Conservation of Momentum: The Ballistic Pendulum

Object: To study the elements of projectile motion and the law of conservation of momentum.

Theory: The Ballistic Pendulum provides the introductory Physics student with an opportunity to study several different physical principles in a single experiment. The ballistic pendulum provides an inelastic collision in system that provides measurement of the initial and final velocities. In order to determine these velocities one must use projectile motion and the conservation of energy. The projectile is a ball that is force forward by a compressed spring. The spring tension should not be changed at anytime during the experiment. The ball is shot into the pendulum which should be still and vertical. The ball and pendulum swing togther to the side and will be stuck on a curved, grooved track. The pendulum hole has a flexible metal spring which breaks easily. Push the metal strip gently into the hole and out of the way before allowing the ball to drop out. DO NOT PUSH THE BALL OUT !!!!!!!!!!!!!!!!!!

There is a marker on the side of the pendulum. That marker represents the center of gravity of the ball and pendulum. The height change of that marker is proportional to the potential energy change of the unit. In this case, the kinetic energy that the ball and pendulum have when the ball collides with the pendulum is equal to the change in the potential energy of the two. You will use projectile motion and conservation of energy to show conservation of momentum in an inelastic collision.

Apparatus:

Blackwood Ballistic pendulum, meter stick, level, carbon paper, sheet of white paper, plumb bob.

Procedure:

1. The pendulum is raised up out of the way. The apparatus is set near the edge of the table and is leveled by adding wedges of paper to the base of the apparatus. Make sure that you have a clear area and there is no danger than the ball will be projected out of the window or hit any one. Fire the gun, note the location of impact. Do not change the position to the gun, do not change the spring compression. Tape a piece of carbon paper, face down on a sheet of white paper, with another sheet of paper on the carbon paper to protect it. You will not change the spring at all. Make at least three trials for the horizontal range. Expose the bottom sheet of paper. Measure the distance from a point just under where the ball leaves the gun as determined by the plumb bob to the spots on the paper. Average the values. Measure the vertical distance from the level of the guns to the floor. These two bits of data, the vertical height and the range with the equations for rectilinear motion enable you to determine the velocity of the gun.

2. Release the pendulum so that it falls freely. Fire the ball into the pendulum and record the position reached by the pendulum. Repeat the procedure six times. Record the number of grooves through which the pendulum rose. Average the readings, set the pendulum at the average position, measure the height of the pointer on the side of the pendulum. Record the lowest position of the pendulum, that is, when the pendulum is vertical. This difference in heights is the one used to calculate the change potential energy of the pendulum plus ball.

3. Remove the pendulum from its support and measure the mass of the pendulum and that of the ball.

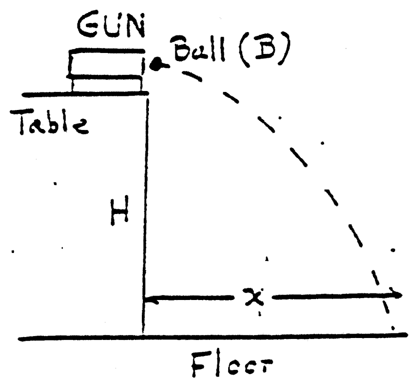
4. Determine the intial speed of the ball.

5. Compute the momentum of the ball just before the collision and that of the ball and pendulum just after the collision. Compare the two quantities

6. Compute the kinetic energy of the ball before the impact and the kinetic energy of the ball and pendulum after the collision.

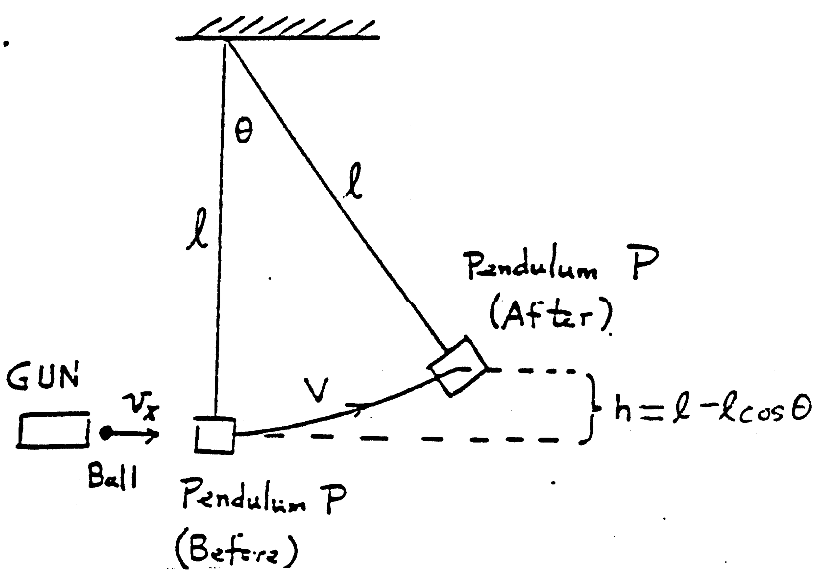
7. Compare the quantities and explain any discrepancies.

1.



$x = v_x t$ $\qquad$ $H = \frac{1}{2} g t^2$

2.



$m_B v_x = (m_B + m_P) V$

$V^2 = 2gh$

Reading	Angle θ
0	39°
10	41.2°
20	43.5°
30	45.8°
40	48°

Ball mass ~ 69 gram Pendulum ~ 268 gr.