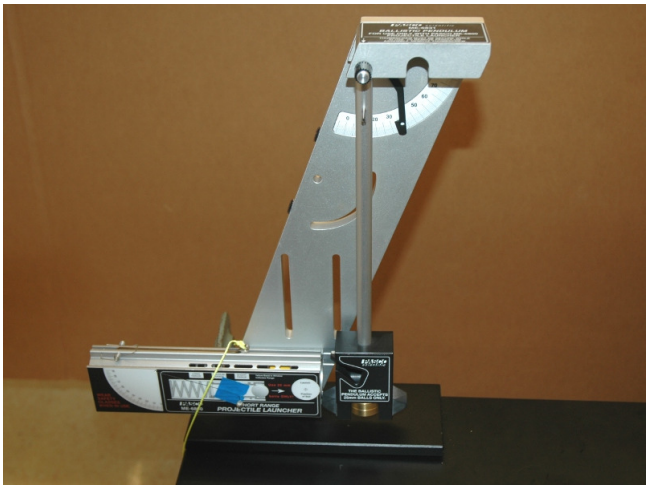
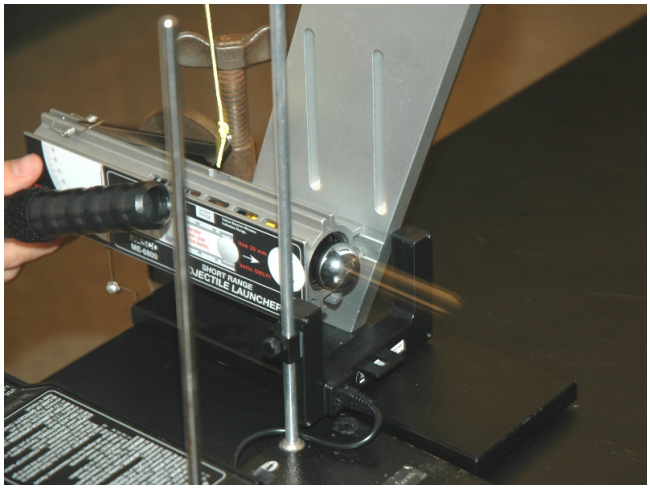
The Ballistic Pendulum: Conservation of Momentum & Conservation of Energy

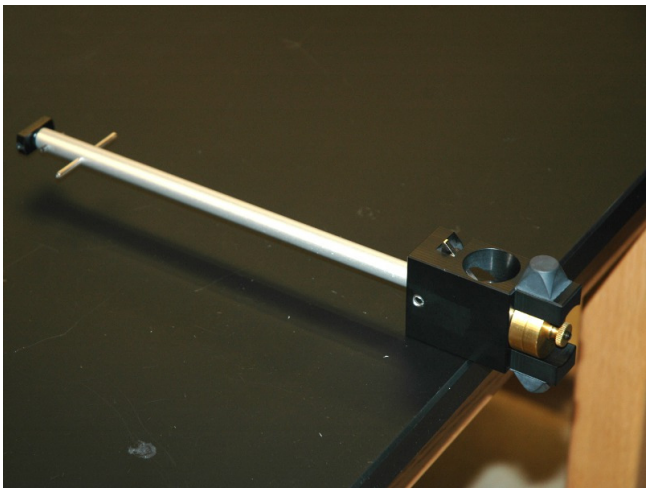
In this lab, we will use a "Ballistic Pendulum" to examine two conservation principles: energy and momentum. The equipment consists of a launcher that fires a steel ball into a cup suspended like a pendulum. The cup captures the ball, so the collision is "completely inelastic". Consequently, the collision itself is not expected to conserve mechanical energy, but it should conserve momentum.



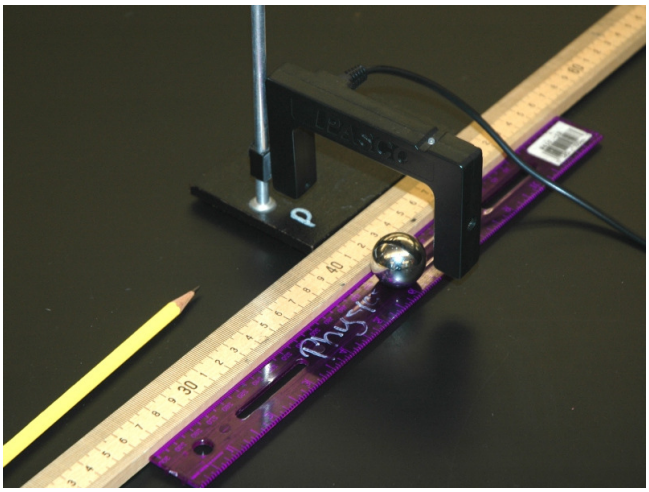
There are many quantities that need to be determined prior to performing the main experiment. In the second picture, the students are firing the ball through a photogate so that they can determine the speed of the ball as it leaves the launcher. The photogate will be removed before they start the main experiment.



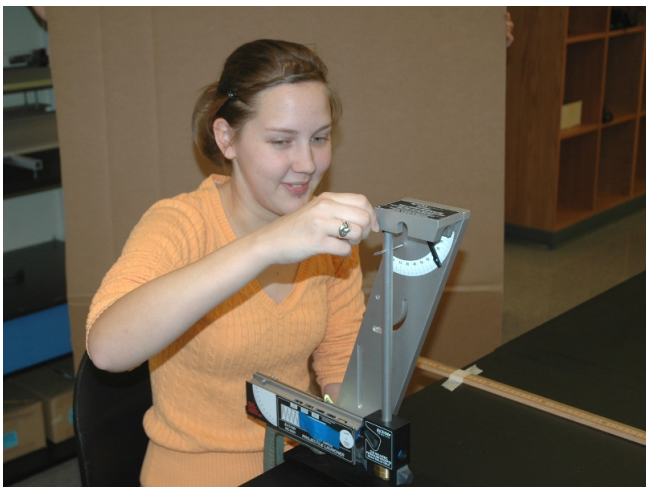
In the third picture, students are attempting to determine the length of the pendulum (with a captured steel ball) by balancing the pendulum on the edge of a table. When the pendulum is just barely balanced, the center of mass of the pendulum is right above the edge of the table.



In the fourth picture, students are using a photogate to determine the diameter of the ball. As with the previous lab, the width of the ball that blocks an individual photogate is more important than the ball's physical diameter. Care must be taken so that the height of the photogate is the same as the height of the center of the ball.



In the fifth picture, the student is reattaching the pendulum after determining its length. Now, they are prepared to perform the main experiment by firing the ball into the pendulum.



In the final picture, we see the rise of the pendulum as a result of colliding with the steel ball. You will measure the maximum angle reached by the pendulum (here seen to be around 50°). Although the initial collision conserves momentum rather than mechanical energy, the process of the pendulum rising conserves mechanical energy (but not momentum). Using energy conservation, you should be able to determine the speed of the pendulum with the captured ball at the moment just after the collision.