10. The Ballistic Pendulum

In this experiment, you will measure the velocity of a bullet using the principles of conservation of energy and conservation of momentum.

Before coming to the lab consider the online simulation at http://mail.mcm.edu/~bykov.tikhon/demos/physlets/lab8.html

This simulation shows the collision of a bullet with a massive block. It allows you to change the values of the mass of the bullet, the mass of the block and the initial velocity of the bullet. Try different combinations of those variables and see how they affect the results of the experiment. Think about what happens to the energy and momentum of this system before, during and after the collision. Derive the equation relating the masses, the initial velocity of the bullet and the height of the swing. Using this equation, find the unknown variables in the simulation.

As you can see, the simulation gives you values of the masses and the output height of the swing. In the real experiment, however, you should find the best way to measure those quantities.

You will be allowed to make any measurements of the apparatus you like. The apparatuses involved are: a small rifle, a bullet, a block suspended from the ceiling, and a meterstick or two. Once you've decided on what you are going to measure and derived all the necessary equations, present your outline to the instructor.

After carrying out the experiment, answer the following questions:

1. What was the value of the kinetic energy of the bullet before the impact?
2. What was the value of the kinetic energy of the block and the bullet after the impact?
3. What fraction of the kinetic energy was lost during the impact?
4. What happened to the energy?
5. Does the momentum of the bullet before the impact equal that of the bullet and block after the impact? Explain.
6. In terms of momentum and energy, how is it that something as small as a bullet (with \( m \approx 2g \)) can harm a person (with \( m \approx 80kg \))?