Linear Momentum

PHYS 211L – H02

Tuesday 10:05am – 12:05pm

Abstract

In this lab, we investigated the conservation of linear momentum by measuring the momentum before and after a collision. We started with two gliders of equal mass, then we experimented with the incident glider having more mass than the target glider, and vice versa. By calculating and comparing the total momentum before the collision to the total momentum after the collision, we found that, within uncertainties, momentum was conserved.

Introduction

Once upon a time some random asshole figured out how to made future students have extra bullshit to do, so he took it upon himself to make that a reality. Bastard.

Procedure

In this lab, we used the following materials: balance, air track with blower, 2 gliders with bumpers, 4 glider masses, additional small masses, 2 photogates, 2 small plastic fences, computer with DataStudio, photogate port, and a USB link.

First, we recorded the mass of each glider, the mass of our large cylinders, the mass of our small cylinders, and the distance between bands on the picket fences. We made sure the track was level by placing one glider on it and turning the air on. If the glider barely moves, then the track is level. We then set up our photogates and DataStudio so that each gate would record the velocity of the glider traveling through it. We performed five trials for three scenarios. First, collisions between the two gliders when they have equal mass. Second, collisions between the two gliders such that the incident glider has more mass than the target glider. Lastly, collisions between the two gliders such that the target glider has more mass than the incident glider. For each collision, we recorded the velocity of the incident glider before it collided with the target glider, and we recorded the velocity of the target glider after it collided with the incident glider. After collecting our data, we did one final trial with just one glider passing through both gates. This was to help us calculate the percent uncertainty in our speed measurements. This uncertainty then spreads to the uncertainty in our momentum calculations.

Results/Analysis/Physics

With our measurements, we can solve for the unknown in the conservation of momentum equation such that .

Measurements taken prior to Experiment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mass of Incident Glider (kg) | Mass of Target Glider (kg) | Mass of Large Cylinder (kg) | Mass of Small Cylinder (kg) | Distance between bands on Picket Fence (m) |
| 0.223 | 0.223 | 0.218 | 0.05 | 0.01 |

Carts have Equal Mass

|  |  |  |
| --- | --- | --- |
| Trial | Incident Velocity (m/s) | Target Velocity (m/s) |
| 1 | 0.16 | 0.14 |
| 2 | 0.37 | 0.35 |
| 3 | 0.42 | 0.40 |
| 4 | 0.44 | 0.42 |
| 5 | 0.14 | 0.12 |

Incident Mass Greater than Target Mass

|  |  |  |
| --- | --- | --- |
| Trial | Incident Velocity (m/s) | Target Velocity (m/s) |
| 1 | 0.44 | 0.54 |
| 2 | 0.46 | 0.55 |
| 3 | 0.44 | 0.54 |
| 4 | 0.62 | 0.75 |
| 5 | 0.75 | 0.88 |

Target Mass Greater than Incident Mass

|  |  |  |
| --- | --- | --- |
| Trial | Incident Velocity (m/s) | Target Velocity (m/s) |
| 1 | 0.64 | 0.40 |
| 2 | 0.56 | 0.35 |
| 3 | 0.58 | 0.37 |
| 4 | 0.44 | 0.26 |
| 5 | 0.49 | 0.29 |

Error Analysis: Case 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Collision | Incident Glider’s Momentum before Collision  (kg \* m/s) | Incident Glider’s Momentum after Collision  (kg \* m/s) | Target Glider’s Momentum after Collision  (kg \* m/s) | Percent Uncertainty in Momentum for Incident Glider | Percent Uncertainty in Momentum for Target Glider |
| 1 | 0.03568 | 0.00446 | 0.03122 | 1.939 | 1.939 |
| 2 | 0.08251 | 0.00446 | 0.07805 | 1.939 | 1.939 |
| 3 | 0.09366 | 0.00446 | 0.08920 | 1.939 | 1.939 |
| 4 | 0.09812 | 0.00446 | 0.09366 | 1.939 | 1.939 |
| 5 | 0.03122 | 0.00446 | 0.02676 | 1.939 | 1.939 |
| 6 | 0.18612 | 0.06570 | 0.12042 | 1.939 | 1.939 |
| 7 | 0.19458 | 0.07193 | 0.12265 | 1.939 | 1.939 |
| 8 | 0.18612 | 0.06570 | 0.12042 | 1.939 | 1.939 |
| 9 | 0.26226 | 0.09501 | 0.16725 | 1.939 | 1.939 |
| 10 | 0.31725 | 0.12101 | 0.19624 | 1.939 | 1.939 |
| 11 | 0.14272 | -0.02648 | 0.16920 | 1.939 | 1.939 |
| 12 | 0.12488 | -0.02317 | 0.14805 | 1.939 | 1.939 |
| 13 | 0.12934 | -0.02717 | 0.15651 | 1.939 | 1.939 |
| 14 | 0.09812 | -0.01186 | 0.10998 | 1.939 | 1.939 |
| 15 | 0.10927 | -0.01340 | 0.12267 | 1.939 | 1.939 |

Conclusion

In conclusion, \*dies\*

Lab Questions

2. Momentum was conserved in this experiment.

3. Newton’s 3rd Law is most closely associated with momentum conservation.

4. Not every collision was the same for each configuration, so taking the average of all the initial momenta and final momenta would result in less accurate data.