# Overview

During a the brief time of a collision we assume that forces external to the system are negligible, and therefore the momentum of the system is conserved. This is an accurate assumption—as long as we are only considering the system’s momentum *immediately* before and *immediately* after the collision. In a laboratory setting, we can easily measure an object’s velocity with high precision. In real-world scenarios, however, this is often not possible, and we must use problem-solving techniques other than conservation of momentum to obtain information.

In this activity, you will use a simulated ballistic pendulum, where you must consider conservation of momentum (during a collision), and conservation of energy (after the collision).

Additionally, you will analyze high-speed footage of a collision between a peanut M&M and an empty soda can. You will decide the best methods to use in this analysis.

# Ballistic pendulum

A ballistic pendulum can be analyzed using three points in time:

1. Just before the collision
2. Just after the collision
3. When the pendulum is at it’s maximum height

From (1) to (2), momentum is conserved. From (2) to (3), energy is conserved.

Go to [geogebra.org/m/gSmRe62s](https://www.geogebra.org/m/gSmRe62s) and uncheck the “Show Initial Bullet Velocity” box (knowing this ahead of time defeats the purpose of the exercise). Click “fire,” and use the tools available to determine the bullet’s initial velocity. (Hint: you’ll first need to determine the velocity of the bullet/block system immediately after the collision.)

*Mass of bullet:*

*Mass of block:*

*Maximum height reached by block:*

*Show your work in the space below.* You may use the equation editor of your word processor, or work your solution out on paper and insert an image.

# Soda can

View the video at [serc.carleton.edu/details/files/37946.html](https://serc.carleton.edu/details/files/37946.html). You may find it useful to slow down the playback speed; you can do so in the bottom-right of the video player. Determine the velocity of the M&M and soda can after the collision. Use this information to determine the velocity of the M&M before the collision.

*Show your work in the space below.* You may use the equation editor of your word processor, or work your solution out on paper and insert an image. You must record your data, and clearly explain how that data was collected.

# Questions

1. Are the collisions you observed elastic or inelastic? Justify your answer with calculations.
2. Find the fractional kinetic energy loss during the simulated collision between the bullet and block, and the collision between the M&M and the soda can. (That is, determine the ratio of final to initial kinetic energy:.) Express this “loss” as a percent—what percent of the initial kinetic energy was “lost?” What became of the “lost energy?” Explain.