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Examining Inelastic Collisions

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Energy Tracking for Non-Elastic Collisions: Crashes made Easy!

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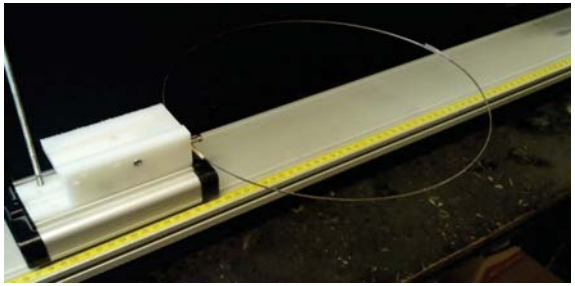
What's Up With That?

Students taking introductory physics classes are presented with concepts of conservation of momentum, and conservation of energy. These concepts can be very daunting. Of particular difficulty are perfectly inelastic collisions. Students see the collision take place but are left with questions regarding the subtleties of tracking where the energy goes, since non-elastic collisions don't have visible changes to the state of the carts.

When observing an elastic collision, these concepts are easily demonstrated:

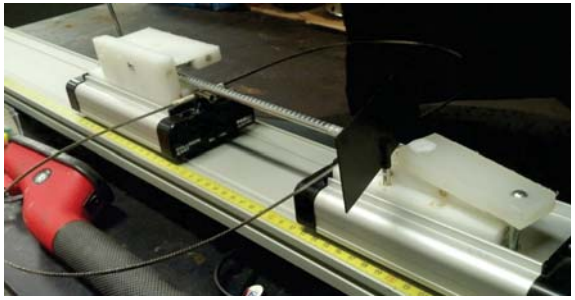
1) Conservation of Momentum is clearly seen by the launch cart moving into the stationary cart, and then the stationary cart moving away.

2) Conservation of Energy is also somewhat obvious by the compressing of springs. Work is being done on the spring by the cart.



Let's slow it down now.

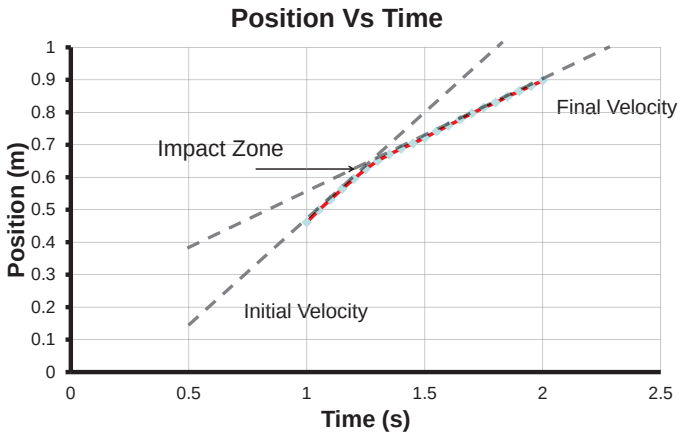
In order to get a better idea of where the energy is going in the collision a ratcheting mechanism can be installed to lock the carts together after kinetic energy from the cart is transferred into potential energy in the spring.



The Approach

Using the Conservation of Momentum, the known mass, of the carts, and calculated spring constants we can start to build a picture of what is happening. A sonic detector is used to track the launch velocity of the rod cart.

Data collection gives a clear look at the velocity before collision, and the velocity of both carts moving together after the collision.



Making Some Sense Out of It

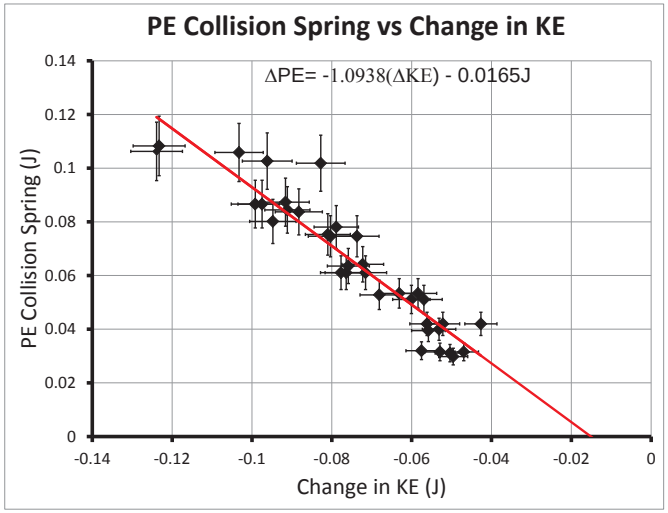
Knowing the spring constants, of the launch spring, and crash spring, the initial and final velocities allows for calculations of the kinetic energy the rod cart has versus how much potential energy is stored in the crash spring after collision.

$$KE = \frac{1}{2}mv^2 \quad PE = \frac{1}{2}k\Delta x^2$$

Results

The Potential Energy the spring holds after every collision can be plotted versus the change in Kinetic Energy providing a direct measure of what happens to the energy in the system after impact.

From the data shown below, The slope indicates a conservation of energy process, but also a loss (the intercept) attributed to friction in the ratchet.



Conclusion

This investigation provides a more visceral discovery of conservation of energy and conservation of momentum in perfectly inelastic collisions than by simple instructor statement that energy is transferred into heat, object deformation, sound, etc.