Motion 5 - Momentum

In physics there is a super special set of observations that rule over all of physics. They are **Laws of Conservation**. In chemistry you met two of them, 'Conservation of Mass' and 'Conservation of Energy'. Today you meet a new Law of Conservation, and in your next and final unit, you will meet yet another.

Laws of Conservation are so important because they form the basis of nearly everything we know about science.

Definitions

- **Momentum** - Momentum is Mass times velocity, $p = mv$.
- **System** - A group of stuff that is interacting.
- **Conservation of Momentum** - Total momentum of a system is conserved IF no forces act on the system.

Conservation of Momentum

Conservation of momentum means that the momentum of a system is constant IF there are no forces acting on the system. Remember, when you apply a force the system changes because your objects accelerate.

Conservation means that the total momentum of the system does not change before, during, or after the collision.

The most common example of conservation of momentum is the game pool. Once the cue (the name for a pool stick) hits the pool ball, the momentum of all the pool balls is conserved because they now form a system. IF someone sticks their hand on the table and grabs or stops a ball they are applying a force to the system and the momentum of the system will change.

Example

If you have a ball that weighs 1 kg, and is rolling at 1 m/s, then the balls momentum is:

$$\text{Momentum} = \text{Mass} \times \text{Velocity}$$
$$p = mv = (1\,\text{kg})\,(1\,\text{m/s}) = 1\,\text{kgm/s}$$

Activity - Total momentum of collisions

You are going to check to see if the conservation of momentum is true. To test this you will analyze 2 different collisions using the 'Tracker' program.

Step 1 - Collide two steel balls

- Get a length of foam track, two steel balls, and a meter stick.
- Tape one end of the track to the floor, and place the meter stick next to the track.
- Place one ball in the middle of the track, and curve the other slightly upward. Place the second ball on the elevated section of the track and release it.
- Record a video of the two steel balls colliding.
  - Make sure you hold the camera still
  - Make sure that you can see the meter stick in your video
- Measure the mass of the steel ball on the balance.
- Process the video using the *Tracker* program.
  - You need to specify the mass of the point mass to have the momentum be correct.
  - You will create a second point mass to track the second ball.

Step 2 - Collisions on the International Space Station

There is a collision that was done on the International Space Station saved to the flash drive. Copy it to your computer then drag and drop the .trk file into the tracker program to open it and view it. Make sure to watch the video!

Step 3 - Sketch the following plots into your labbook

For **EACH** of your two collisions sketch the following graph into your lab notebook.

- On the **SAME** graph plot:
  - The total momentum (p) of the first mass.
  - The total momentum (p) of the second mass.
  - The sum of the two momentums (you will have to do this by hand).

To plot two things at the same time right click the graph and select 'Compare with...' from the drop down menu. Then click the mass that is not currently displayed.

Step 4 - Complete the lab report in Schoology