

The Ballistic Pendulum

(or Conservation of Energy and Momentum in One Problem)

Background

Conservation of momentum and conservation of energy are two fundamentally important physics laws, and many common problems require the appropriate application of both.

Objectives

To experimentally determine, in two different ways, the “muzzle velocity” of a bullet leaving a gun. The first approach will use a classic projectile-based, kinematics approach to finding v_{bullet} . The second approach will involve using a “ballistic pendulum.” All the information you will need will be found in [the video](https://youtu.be/B1Bv_AVnS3c) found at https://youtu.be/B1Bv_AVnS3c.

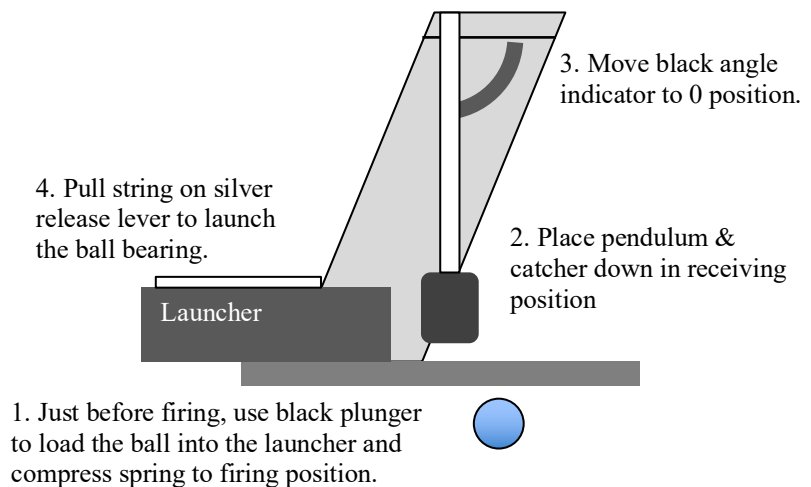
Equipment

Ballistic pendulum unit, w/ steel ball (the bullet)
 Meter stick
 Balance

Procedure: Data Taking: This is two labs in one.

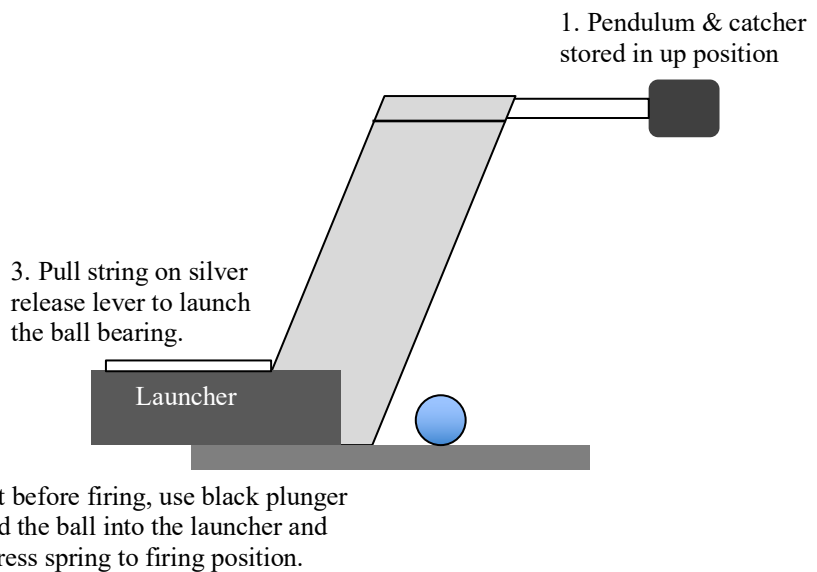
Part A (the ballistic pendulum):

- 1.) In the first part, the ball will be forced down the barrel of the launcher. The pendulum arm with a catch at its end will be positioned so as to grab the ball once the launcher is fired. Once caught, the pendulum arm will swing upward executing some measurable angular displacement. The data required for this part is:
 - a.) The mass of the ball;
 - b.) The mass of the pendulum arm;
 - c.) The length of the pendulum arm;
 - d.) The angle the arm swings up after catching the ball.
- 2.) Watch the video and record the four bit of data required for this section.



Part B (the device used as a gun to shot the ball out into the room):

- 1.) In the second part, a ball will again be forced down the barrel of a launcher. In this case, though, the pendulum arm will be removed so that when the launcher is fired, the ball will fly out into the room. The initial velocity, assumed in the horizontal, will be the launcher’s muzzle velocity. The data required for this part is:
 - a.) The ball’s initial y-coordinate;
 - b.) The ball’s final x-coordinate.
- 2.) Watch the video and record the required data.



Calculations:

Part A. Muzzle Velocity of the Ball using the Ballistic Pendulum;

1. When, during the experiment, is energy conserved? When is it NOT conserved?
2. When, during the experiment, is momentum conserved? When is it NOT conserved?
3. Use *conservation of momentum* and *conservation of energy* to derive a general algebraic expression for the muzzle velocity of the launcher. Blurb well, and be very careful about labeling your velocities.
4. Use you data to come up with a numerical value for the muzzle velocity of the launcher.

Part B. Muzzle Velocity of the Ball using kinematics:

- 5.) Noting that the initial velocity in the x-direction was the muzzle velocity of the launcher (where the initial y-velocity was zero), use kinematics to derive a general algebraic expression for the muzzle velocity of the launcher.
- 6.) Use your data to come up with a numerical value for the launcher's muzzle velocity.
- 7.) Do a % comparison between the two muzzle velocities.

Questions

- 1.) In a real CSI lab, which approach would be most reasonable to use in determining the velocity of a bullet coming out of a gun? Briefly explain.
- 2.) Was much energy lost in the collision? Determine how much kinetic energy the ball had just before the collision and how much KE it had just after the collision. What % of energy was lost in the collision? What do you results tell you about energy loss in collisions of this sort?