Collisions lab

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Collisions in Two Dimensions Abstract: This lab was conducted to investigate the theories of conservation of momentum and kinetic energy in different types of 2D collisions. In order to do this, both an elastic and inelastic collision was conducted on an air table with pucks. A video was taken and analyzed to determine velocity, allowing for future finding of momentum and kinetic energy values. By finding these, it was possible to determine which kind of collision took place. With low values of change in momentum and kinetic energy that occurred in elastic collisions, it is understood that both are conserved in this type of collision.

However, in the inelastic collision, momentum is conserved while kinetic energy is not. Possible error in this lab may have resulted from the neglect of friction and rotational kinetic energy. Overall, however, the results matched up well with the expected values. The objective of the lab was therefore met. Objective: The objective of this lab is to support that momentum will be conserved in all forms of collisions, and that kinetic energy will be conserved only in elastic collisions. Materials: Materials used in this lab were a video camera, an air table with pucks and Velcro bands, and Logger Pro software.

Procedure: Videos of collisions of air hockey pucks will be recorded onto the computer’s hard drive. Two different types of collisions will be analyzed. The first will be nearly-elastic, with each puck going separate directions after the collision. The other type is completely inelastic with each buck bearing Velcro so as to stick together upon collision. The first collision requires first setting an origin on the video. Using the Set Scale tool, a distance scale will be set. Trajectory of the center puck is marked and an arbitrary time is picked at which data will begin being extracted.

Points will then be added one frame at a time until enough measurements are taken before and after the collision. This is then repeated on the incident puck. This is done for both the center and the white dot on each puck. This data is automatically entered into Logger Pro. The data sets are then graphed. Straight lines are fitted to the graphs to determine the velocities , wich will be used to determine angular speed of the puck’s rotation. A new video will be analyzed in part two. In this collision the position of the center of mass of both pucks will be tracked, along with the position of the center of one of the pucks.

This will result in 8 sets of data points. Linear fits are used to determine the velocity components of each. Radius is then used to calculate angular velocity. Results: ELASTIC COLLISION| | Mass 1| Mass 2| V1ix| V1iy| V1fx| V1fy| V2fx| V2fy| | | 0. 05| 0. 05| 2. 557| 1. 511| 0. 077| 1. 056| 2. 488| 0. 3909| | Errors| | | 0. 003525| 0. 003886| 0. 002806| 0. 003190| 0. 00481| 0. 003588| | | P1ix| P1iy| P1i| P2ix| P2iy| P2i| Pi Tot| | | | 0. 1279| 0. 0756| 0. 04174| 0| 0| 0| 0. 04174| | | Errors| | | 0. 0001061| | | 0| 0. 0001061| | | | P1fx| P1fy| P1f| P2fx| P2fy| P2f| Pf Tot| ? P| ? P/Pi| | 0. 1654| 0. 03378| 0. 03761| 0. 01316| -0. 00198| 0. 01331| 0. 05092| 0. 00918| 0. 2199| Errors| | | 0. 001665| | | 0. 000224| 0. 00168| | | | KE1i| KE2i| KEi Tot| KE1f| KE2f| KEf Tot| ? KE| ? KE/KEi| | | 0. 01767| 0| 0. 01767| 0. 01435| 0. 001796| 0. 01615| -0. 00152| -0. 08602| | INELASTIC COLLISION| | Mass 1| Diameter 1| Mass 2| Diameter 2| V1ix| V1iy| V1fx| V1fy| V2Fx| V2Fy| | 0. 052| . 05| 0. 052| 0. 05| 1. 361| 1. 231| 0. 7372| 0. 9625| 0. 5867| 0. 9481| Errors| | | | | . 007372| . 005637| . 04805| . 02558| . 007288| . 02936| | P1ix| P1iy| P1i| P2ix| P2iy| P2i| Pi Tot| | | | | 0. 2832| 0. 02731| 0. 03934| 0| 0| 0| 0. 03934| | | | Errors| | | 0.

000164| | | 0| 0. 000164| | | | | P1fx| P1fy| P1f| P2fx| P2fy| P2f| Pf Tot| ? P| ? P/Pi| | | 0. 01479| 0. 01901| 0. 02409| 0. 02274| 0. 02443| 0. 03338| 0. 03338| -0. 00596| -0. 1515| | Errors| | | 0. 000242| | | 0. 000243| 0. 000343| | | | | ? | KE1i| KE2i| KE rot i| KEi Tot | KEf lin = KE1f = KE2f| KEf Rot| KEf Tot| ? KE| ? KE/KEi| | 3. 27| 0. 015| 0| 0| 0. 015| 0. 005387| 0. 003397| 0. 008784| -0. 00622| -0. 4144| Data Analysis: Angular Velocity = vr Conservation of Momentum: Elastic: x-component 1v1ix+m2v2ix= m1v1fx+m2v2fx 502. 557+500= 50. 077+502. 488 127. 85= 128. 25 Error:. 311% y-component m1v1iy+m2v2iy= m1v1fy+m2v2fy 501. 511+500= 501. 056+50. 3909 75. 55= 72. 345 Error: 4. 24% Inelastic: x-component 50(1. 361)+50(0)= 50(. 7372)+50(. 5867) 68. 05= 66. 2 Error: 2. 8% y-component 50(1. 231)+50(0)= 50(. 9625)+50(. 9481) 109. 675= 95. 53 Error: 12. 9% Conservation of Kinetic Energy 12m1v1i2+12m2v2i2+12I11i2+12I12i2= 12m1v1f2+12m2v2f2+12I11f2+12I12f2 12506. 54+1250(0)+12(15625)(. 01)+12(15625)(. 003)= 12(50)(. 006)+12(50)(6. 19)+12(15625)(. 0018)+12(15625)(. 0002) 265. 0625= 270 Masses measured in [kg]*Velocities measured in [m/s] *Momentums measured in [kgm/s]*Energies measured in [J] * ? measured in [rad/s] Discussion: The theories of conservation of momentum and conservation of energy in collisions in two dimensions were supported in this lab. While conservation of momentum was supported through both elastic and inelastic equations, conservation of energy was supported only through elastic collisions. Rotational kinetic energy also played a role in the results. The theories are highly supported due to the low amount of error present in this lab.

In calculating the final results of kinetic energy and momentum, mass and velocity measurements were used. Momentum and kinetic energy are variables dependent on those of mass and velocity, the independent variables. Because the graphs were position vs. time graphs, the velocity could be derived by looking at the slope. Because the change in momentum in the elastic equation was a relatively small change, momentum in this collision was proven to be conserved. Kinetic energy was also conserved, as is characteristic of elastic collisions, with another very small change.

As expected, momentum was also conserved for the inelastic collision. Although the change in kinetic energy was small, the fact that there was some change supports it being an inelastic collision. Energy was not conserved, as expected. Some error in the lab could be contributed to the nearly (but not quite) frictionless air tables. Even slight friction may have affected the data. Another contributing factor to overall error could be the rotational kinetic energy not accounted for in the elastic collision, seeing as energy would have been added to the system.

This error could be reduced or eliminated by taking rotational kinetic energy and friction into account. Conclusion: The objective of this lab was to support the theories of conservation of momentum in both elastic and inelastic collisions, and to support the theory of kinetic energy conservation in elastic collisions. Because the changes in the values of kinetic energy and momentum were so small, they proved insignificant and the theories were supported. Therefore, the objective of the lab was met.