Free essay on conservation of momentum ballistic pendulum

Technology, Development

The law of conservation of momentum states that the total linear momentum of a system remains constant. Bodies under collisions exert equal and opposite forces, however, in the absence of external forces, their change in momentum is equal and opposite. There are two types of collisions: elastic and inelastic collisions. In elastic collisions, both the total kinetic energy and momentum of the colliding bodies is conserved. On the other hand, only momentum is conserved in inelastic collisions. In the latter, bodies fuse together after collision (Wilson and Hernandez 129).

The experiment investigates the conversation of linear momentum in an inelastic collision of the ballistic pendulum; where kinetic energy is not conserved. The collision between the projectile and ballistic pendulum is inelastic; thus, the law of conservation of momentum holds.

Initial momentum = final momentum

Pi = Pf

If a projectile, of mass m and velocity u, is fired to the horizontal into a pendulum of mass M at rest. The total momentum of the system to the horizontal will be conserved. Therefore, the equations of momentum are as shown below.

The pendulum is initially at rest, the initial momentum is Pi = mu, where u = the velocity of the projectile, and Pf = (m +M)v, where v = velocity of the system after collision. Since, the projectile is embedded into the pendulum bob, and the collision is inelastic.

Therefore, mu = (m +M)v; since momentum is conserved.

Therefore, v =

The kinetic energy before collision is given by Ki = 1/2mu2, while after collision is given by Kf.

Kf = ½ (m + M)v2 = (Wilson and Hernandez 129).

The fractional loss in kinetic energy is a function of the masses (pendulum and the projectile) as shown below.

After the collision, the system swings at a maximum height h, and the kinetic energy is converted in to gravitational potential energy. The system of pendulum and the impeded projectile rises to a height h. The total mechanical energy of the system is conserved. However, the kinetic energy is not conserved for the inelastic collision. Therefore, the final velocity can be determined from this relationship.

½ (m + M)v2 = (m +M) gh

v =, where h= L(1-cosθ), θ = angle between the initial position of the pendulum and the final position, and L is the length of the pendulum (Wilson and Hernandez 129).

Procedure

The apparatus used in the experiment include a pendulum, spring gun, heavy bob, projectile (small steel sphere), and a marker. The arrangement of the apparatus is as shown below.

The ballistic pendulum above consist of a launcher to launch the projectile, the heavy bob on the projectile is hollowed to receive the steel sphere when fired. The steel sphere is fired and captured in the pendulum. The figure below shows the positions of the pendulum before (a), and immediately after collision (b). Also, it shows the position when the pendulum has reached the maximum height (c).

The mass of the pendulum bob was measured and recorded. The projectile was placed in the launch positions (short range, mid range, and long range) using a ramrod. Moreover, the angle indicator was positioned against the pin and the initial angle of the pendulum θ_i was measured. After releasing the projectile into the pendulum, the final angle of the pendulum θ_f was measured. The change in the angle was used to estimate the maximum height h. These steps were repeated for the three launch positions, and the average change in the angles recorded.

The pendulum was placed at the top of its swing, and the projectile was launched horizontally from the three launch positions. In this case, the average horizontal distance x were measured and recorded. Moreover, the vertical distance y for which the projectile was falling was measured and recorded. These measurements were used to measure the initial velocity u of the projectile.

Uncertainty of errors in the experiment

Measurements are associated with errors. Random errors are common in many experimental measurements. To improve uncertainty of measurements, the measurements are taken several times and the average value taken. In this experiment, the average value for the measurements were obtained; thus, reducing random errors in the experiment.

In this experiment, the most probable source of errors is the random errors in the measurements. This is quantified by estimating the standard error in the measurements. The standard error δ = (Wilson and Hernandez 129). Uncertainties in the experiment include errors in measuring the angles and the distances (horizontal and vertical height). Also, uncertainties resulted from the measurements of the mass of the projectile and the pendulum.

Works Cited

Wilson, Jerry and Hernandez Cecilia. Physics Laboratory experiments.

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