of the car after it has fallen but before it begins to stop.

4. Note the three distances marked on the vertical section of the track. These correspond to the measured height column in the data table.

5. Use the Collecting Time Data method as described in Lesson 2 in the Appendix to find the velocity of the car at the position of the photogate. (Measure the width of the tab on the car using a vernier caliper).

6. Line up the center of mass mark on the car with the .15m height. Press RECORD and release the car.

7. Calculate and record the velocity and stopping distance in the data table. Repeat two more times and record in the data table.

8. Repeat step 6 and step 7 for .3m and .6m.

9. Use a calculator or the AVERAGING VALUES program to find the average velocity and average stopping distance for each of the three heights. Record in the data table.

10. Use the ENERGY program to complete the data table.

11. Plot a graph of stopping distance vs. velocity using CRICKET GRAPH (average stopping distance on the vertical axis and velocity on the horizontal axis).

12. Plot a graph of stopping distance vs. kinetic energy.

13. Plot a graph of velocity vs. height.

14. Plot a graph of velocity squared vs. height.