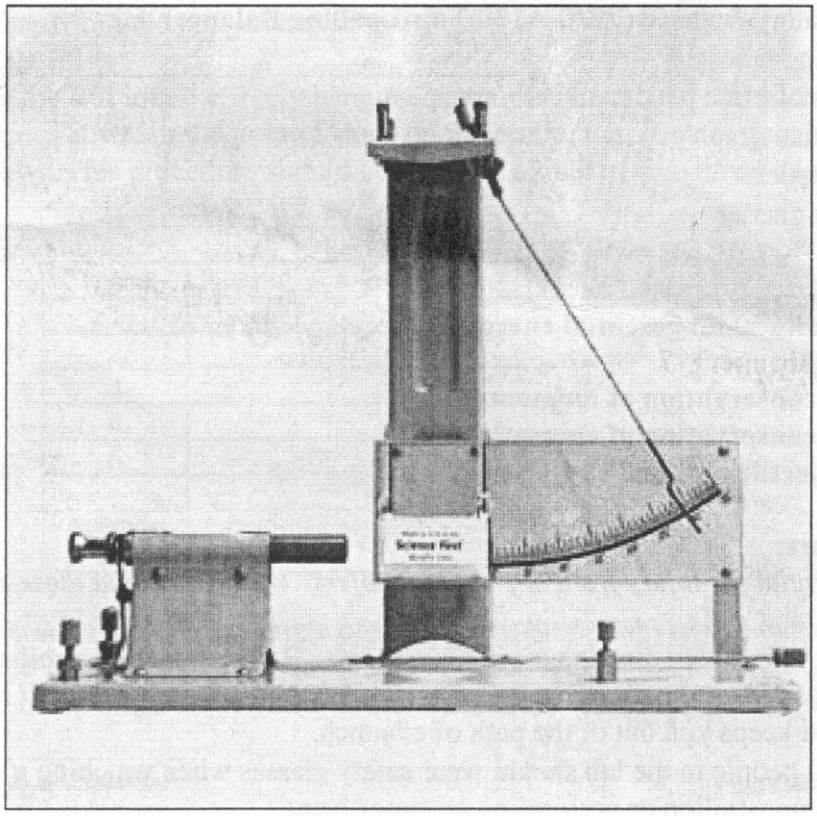
The Ballistic Pendulum



Description: The ballistic pendulum is a classic in the Physics lab with an impressive military history. Its premise had long been known by the makers of munitions. Invented in 1742 by Benjamin Robins to measure the speed of bullets, he soon realized that, by knowing the weight of the pendulum with its target, the weight of the shot fired, and the distance the pendulum moved when struck, he could calculate the velocity of the shot. By performing experiments at various distances, he was also able to determine the effects of air density and gravity as the range increased.

Experiment 1: The Ballistic Pendulum

Procedure:

1. Determine the mass of the steel ball. M_b=_____ (kg)
2. Place the projectile ball in the spring gun opening.
3. Pull the spring mechanism back to launch the ball that is inside the gun's chamber.
4. Launch the ball a few times to assure that the ball will fire into the block.
    a. This will show you how the apparatus operates. If the block does not catch and come to a stop, you should adjust the pendulum suspension to obtain the proper alignment.
5. The center of mass of the pendulum block should be in the direct center of the block. Mark this spot using a pencil. With the pendulum hanging freely, measure the height, h_1, of the marked spot above the base's surface. Record h_{CoM}=_____ (m)
6. Record the starting angle of the pointer. (Ideally, this angle should be set at 0^0) θ_o=____
7. Fire the ball into the freely hanging, stationary pendulum and note the angle in degrees at which the pointer stops on the protractor. This procedure should be repeated a total of five times total.
8. Determine the average angle of the trials in Step 7 and record. Next, calculate the height, h, of the ball/pendulum after the collision. Use the average angle value in the calculation. This is calculated as follows:

$$h = L - L \cdot \cos\theta$$

L = length of the pendulum to the center of mass.

9. Carefully remove the pendulum with steel ball embedded from the apparatus. Weigh the pendulum support containing the steel ball on a top-loading balance. Record this value below. Mass of ball plus pendulum m_{bp}= _____(kg)
10. Calculate the magnitude of the initial velocity using the equation below.

$$v_{\text{initial 1}} = \frac{m_{ball+pendulum}}{m_{ball}} \times \sqrt{2gh}$$

Experiment 2: Projectile Motion

1. Repeat the table drop experiment to find the initial velocity of the ball.
2. Use this as the calculated value for error analysis purposes.