Collisions

In every collision

1) Conservation of momentum is observed
2) Conservation of ***total*** Energy is observed

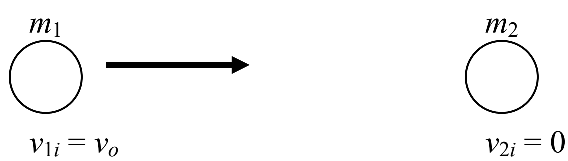
There are 2 types of collisions:

1) Elastic (*KE is conserved*)
2) Inelastic (*KE is NOT conserved*)

For inelastic collisions, the missing *KE* goes to *heat, deforming, friction …*

Ex.

Consider 2 objects of mass m_1 and m_2 colliding elastically. Let m_1 have an initial velocity and m_2 be initially at rest.



What are the final velocities of m_1 and m_2 if:

$a)\ m_1 = m_2$

$b)\ m_1 >> m_2$

$c)\ m_1 << m_2$

From Conservation of momentum

$$p_i = p_f$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$m_1 v_o = m_1 v_{1f} + m_2 v_{2f}$$

From Conservation of 'Mechanical' Energy

$$E_i = E_f$$

$$\frac{1}{2}m_1 v_{1i}^{\ 2} + \frac{1}{2}m_2 v_{2i}^{\ 2} = \frac{1}{2}m_1 v_{1f}^{\ 2} + \frac{1}{2}m_2 v_{2f}^{\ 2}$$

$$m_1 v_o^{\ 2} = m_1 v_{1f}^{\ 2} + m_2 v_{2f}^{\ 2}$$

Combining the momentum and energy expressions and using a lot of algebra, we find that

$$v_{1f} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) v_o$$

$$v_{2f} = \left(\frac{2m_1}{m_1 + m_2}\right) v_o$$

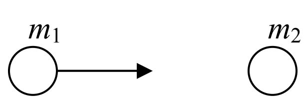
From these expressions, we can determine the motion of the system by just knowing the initial velocity of m_1 and both masses.

a) $m_1 = m_2$ (2 *pool balls*)

$v_{1i} = v_o$ $\quad$ $v_{1f} = 0$

$v_{2i} = 0$ $\quad$ $v_{2f} = v_o$

Before:



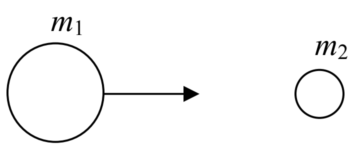
After:

b) $m_1 >> m_2$ (*bowling ball hitting a stationary ping pong ball*)

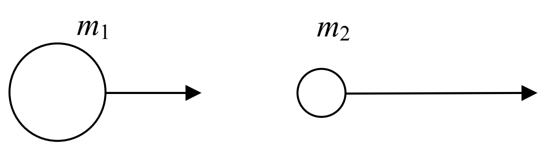
$v_{1i} = v_o$ $v_{1f} \approx v_o$

$v_{2i} = 0$ $v_{2f} \approx 2v_o$

Before:



After:

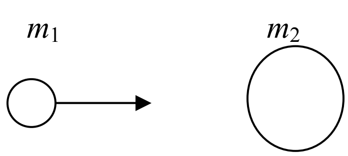


c) $m_1 << m_2$ (*ping pong ball hitting a stationary bowling ball*)

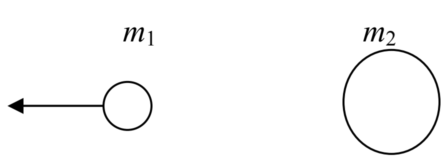
$v_{1i} = v_o$ $v_{1f} \approx -v_o$ (*reverses direction*)

$v_{2i} = 0$ $v_{2f} \approx 0$

Before:



After:



Note: m_2 will actually move if m_1 is not $<<$ m_2.