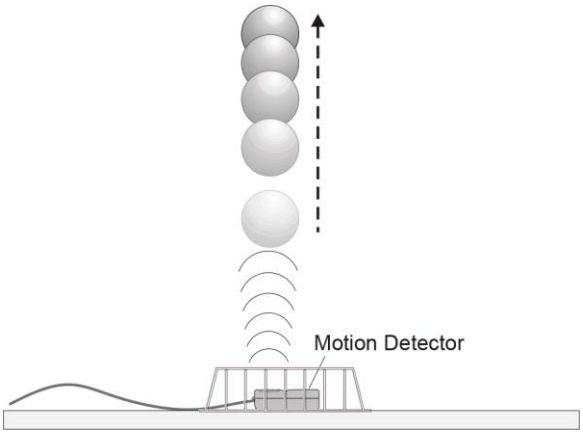
LAB 6. MECHANICAL ENERGY

When a juggler tosses a ball straight upward, the ball slows down until it reaches the top of its path and then speeds up on its way back down. In terms of energy, when the ball is released it has kinetic energy, *K*. As it rises during its free-fall phase it slows down, loses kinetic energy, and gains gravitational potential energy, *U*. As it starts down, still in free fall, the stored gravitational potential energy is converted back into kinetic energy as the object falls. If there is no work done by frictional forces, the total energy *E* will remain constant. In this experiment, we will see if this works out for the toss of a ball.



In this experiment, we will study these energy changes using a motion detector.

Supplies

Computer; Vernier computer interface; volleyball, basketball, or other similar, fairly heavy ball; Logger Pro wire basket; Vernier Motion Detector

Procedure

1. Measure and record the mass of the ball you plan to use in this experiment. _____ kg
2. Connect the Motion Detector to the DIG/SONIC 1 channel of the interface. If the Motion Detector has a switch, set it to Normal. Place the Motion Detector on the floor and protect it by placing a wire basket over it.
3. Open the file "16 Energy of a Tossed Ball" from the "Physics with Vernier" folder.
4. Hold the ball about 1.0 m directly above the Motion Detector. Use two hands. Have your partner click "collect" to begin data collection. After you hear the Motion Detector begin to click, toss the ball straight up. Pull your hands away from the ball after it starts moving so they are not picked up by the Motion Detector. Throw the ball so it reaches maximum height of about 1.5 m above the Motion Detector. Catch the ball before it lands on the cage over the detector. Verify that the position vs. time graph corresponding to the free-fall motion is parabolic in shape, without spikes or flat regions, before you continue. This step may require some practice. When you have three good data runs, save them for analysis. Confirm with your instructor that you have good data on the screen for each run and then proceed to the Analysis section.

Analysis

Graph the ball's kinetic, potential, and total energy vs. time.

1. Logger Pro can calculate and graph the ball's kinetic energy according to $K = \frac{1}{2} mv^2$ if you supply the ball's mass. To do this, adjust the mass parameter.

2. Logger Pro can also calculate the ball's potential energy according to $U = mgh$. Here m is the mass of the ball, g the free-fall acceleration, and h is the vertical height of the ball measured from the position of the Motion Detector. The same mass parameter will be used to find U.
3. Go to the next page by clicking on the "Next Page" button.
4. Record the two energy graphs by printing or sketching.
5. Logger Pro will also calculate Total Energy, the sum of K and U, for plotting. Record the graph by printing or sketching.

Interpretation

1. Inspect your kinetic energy vs. time graph for the toss of the ball. Explain its shape.

2. Inspect your potential energy vs. time graph for the free-fall flight of the ball. Explain its shape.

3. What do you conclude from this graph about the total energy of the ball as it moved up and down in free fall?
   a. Does the total energy remain constant?

   b. Should the total energy remain constant? Why?

   c. If it does not, what sources of extra energy are there or where could the missing energy have gone?

4. Compare your energy graphs predictions (from the prelab) to the experimental graphs.

5. What would change in this experiment if you used a very light ball, like a beach ball?

6. If you had entered the wrong mass for the ball, how would that have affected your analyses?