Calculations and analysis of data reports examples

1. The average values of hi, hf, y, and X were found to be:

hi = 5 cm

hf = 15. 87 cm

y = 104. 84 cm

X = 310. 235 cm

2. h = 15. 87 – 5 = 10. 87 cm

3. Using equation (10) to determine the initial velocity and equation (11) to determine initial momentum, we find

vi = 3. 10235*sqrt(9. 81/2*1. 0484) = 7. 035 m/s

pi = 0. 06944*7. 035 = 0. 4885 kg m/s

4. Using equation (7) to calculate the final momentum of the system, we find

pf = (M + m)*sqrt(2*g*h)

pf = 0. 3321*sqrt(2*9. 81*0. 1087) = 0. 4849 kg m/s

5. The percent fractional error is

PFE = | 0. 4885 – 0. 4849 | / 0. 4885 = . 0036/. 4885 = 0. 736%

Questions

1. According to the percent fractional error calculated in part 5 of the analysis, momentum in the horizontal direction is conserved within less than 5% (it is conserved within 0. 8%).

2.(a) The initial kinetic energy of the system before collision is

KEi = (0. 4885)^2 / 2(0. 06944) = 1. 72 J

(b) The final kinetic energy of the system an instant after collision is

KEf = (0. 332)*9. 81*0. 1087 = 0. 35 J

(c) The fractional loss of kinetic energy is

| 0. 35 – 1. 72|/1. 72 = 79%

(d) The ratio of the mass of the pendulum to the sum of the masses of the ball and pendulum is

(332 – 69. 44) / (332 + 69. 44) = 65%

This ratio is very close (within 14%) to the ratio of the kinetic energies.

(e) The principle of conservation of energy is not violated when the ball collides with the pendulum, as some of the kinetic energy is absorbed by the system during the inelastic collision.

3. Because there are no external forces acting on the system when the collision occurs, linear momentum must be conserved.

Conclusion

The objective of this report is to validate the law of conservation of momentum. We accomplish this by comparing the results of two experiments conducted with a ballistic launcher and pendulum apparatus. In the first experiment, kinematic methods are used to determine the initial velocity of a projectile. In the second experiment, the velocity of the projectile after an inelastic collision with a pendulum is derived using the principles of conservation of energy and momentum.

The velocities for both experiments matched within a very reasonable margin of error (less than 1%). This result seems to confirm our expectation for the conservation of momentum.

Our measurements in the pendulum experiment were less accurate. We expected to find that the fractional loss of kinetic energy during the inelastic collision of the projectile with the pendulum would be equal to the ratio of the initial mass of the system (the projectile) to the final mass (the projectile and the pendulum). However, the variance in the values was larger than expected, about 14%. Since friction plays a significant role in the pendulum experiment, it may account for some of the loss of accuracy here.

Another possible explanation for the difference in accuracy between the first and second experiments involves the difference in the scale of the measurements. In the kinematics experiment, the ball is launched over a distance of several meters, and the final resting distance is measured from the launch point. In the pendulum experiment, we measured the difference in height of the center of mass of a pendulum only about 40 centimeters in length. The heights that were measured in the pendulum experiment were a fraction of the length of the pendulum, since the pendulum only swings through an angle of 30 – 60 degrees.

Considering the factors that affected the accuracy of the experiment, the measured results confirmed the predicted values reasonably well. This experiment provides a successful validation of the conservation of momentum.