Lab 10

Conservation of Momentum

~~Momentum = velocity~~

Purpose: To demonstrate that momentum is conserved during a collision, by analyzing elastic and inelastic collisions.

Theory: ✓-

Momentum is a measurement of mass in motion. Unless there is an outside force, the ~~momentum~~ amount of momentum must be the same at two points in time, which we call conservation of momentum. This law can be expressed in the following equation: →

→ Momentum can be calculated using the following equation:

$$P = mV \qquad \begin{array}{l} P = \text{Momentum} \\ m = \text{mass of object} \\ V = \text{Velocity of object.} \end{array}$$

$$\rightarrow P_0 = P_f \Rightarrow m_1 V_{10} + m_2 V_{20} = m_1 V_{1f} + m_2 V_{2f}$$

In elastic collisions ... In inelastic collisions ...

- External force applied to an object → change in momentum.
- Amount that momentum changes depends on time the force is applied.
- Relationship between force and time → impulse.
- Impulse required to change an object's momentum →

$$\text{Impulse} = F(t_f - t_0) = \Delta P = m(V_f - V_0)$$

Next Steps
- Procedure → Lab
- Questions → Lab
- Calculations & Graphs → Momentum → Kinetic Energy → Impulse   Percent Error
- Conclusion

Questions
~~16.~~

17. A stiffer rubber band would result in the impulse being greater since the tension force would increase.

14-16 → Logger Pro analysis

Procedure
Part 1: Elastic Collision
1. Opened Physics Classroom - Momentum & Collision Simulation.

Set mode to "Elastic Collision" →

2. Set blue cart initial V to 0 m/s
3. Calculated initial momentum based off masses of 1 kg for blue and red cart.
4. Ran simulation.
5. ~~Recorded~~ Calculated & recorded final momentum.
6. Repeated steps 2-5 but set blue cart to 2 kg & red cart to 1 kg. ~~Also calculated initial kinetic energy.~~ Also
7. Calculated final momentum & kinetic energy.
8. Calculated percent difference between values from step 7 and the initial values calculated in step 6.
9. Repeated step 6-8 with both masses of blue cart & red cart set to 1 kg, and initial velocity of blue cart set to -3 m/s.

A 10. Repeated step 6-8 w/ ~~blue~~ red cart at 2 kg and ~~0 m/s~~, and ~~red~~ blue cart at 0 m/s.

Procedure

Part 2: Inelastic Collisions

11. ~~[illegible]~~ Set simulation mode to "Inelastic Collisions"
12. Set mass of both carts to 1 kg, ~~and~~ initial velocity of red car to 6 m/s, and initial velocity of blue car to 0 m/s.
13. Calculated initial momentum & kinetic energy in simulation.
14. Ran simulation.
15. Calculated final momentum & kinetic energy of simulation. Also calculated percent difference between initial values calculated in step 13.

~~Part~~ 16. Set mass of blue cart to 3 kg and initial velocity of 0 m/s. Kept red cart settings the same.

17. Repeated steps 13 – 15 for new setup.

Part 3: Force During a Collision

18. Opened Logger Pro.
19. Set range switch on Force Sensor to 10N, and callibrated it using 500g of mass.
20. Removed second cart from tracks.
21. Placed clamp mid way on tracks.
22. Set Force Sensor against clamp towards first cart.
23. Attached elastic string to cart and Force Sensor
24. Zeroed all sensors, ~~[illegible]~~
25. Pushed cart away from Force Sensor using a gentle push.
26. Stopped cart on way back to Force Sensor.
27. Analyzed data using Logger Pro.

Calculations & Graphs

Ca

- Momentum

$$P = mv \qquad \text{(eq: momentum)}$$

P: momentum

m: mass of object

v: Velocity of object

Sample Calc

- Initial Momentum of ~~blue~~ red Cart Part 1: Trial 1

$P = mv$

$P = (1\,kg)(\cancel{8}\,5\,m/s)$

$P = \cancel{8}\,5\,kg\,m/s$

- **Kinetic Energy**

$$KE = \frac{1}{2}mv^2 \qquad \text{(eq: kinetic E)}$$

KE: Kinetic Energy

m: mass

v: velocity

Sample Calc

Initial Kinetic Energy of red cart trial 2

$KE = \frac{1}{2}mv^2$

$\cancel{Ks} = \frac{1}{2}(1\,kg)(5\,m/s)^2$

$= 12.5\,J$