Direct measurement videos activity.
http://serc.carleton.edu/student_videos/index.html#impulse_momentum

Task 1. Blow Dart Collides with Cart

Step 1: Getting to know the video

- Play around with the video figuring out what the frame counter is, what the measurements are on the video, and how to go frame by frame.

How <u>many frames</u> does it take the dart to go from 0 cm to 10 cm?

How <u>much time</u> did it take the dart to go from 0 cm to 10 cm?

Step 2: Calculations

1. **Calculate the velocity of the dart before the collision.**
2. **Calculate the velocity of the dart after the collision.**
3. **Calculate the velocity of the cart before the collision.**
4. **Calculate the velocity of the cart after the collision.**
5. **Calculate the momentum of the dart before the collision.**
6. **Calculate the momentum of the dart+cart after the collision.**

Step 4: Analysis

7. **Do your answers from 5 and 6 suggest conservation of momentum? Why/Why not? If not, where do you think momentum was lost or gained?**
8. **How much Kinetic Energy was lost in this collision?**

Task 2. Center of mass: boys on skates

Measure the position of the boys based on the location of the leading edge of their skates.

1. Using the first frame, calculate the position of the center of mass for the two boys at the start of the video.
2. Let the video play for a bit, and choose another time point. Re-calculate the center of mass's position
3. Find the CM at two other time points. Record the times.
4. Given that the boys are at rest at the start, do your results make sense? Does the CM move in a clear direction? Are there outside forces? Remember that $V_{CM}=p_{total}/m_{total}$.

Task 3. 2D motion center of mass calculation (2-d collision)

For this problem you may leave all distances in cm and masses in grams.

1. Calculate the initial velocity and momentum of the first puck.
2. Determine the velocity of the center of mass in the x-direction before the collision. Remember that $V_{CM}=p_{total}/m_{total}$ and can be calculated separately for the x and y direction.
3. Calculate the x and y velocities and x and y momentum of the green puck AFTER the collision.
4. Calculate the x and y velocities and x and y momentum of the purple puck AFTER the collision.
5. What would you expect the y component of the velocity of the center of mass to be after the collision? (Hint, what was the y component before?)
6. Determine the velocity of the center of mass in the x and y-direction after the collision. Does it agree with our expectation that the center of mass doesn't change direction when collisions happen?
7. By using the Pythagorean formula to find the whole velocity of each object, find the change in kinetic energy in this collision.