Collisions

Momentum PowerPoint Slides 2, 3, 4, 5 , 6, 7, 8, 9

A large truck and a small car collide head on. Which will experience a greater impact force upon colliding?
Which has a greater **change** in momentum? (Δp)
Which experiences more acceleration?

Hewitt video #25 Conservation of Momentum

Law of Conservation of Momentum – in the absence of an external force the momentum of a system remains unchanged.

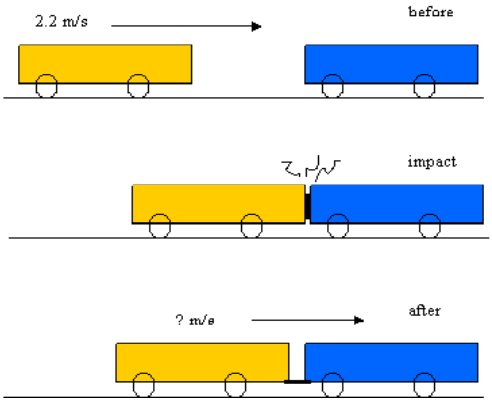
So ignoring external forces (friction, heat, air resistance) the momentum before a collision between objects equals the momentum after a collision.

momentum before collision = momentum after collision

$$p_i = p_f$$

Inelastic collisions – 2 or more **separate** objects collide and stick together after the collision. They could both stop but usually they will continue to move in one direction or another.

A freight car moving at 2.2 m/s collides with an identical freight car at rest and they couple together. (Both train cars have the same mass). What is the final combined velocity after they couple together?



This should be really easy if the masses of the two objects are equal simply divide the original momentum by 2.

Usually the masses of the two objects will not be equal so we need to develop an equation to deal with this. Keep in mind that…… "momentum before collision = momentum after collision".

So for two objects that collide and stick together ***Inelastic collision***

$$m_1v_1 + m_2v_2 = (m_1+m_2)\, v_f$$

Hewitt #26 Fish lunch problem

A big fish with a mass of 5kg moving at 1m/s eats a smaller 1kg fish at rest and keeps swimming. What is the final velocity of the big fish immediately afterwards?

$m_1 = 5$ kg $v_1 = 1$ m/s $m_2 = 1$ kg $v_2 = 0$ m/s now solve

$$m_1v_1 + m_2v_2 = (m_1+m_2)\, v_f$$

$$(5 \text{ kg})(1 \text{ m/s}) + (1 \text{ kg})(0 \text{ m/s}) = (5 \text{ kg}+1 \text{ kg})\, v_f$$

$$5 \text{ kg m/s} + 0 = (6 \text{ kg})\, v_f$$

$$\frac{5 \text{kg m/s}}{6 \text{ kg}} = v_f \qquad \mathbf{v_f = 0.83 \text{ m/s}}$$

An ice skater with a mass of 80 Kg is moving at 10 m/s. Without slowing down the skater picks up her small 15kg child who is standing still on the ice. What is the final speed of the mother and child?

$m_1 = 80$ kg $\quad v_1 = 10$ m/s

$m_2 = 15$ kg $\quad v_2 = 0$

$$m_1v_1 + m_2v_2 = (m_1+m_2)\, v_f$$

$$(80 \text{ kg})(10 \text{ m/s}) + 0 = (80 \text{ kg} + 15 \text{ kg})\, v_f$$

$$800 \text{ kg m/s} = (95 \text{ kg})\, v_f$$

$$\frac{800 \text{ kg m/s}}{95 \text{ kg}} = v_f$$

$$v_f = 8.4 \text{ m/s}$$

An 800 kg car moving 10 m/s is rear ended by a 4000 kg delivery truck going 60 m/s. The truck does not apply the brakes and the two vehicles stick together and continue to move as one as one crumpled mess. What is the final velocity of the two vehicles??

$m_1 = 800$ kg $\quad v_1 = 10$ m/s

$m_2 = 4000$ kg $\quad v_2 = 60$ m/s

$$m_1v_1 + m_2v_2 = (m_1+m_2)\, v_f$$

$$(800 \text{ kg})(10 \text{ m/s}) + (4000 \text{ kg})(60 \text{ m/s}) = (800 \text{ kg} + 4000 \text{ kg})\, v_f$$

$$8000 \text{ kg m/s} + 240{,}000 \text{ kg m/s} = (4800 \text{ kg})\, V_f$$

$$\frac{248{,}000 \text{ kg m/s}}{4800 \text{ kg}} = V_f$$

$$V_f = 51.7 \text{ m/s}$$