COMPILATION: Unit 9: Momentum in 2-cart collisions

Date: Thu, 24 Feb 2000
From: John Barrere <forcejb@YAHOO.COM>
Subject: momentum

I've re-read Greg's excellent post from last year about treating force as a momentum "current". Does anyone have a way to present this that doesn't bamboozle "regular" students? Also, how come energy in the moving cart(s) "leaks" out of the system so easily during most collisions but momentum doesn't? I still don't have a presentation/discovery strategy for handling these
issues that I'm happy with.

Date: Sun, 27 Feb 2000
From: John Barrere <forcejb@YAHOO.COM>

Gregg Swackhamer patiently traded some very helpful emails with me last week on the subject of energy conservation vs. momentum conservation. But I’m still left with a nagging "how come" so I thought I'd post this question to our whole group. Consider a system consisting of 2 Pasco carts on a low-friction track, one parked and the other moving arranged to have an inelastic collision. The before and after speeds are measured so as to minimize the effects of rolling friction. So the system energy is initially stored solely in the moving cart (as Ek). I believe there is only one mechanism for the transfer of both energy and momentum within the system (ie, from cart 1 to cart 2). That mechanism is the force of the moving cart acting on the parked cart during the collison. The integral of this force with respect to time yields the momentum gain of the parked cart which is exactly equal to the momentum loss of the moving cart; ie, perfect conservation of momentum. The integral of this SAME FORCE with respect to distance yields the energy gain of the parked cart which is equal to the energy loss of the moving cart EXCEPT that a large portion of the energy is "spilled" in the process showing up as Ediss at the expense of Ek. That is, the energy pie that was 100% Ek immediately prior to the collision is now less than 40% Ek immediately after the inelastic collision.

At least at the macroscopic level, it seems to me that the process is fundamentally the same for both energy transfer and momentum transfer - the application of a force by one object on another for a specific time and distance interval. "How come" the transfer process for Ek is highly dissipative while the process for momentum (fundamentally the SAME process) is perfectly conservative? If some of the force vs. distance integral (energy) is "used up" in producing vibrations and distortions within the system, "how come" none of the force vs. time integral (momentum) meets the same fate? It's the same force. Even with Gregg's patient prodding, I have been unable to come up with a satisfactory mental model to explain this behavior. HELP!!

Date: Mon, 28 Feb 2000
From: Bob Baker <bob.baker@WORLDNET.ATT.NET>

A response to John Barrere's question about momentum in two-cart linear collisions.

This is one way to consider conservation of momentum with non-conservation of kinetic energy in a linear collision.

When considering change in momentum in a linear collision, the momentum in the direction of the motion , the x direction, is conserved and the momentum of the individual particles in the y and z directions before and after the collision add up to zero. However, the y and z direction particle's kinetic energies before and after the collision do not necessarily add up to zero since the kinetic energies are not vectors and all their values are positive. It is difficult or even impossible to measure the velocities of y and z direction particles, but it is easy to measure the average velocity of all of the x-direction particles by assuming the object is one large particle. The extra velocity obtained by the y and z direction particles from the collision should account for some of the kinetic energy loss. This in no way conflicts with the momentum being conserved in the x direction. Other energy losses occur from other forms of energy transfer outside of the defined system. In a true linear x direction elastic collision, particles gain no velocity in the y and z directions on the average. I hope this is useful.