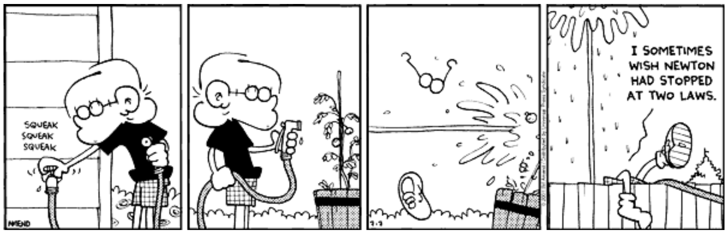
AP Discovery Lesson: Momentum

Name______________________________________
Period________



Experiment: What is Conserved?

(a) For this experiment, face the Velcro ends of each cart toward each other. One carts will start <u>at rest</u> while the other cart will roll I, hit, and stick both carts together. Position the motion detector behind the cart that moves initially so that the speed just before and just after the collision can be recorded.

Masses (kg)		Initial Velocity (m/s) One's at rest while the one that's measured comes in and hits and sticks to it		Final Velocity (m/s) they move off together after the collision		Initial Kinetic Energy (J) [1/2mass*v_{final}^2]		Final Kinetic Energy (J) [1/2mass*v_{final}^2]	
Cart 1	Cart 2	Cart 1	Cart 2	Cart 1	Cart 2	Cart 1	Cart 2	Cart 1	Cart 2

(b) Carry out three collisions: (a) 2 empty carts, (b) 1 empty cart and 1 carrying 500g of mass, and (c) 1 empty cart and 1 carrying 1kg of mass. For each collision determine from the graph what the initial speed of the incoming cart is just before it collides and what the final speed of both carts are just as they begin to move together.

(c) Perform the calculations to fill in the table.

(d) How fast were the carts moving at the beginning in each case?

(e) Did the carts move after the two of them became stuck together?

(f) Perform the calculations to fill in the table below.

Total Initial Velocity (m/s) [$v_{1i}+v_{2i}$]	Total Final Velocity (m/s) [$v_{1f}+v_{2f}$]	Conserved? (initial=final?)

Total Initial KE (J) [$KE_{1i}+KE_{2i}$]	Total Final KE (J) [$KE_{1f}+KE_{2f}$]	Conserved? (initial=final?)

(g) Were the total initial and total final velocities the same before and after the force was applied? (In other words, was velocity "conserved"?)

(h) Were the total initial and total final kinetic energies ($\frac{1}{2}mv^2$) the same before and after the force was applied? (In other words, was *kinetic* energy "conserved"?)

(i) It was helpful for us to analyze energy in a table, knowing that it was "conserved" so the total stayed constant as long as no work was done by external nonconservative forces. We could tally the individual parts and keep track of the totals. Here, kinetic energy of the lab carts is dissipated into the environment during the collision as via heat and sound, transferring some of its kinetic energy to the energy of air molecules and molecules within the surfaces of both carts (internal thermal energy).

<u>PREDICT</u>: Is there anything **other than energy** that is “saved” for after the force acts: of which the total amount in the system is constant (the same before and after a force is applied) so that we can say that “<u>*this thing*</u> is conserved.” – similar to our analysis of energy? What’s your hypothesis?

(j) Fill in the tables below:

Initial *mass x velocity* (kg*m/s) [mass*velocity $_{initial}$]		**Initial** Total *mv* (kg*m/s) [$m_1v_{1\ initial} + m_2v_{2\ initial}$]
Cart 1	Cart 2	

Final *mass x velocity* (kg*m/s) [mass*velocity $_{final}$]		**Final** Total *mv* (kg*m/s) [$m_1v_{1\ final} + m_2v_{2\ final}$]
Cart 1	Cart 2	

(k) When you multiply mass times velocity, what happens? Were the slower ones more massive or less massive?

Initial Total *mv* (kg*m/s) [$m_1v_{1\ initial} + m_2v_{2\ initial}$]	**Final** Total *mv* (kg*m/s) [$m_1v_{1\ final} + m_2v_{2\ final}$]	Conserved? (initial=final?)

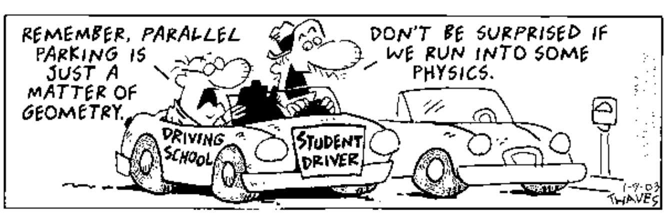
(l) Observe how much total *mass times velocity* the carts have at the end in each case when you add the *mass times velocity* of the two carts.
Compare the total *mass times velocity* before and after each launch. Was there a *significant* difference?

(m) Were the total initial and total final *mass times velocity* values the same before and after the force was applied? (In other words, was *mass times velocity* "conserved"?)

*From this, we can conclude two things:

1) It's useful to multiply mass times velocity.
Isaac Newton referred to this as the "quantity of motion." These days we call it "momentum" and use "p" to represent it. Thus, to calculate momentum (p), all you have to do is multiply mass and velocity: p = mv

2) M*omentum* can be conserved. Mathematically: $m_{1i}v_{1i} + m_{2i}v_{2i} = m_{1f}v_{1f} + m_{2f}v_{2f}$ because $p_{1i} + p_{2i} = p_{1f} + p_{2f}$



Momentum is useful in analyzing collisions