COMPILATION: Unit 9 - Momentum conservation diagrams (bar graphs)

Date: Sat, 24 Feb 2001
From: Mark Schober <mschober@JBURROUGHS.ORG>
Subject: Representing Momentum Conservation

When I first encountered the impulsive force/momentum model, I felt that it lacked a good graphical/diagrammatic representation. Of course, motion maps and force diagrams are utilized, but there wasn't something simple and rich for representing momentum conservation. I am very enamored of the energy conservation diagrams and the way they allow the students to see the energy conservation equation graphically, so I attempted to create something similar for one-dimensional linear momentum conservation.

I will attempt to describe it below, but looking at the examples I have posted on the web will probably be essential in figuring out what I'm doing.

http://www.jburroughs.org/science/mschober/momentum/ws2a.html
or http://jburroughs.org/science/mschober/physics.html

The result is again a bar graph for the initial and final situations, but this time with horizontal bars extending from zero in the middle of each graph. Momentum to the right gets a bar to the right, and momentum to the left gets a bar to the left. The sum of the bars in the initial situation needs to equal the sum of the bars in the final situation. Each bar gets labeled with the mass, object name and velocity, and writing down the bar labels results in the momentum conservation equation for the situation. I also have students write down the event that separates the initial situation from the final situation, which is one of the more difficult aspects for my students to identify. Students define the system of interest by choosing what objects will be listed on their bar graph, and objects accounted for in the initial situation must be accounted for in the final situation. Since a change in bar length is a change in momentum, it is also an impulse, and this makes a meaningful tie to the impulse-momentum theorem.

Having already seen the energy conservation graphs, my students quickly latched on to the momentum conservation graphs and told me that they were similarly helpful. Their improved test scores over last year's group indicated their value for me.

I think it would be overly cumbersome to utilize these graphs for 2-dimensional problems and for more advanced students the graphs are probably unnecessary. However, the graphs are

valuable for students who are just trying to get a feel for momentum conservation and impulse. I hope you find them useful or can offer some suggestions for improvements.

Here's two solved example problems:
http://www.jburroughs.org/science/mschober/momentum/solutionconp.html

I have posted Worksheet 2 with the graph templates inserted at:
http://www.jburroughs.org/science/mschober/momentum/ws2b.html

It ended up with the name "2b" since, in hindsight, I figured it would have helped to have a qualitative version first. My qualitative worksheet 2a also has several ambiguous questions forcing students to figure out how to deal with the earth.

Date: Mon, 26 Feb 2001
From: Kathleen Andre Harper

Mark Schober's development of a diagrammatic representation for momentum conservation sounds excellent to me! I can report some success with a weaker attempt at doing the same thing. A few years ago, I had a few students who were really struggling with the concept. We tried using a bar chart analogous to the energy bar charts. The students showed marked improvement afterward, and at least one specifically cited the bar charts as a help. I really like Mark's idea of making the axis horizontal - why didn't I think of that? :)

I understand that Tom O'Kuma of Lee College in Texas has been applying bar charts in a variety of situations, but I've never gotten the specifics on them.

Date: Mon, 26 Feb 2001
From: Larry Dukerich <dukerich@ASU.EDU>

Having just given the unit test for momentum in my regular class, I was wondering how I could get my students to more accurately represent a collision event algebraically, since many of them seemed to be writing equations haphazardly. Then I read Mark Schober's post regarding his use of momentum bar graphs that parallel the energy bar graphs we used earlier.

I really like this idea and intend to use it next year.
