COMPILATION: unit 3: Direction of Acceleration

Date: Thu, 18 Oct 2001
From: Sandy Bouchier <Sandy_Bouchier@NCSD.K12.WY.US>
Subject: Direction of Acceleration

There was a question asked about how to explain the direction of acceleration before students learn about forces. My first year teaching I came up with a method that is "artificial" but I still use because almost all students get it!

I give the class the following 4 problems and ask them to solve for acceleration using the definition that the average acceleration is the change in velocity divided by the change in time. I then ask what is happening in terms of "change in speed" and the direction traveled for each problem. We agree that an increase in speed can be thought of as a positive (+) and a decrease in speed can be seen as a negative (-). We also agree that traveling in the positive direction is positive (+) and traveling in the negative direction is negative (-). I remind them of the old math rule that two positives or two negatives result in a positive answer while a negative and a positive result in a negative answer. We end up with the following information after going through all of these steps:

Time interval is 1 sec throughout

Initial Velocity	Accel.	Change in speed	Direction traveled	Direction of Accel.	Final Velocity
1) 3 m/s increasing	4 m/s/s	(+)	(+)	(+)	7 m/s
2) 7 m/s decreasing	-4 m/s/s	(-)	(+)	(-)	3 m/s
3) -3 m/s increasing	-4 m/s/s	(+)	(-)	(-)	-7 m/s
4) -7 m/s decreasing	4 m/s/s	(-)	(-)	(+)	-3 m/s

I emphasize that I broke velocity into speed and direction, so when we talk about speed increasing or decreasing I don't have to worry about the signs.

I still talk about these four problems in more traditional ways. I tell them I am standing on a skateboard and traveling in the appropriate direction with the initial speed. I ask them which direction they would have to push me to make me have the final speed. I link acceleration to forces this way even before we have discussed forces.

I also graph the initial and final velocities and look at the direction of the slopes. (They know the slope of the velocity graph is the acceleration.)

All year my students say things like "Going in the negative direction speeding up is a negative acceleration." I can almost see the positive and negative signs in their eyes!

Date: Thu, 18 Oct 2001
From: Richard McNamara <richmcn@EARTHLINK.NET>

Sandy Bouchier wrote:
<< I emphasize that I broke velocity into speed and direction, so when we talk about speed increasing or decreasing I don't have to worry about the signs. >>

For the kids who can't handle the signs, another very simple way of looking at the question of acceleration and speeding up vs slowing down is to very simply say that:
"If the acceleration and the velocity are in the same direction, the object speeds up. If the acceleration and the velocity are in the opposite direction, the object slows down.

(I can't take credit for this because it was a student who put it so succinctly!)

From that point on it's a piece of cake. If it has a positive velocity and it's speeding up, it must have a positive acceleration. If it has a positive velocity and it's slowing down, it must have a negative acceleration. And vice versa.

Date: Fri, 19 Oct 2001
From: Matt Green <matt_green@CARYACADEMY.ORG>

Richard McNamara wrote:
<<For the kids who can't handle the signs, another very simple way of looking at the question of acceleration and speeding up vs slowing down is to very simply say that:
"If the acceleration and the velocity are in the same direction, the object speeds up. If the acceleration and the velocity are in the opposite direction, the object slows down. "

I also explain things this way. But this is the first year I have used acceleration arrows on the motion maps. After first determining the motion map for the object that was slowing down, one of my students said, "the acceleration is chipping away at the velocity." We later extended that to speeding up cases by saying "the acceleration is stretching the velocity." While it implies a causal relationship proper for forces rather than acceleration, it is an image that has helped some of my students understand.

Date: Fri, 19 Oct 2001
From: Marc Reif <mreif@FAYAR.NET>

If you have a rotary motion sensor, you can do a "Jerk" lab. Take a pull chain (like on a lamp), rest it on a table top with the sensor's wheel level with the table top, so that when you take your finger off the chain, it slides off the table, over the sensor, spinning the wheel. You'll collect a cubic pos-t graph, quadratic v-t graph, and linear a-t graph. Works pretty well. The RMS takes 1440 samples a rev in high mode. I tried it with a smart pulley and didn't get as good results.

Original idea comes from Lowell Herr, formerly of Catlin Gabel school in Portland, OR and one of the creators of Project PHYSLab.

Date: Sat, 20 Oct 2001

From:	John and Judie Koski <jkoski@SWBELL.NET>

I have a very effective way to demonstrate how acceleration affects velocity, and if you whiteboard (any of you out there who don't?) you do, too.

Take a black Expo marker and hold it up to the class, so the class sees it pointing to the right (positive) direction. Tell them this is a velocity vector (complete with a black arrowhead to indicate direction!). Directly below it, hold a different colored marker (I'll use red), pointing in the same direction. Explain that this is an acceleration vector, which indicates how much the velocity will change in the next time interval. Ask what the velocity will be at the start of the next time interval. Then (and here's the great part, in case you haven't seen it coming), push the acceleration marker onto the top of the velocity marker. You now have a new velocity vector that is two markers long.

But you're not done. Change the red marker out for a black one. Hold the red marker below the "two marker" velocity vector and tell the class the object is still accelerating. What will the velocity be at the start of the next time interval? Move the acceleration vector to the top of the two-marker vector, and you have a three-marker vector.

Repeat once more.

THEN hold the red marker so the class can only see the top of the red cap (no acceleration). The velocity vector will no longer increase in length-constant velocity.

THEN reverse the direction of the red marker (negative acceleration). Ask what the velocity will be at the start of the next time interval. Move the red marker to the head of the velocity vector and explain that the red marker "cancels out" one black marker. The new velocity vector will be three markers long. Continue until you have no black markers left.

THEN ask what will happen if you STILL have this negative acceleration. Hold a black marker up so the class can see only the top of the black cap (zero velocity), and hold the red marker below it. The next velocity vector will be one marker long, pointing in the negative direction.

Like I said, I have found this method to be extremely effective, especially for my lower level kids. It also is a very nice preview/lead-in to vector addition, which I do later.
