When you hold a ball at some height, it has gravitational potential energy of \( mgh \) (\( m \) is the mass of the ball, \( g \) is the acceleration of gravity, and \( h \) is the height) and has 0 kinetic energy (since it is at rest). Once you let go of the ball, the gravitational potential energy is converted to kinetic energy, \( \frac{1}{2}mv^2 \) (\( m \) is the mass of the ball and \( v \) is the velocity of the ball). Read the introduction to the Conservation of Mechanical Energy lab in your lab manual.\(^1\) You will measure the change in potential energy and kinetic energy as a mass falls a certain distance. You will use an air track that reduces friction, gliders with U-shaped flags attached, two photogates, and a hanging mass to make your measurements. The hanging mass is attached by a string to a glider. As the hanging mass falls vertically, the glider moves horizontally through the photogates. The hanging mass moves at the same velocity as the glider in the system. The distance the glider travels horizontally is the same distance that the hanging mass falls vertically. The hanging mass will lose gravitational potential energy by

\[
\Delta PE = m_h g (x_f - x_i)
\]

where \( x_f-x_i \) is the distance between the photogates and the height that the hanging mass falls during the time the glider passes through both photogates. The glider does not have a change in gravitational potential energy since it does not change height. As the hanging mass falls and loses gravitational potential energy, it gains kinetic energy by

\[
\Delta KE_h = \frac{1}{2}m_h v_f^2 - \frac{1}{2}m_h v_i^2
\]

Where \( v_f \) and \( v_i \) are the final and initial velocities of the hanging mass which is also the final and initial velocities of the glider. As the hanging mass falls, the glider gains kinetic energy by

\[
\Delta KE_g = \frac{1}{2}m_g v_f^2 - \frac{1}{2}m_g v_i^2
\]
Since energy is conserved, the loss in gravitational potential energy of the system should equal the gain in kinetic energy of the system \((\Delta PE = \Delta KE_h + \Delta KE_g)\) when there are no other outside factors.

The Tennessee Valley Authority uses gravitational potential energy to help generate electricity.\(^2\) A dam separates water so that water on one side is at a higher level than the water on the other side of the dam. When the water flows down to the lower side, it gains kinetic energy that helps turn a turbine which is then connected to a generator that produces electricity.\(^3\), \(^4\) There are many dams in East Tennessee!

Questions:

1. Create the Excel spreadsheet as shown in Figure 3 on page 57 of your lab manual.\(^1\)
2. What is the gravitational potential energy of a 0.4 kg mass at a height of 1.0 m?
3. What is the kinetic energy of a 0.4 kg mass that is moving with velocity 1.2 m/s downward?
4. If a 0.25 kg mass is dropped from a height of 2.2 m, what is its kinetic energy when it reaches the ground?

Things to remember during the lab:

1. Make sure that your track is level as described in #5 of Data Acquisition Setup on page 57 in your lab manual.\(^1\) There is a leveling bubble on the track that is also helpful.
2. Put the small masses and hanger back in the can when you are through with the experiment. Leave your station neat and orderly.

References:


\(^2\) https://www.tva.gov/

\(^3\) https://water.usgs.gov/edu/hyhowworks.html

\(^4\) https://www.tvakids.com/electricity/hydro.htm