Name: _____ Partner's Name: _____

The Ballistic Pendulum

In this experiment, you will study the conservation of momentum and energy using a ballistic pendulum apparatus.

Today's lab will be the study of the ballistic pendulum. For this reason, we will be using conservation of momentum and conservation of mechanical energy (we will assume that there are no *non*-conservative forces acting on the spring-ball and ball-pendulum systems.)

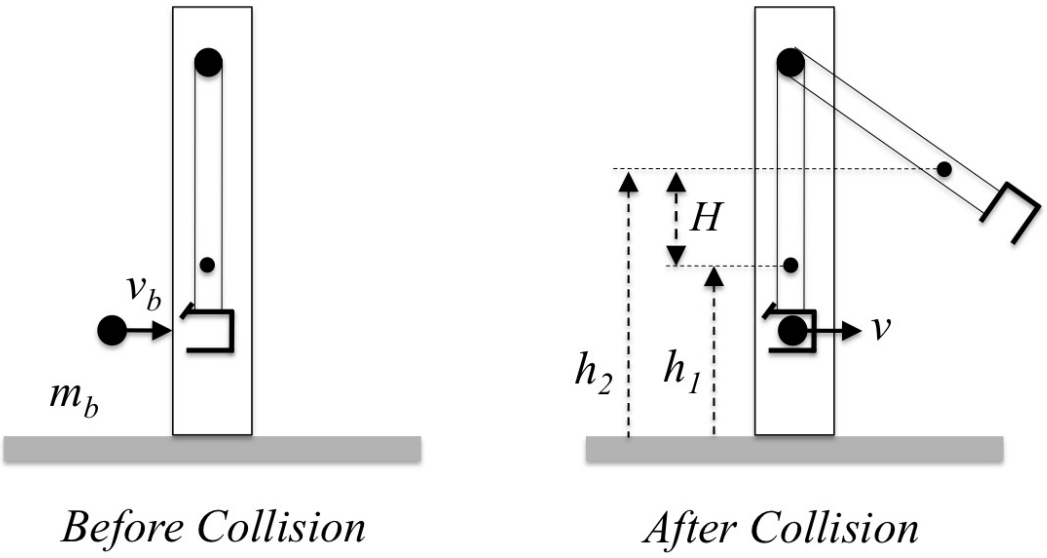
GOAL:

To calculate the velocity of the ball shot from a spring-loaded gun as well as the gun's spring constant. To do that, we will measure the maximum swing height H of a pendulum after it collides (perfectly) inelastically with the ball.

THEORY:

The analysis of the ballistic pendulum is a three-step process.

1. The transfer of mechanical energy from the spring of the gun to the ball.
2. The transfer of momentum from the ball to the system consisting of the ball and the pendulum. Recall that in inelastic collisions kinetic energy is not conserved.
3. The conservation of mechanical energy is then employed to determine how high the pendulum will swing given a particular post-collision velocity of the pendulum.



PROCEDURE:

1. Make sure the apparatus is level and clamped securely to the table. Use the leveling screws and the bubble level on the apparatus base to level properly.
2. Rotate the thumbscrew holding the pendulum in place and remove.
3. Measure the mass of the pendulum m_p and the ball m_b using an electronic balance.
   m_p=_____ m_b=_____
4. Measure the distance between the base and the center of mass of the pendulum (indicated by the center of mass pin on the pendulum).
   h_1=_____
5. Place the metal ball on the end of the gun shaft and cock the gun with the handle provided until the shaft is locked in position.
6. Using a ruler, measure the length of the spring.
   x_1 =_____
7. Press back on the trigger to fire the ball.
8. After the pendulum comes to rest, measure the vertical distance h_2 between the base of the apparatus and the center of mass of the pendulum (indicated by the center of mass pin on the pendulum).
   h_2=_____
9. The value of H is the difference between the two height measurements ($H = h_2 - h_1$).
   H=_____
10. Also measure the equilibrium length of the spring.
    x_2=_____
11. The maximum compression of the spring is given by the difference between the two spring length measurements ($\Delta x = x_2 - x_1$).
    Δx=_____
12. Use a separate piece of paper to find the following quantities:
    (a) The velocity of the ball v_b after it has left the gun and before it collides with the pendulum.
    (b) The spring constant k.

SHOW YOUR WORK AND USE GOOD PROBLEM SOLVING TECHNIQUES, (i.e. draw a picture; identify the various steps in the problem and concepts for each step, etc.)

DUE NEXT WEEK...

1. The lab manual pages with all variables measured.
2. Values for v_b and k from part 12.
3. The separate sheet of paper where you have solved this problem.