Examples

May 24, 2017 8:02 AM

The direction is very important. Keep track of + and – signs. Many examples will have one object at rest or will come to rest. There are three main examples we use for conservation of momentum in 1-dimension. and 2-dimensions.

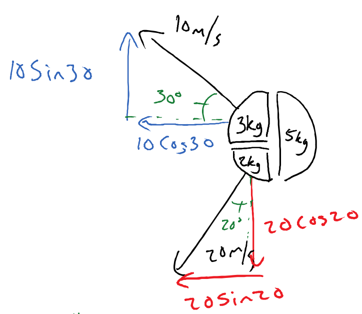
use these as a template

1. Collisions (non-stick) : $m_a v_a + m_b v_b = m_a v_a' + m_b v_b'$ Perfectly Elastic
2. Collisions (stick) : $m_a v_a + m_b v_b = (m_a + m_b) v'$ Inelastic
3. Explosions : $(m_a + m_b) v = m_a v_a' + m_b v_b'$ Inelastic

whenever a collision is perfect: the kinetic energy is conserved. $KE_i = KE_f$

Explosive Example

Find the velocity of the 5kg mass. Initially all the mass is together travelling @ 3 m/s to the right.



Initially $\longrightarrow$ 3 m/s

Initial

x-direction

$$P_{i_x} = (M_a + m_b + m_c) V_i$$
$$= (10)(3)$$
$$= 30 \text{ kg m/s}$$

y-direction

$$P_{i_y} = 0 \text{ kg m/s}$$

Final

x-direction

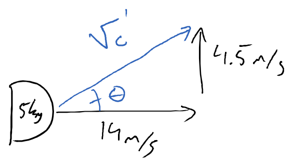
$$P_{f_x} = m_a V_{a_x}' + m_b V_{b_x}' + m_c V_{c_x}'$$
$$= (3)(-10\cos 30) + 2(-20\sin 20) + 5 V_{c_x}'$$

y-direction

$$P_{f_y} = m_a V_{a_y}' + m_b V_{b_y}' + m_c V_{c_y}'$$
$$= 3(10\sin 30) + 2(-20\cos 20) + 5 V_{c_y}'$$

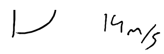
$$P_{i_x} = P_{f_x}$$
$$30 = 3(-10\cos 30) + 2(-20\sin 20) + 5 V_{c_x}'$$
$$V_{c_x}' = 14 \text{ m/s right}$$

$$P_{i_y} = P_{f_y}$$
$$0 = 3(10\sin 30) + 2(-20\cos 20) + 5 V_{c_y}'$$
$$V_{c_y}' = 4.5 \text{ m/s up}$$



$$V_c = \sqrt{14^2 + 4.5^2}$$
$$= 14.7 \text{ m/s}$$

$$\theta = \tan^{-1}\left[\frac{4.5}{14}\right]$$



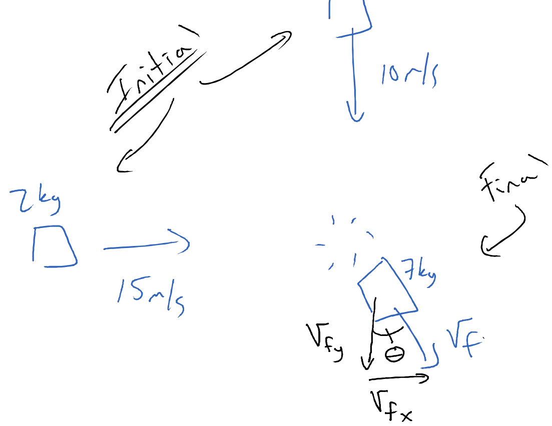
$$\theta = \tan^{-1}\left[\frac{4.5}{14}\right]$$

$$\theta = 18^\circ$$

$V_c' = 14.7\,m/s$ @ 18° above the horizontal

Example 2

Find P_f if the two objects sticks together. Find V_f and E_{lost}



x-direction

$P_{ix} = (2)(15)$

$= 30\,kg\,m/s$

$P_{fx} = (7)\,V_{fx}$

$= 7(V_f)\sin\theta$

$P_{ix} = P_{fx}$

Eq 1 $\boxed{30 = 7V_f\sin\theta}$

y-direction

$P_{iy} = (5)(+10)$

$= +50\,kg\,m/s$

$P_{fy} = (7)\,V_{fy}$

$= 7(V_f)\cos\theta$

$P_{iy} = P_{fy}$

Eq 2 $\boxed{+50 = 7(V_f)\cos\theta}$

$\frac{Eq1}{Eq2}$

$$\frac{30}{+50} = \frac{\cancel{7V_f}\sin\theta}{\cancel{7V_f}\cos\theta}$$

$+0.6 = \tan\theta$

$+31^\circ = \theta$

$30 = 7V_f\sin\theta$

$30 = 7V_f\sin(+31)$

$+8.32\,m/s = V_f$

$V_f = 8.32\,m/s$ @ 31° East of South

$E_i = KE_2 + KE_5$

$= \frac{1}{2}(2)(15)^2 + \frac{1}{2}(5)(10)^2$

$E_f = KE_7$

$= \frac{1}{2}(7)(8.32)^2$

$$= \frac{1}{2}(7)(15)^2 + \frac{1}{2}(5)(10)^2$$

$$= \underline{\underline{475\text{ J}}}$$

$$= \frac{1}{2}(7)(8.32)^2$$

$$= \underline{\underline{242\text{ J}}}$$

$$E_{lost} = E_i - E_f$$

$$= 475 - 242$$

$$= \underline{\underline{233\text{ J}}}$$