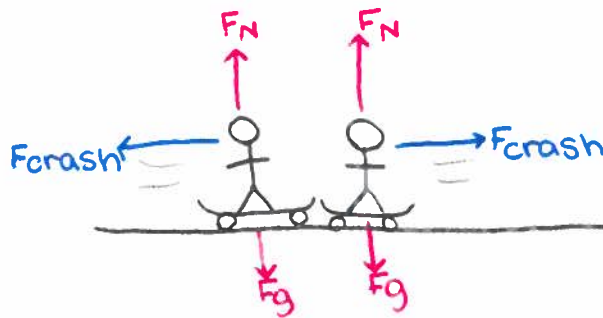**Section 6.3: Conservation of Momentum**

In a system (a collection of objects), an *external force* is one that comes from

__outside the system__.

system is two skateboarders
- external forces
- internal forces

An __isolated system__ is a system where all the __external forces__ __add to zero__.

In an isolated system, two colliding/exploding objects experience...

__equal and opposite force__ (Newtons 3rd Law)

and therefore

__equal and opposite impulse__ (b/c same Δt)

impulse

$$\Delta t \ \Sigma \vec{F} = \Delta \vec{p}$$

and therefore have

__equal and opposite change in momentum__

This leads us to the **Law of Conservation of Momentum...**

"In an isolated system, __momentum can't be created or distroyed__"

or

$$\Sigma \vec{p}_i = \Sigma \vec{p}_f$$

An __elastic collision__ is one where the objects __bounce apart__.

Example: A 0.25 kg cue ball is traveling east at 4.5 m/s when it collides head on with a 0.25 kg 8 ball traveling west at 5 m/s. After the collision, the cue ball is traveling west at 2 m/s. What is the final velocity of the 8 ball?

Initial   Final

4.5m/s   5m/s   2m/s   ?
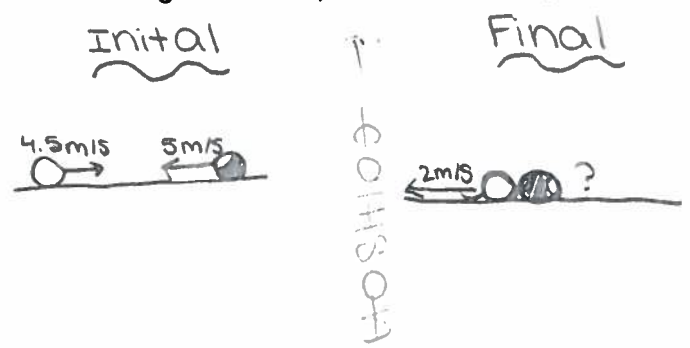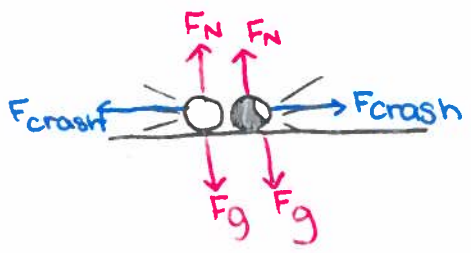
- external forces add to zero therefore, it an isolated system therefore, we can use $\Sigma \vec{p}_i = \Sigma \vec{p}_f$

$$\Sigma \vec{p}_i = \Sigma \vec{p}_f$$

$$mV_{cue} + mV_{8-ball} = mV_{cue} + mV_{8 ball}$$

$$0.25(+4.5) + 0.25(-5) = 0.25(-2) + .25(\vec{v})$$

$$1.125 - 1.25 = -0.5 + .25(\vec{v})$$

$$0.375 = .25(\vec{v})$$

$$1.5m/s \text{ right} = \vec{v}_{8-ball}$$

An __inelastic collision__ is one where the objects __stick together__.

Example: A 35 g bullet strikes a 5 kg stationary wooden block and embeds itself in the block. After the collision, the block and the bullet move together at 8.6 m/s. What was the original speed of the bullet?
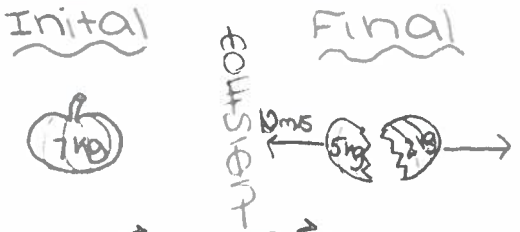
Initial   Final

? $\vec{v}=0$ 8.6m/s

$$\Sigma \vec{p}_i = \Sigma \vec{p}_f$$

$$(0.035)\vec{v}_{bullet} + 0 = (0.035)(8.6) + 5(8.6)$$

$$\vec{v}_f \text{ bullet} = 1237.17 \text{ m/s right}$$

We can also use the *law of conservation of momentum* in the case of explosions.

Example: A firecracker sits in a 7 kg pumpkin. After it explodes, the pumpkin splits in two chunks. A 5 kg piece travels west at 10 m/s. What is the mass and velocity of the other piece?

Initial   Final

7kg   10m/s 5kg   2kg

$$\Sigma \vec{p}_i = \Sigma \vec{p}_f$$

$$0 = 5(-10) + 2\vec{v}$$

$$50 = 2\vec{v}$$

$$\vec{v} = 25 \text{ m/s right}$$