**Momentum and Energy Transfer**

In this activity we will explore the transfer of linear momentum and kinetic energy in an explosion and in a collision using low-friction carts.

Momentum = **p** = m**v**. It has both magnitude and direction. If there are no external forces acting on a system, then the total momentum remains constant although momentum can be transferred from one object to another.

Kinetic energy = ½ mv2. This has only magnitude and no direction. Kinetic energy can be lost, gained or transferred.

Explosion

Two carts can be pressed together with the spring plunger on one of the carts pushed in. When the plunger is released they will fly apart in opposite directions.

m1

m2

motion sensor

*Prediction*: Assume that m2 > m1.

1. Which mass will have the greatest momentum? Why?
2. Which mass will have the greatest kinetic energy? Why?

*Check*: Now set up the explosion as shown in the diagram with a 250 g mass added to one of the carts and measure v2. Repeat with the carts reversed and measure v1. Calculate the momenta and kinetic energies and check your predictions.

Can you explain the results?

*Question*: What is the total energy stored in the compressed plunger? What is the spring constant (k) of the plunger? (E = ½ kx2)

If time allows, repeat using different masses.

Inelastic Collision

Two carts can collide and stick together with the Velcro ends facing each other (if they are not going too fast).

m1

m2

motion sensor

*Prediction*: Assume that m2 > m1 and that mass 2 is initially at rest.

1. Which has the greatest momentum – cart 1 before the collision or the coupled carts after the collision? Why?
2. Which has the greatest kinetic energy – cart 1 before or the coupled carts after the collision? Why?

*Check*: Now run the experiment as shown with 250 g added to mass 2. Measure v1 before and v after the collision. Use your measurements to calculate the momenta and kinetic energies and check your predictions. Can you explain your results?

Elastic Collision

A nearly elastic collision between the carts can occur if you have the ends with the embedded magnets facing each other. To do this experiment you would need to measure the velocities of both carts simultaneously. This is a more complicated experiment and we will not do it. But you can play around with such a collision to see how it might work. For example, what should happen if 1) m1 = m2, 2) m1 > m2, 3) m1 < m2?

Collision Simulation

Here are some sites with nice collision apps. Try them out.

<https://phet.colorado.edu/> (Note that you can change the elasticity. The collision app will not run on an iPad.)

<http://www.walter-fendt.de/html5/phen/> (Will run on iPad or PC.)