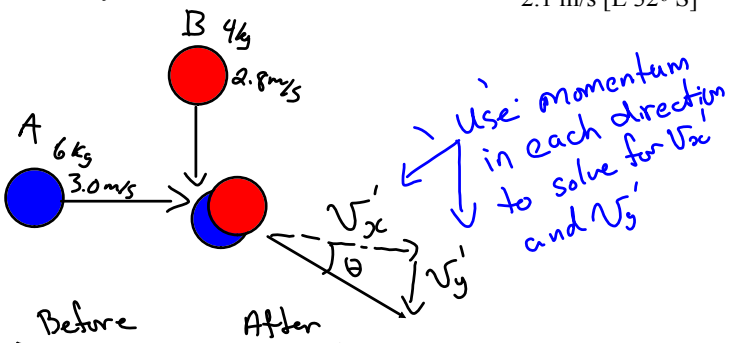
Two Dimensional (2D) Collisions

In order to solve two dimensional collision problems, write a conservation of momentum equation for the horizontal components of the momenta and a conservation of momentum equation for the vertical components of the momenta.

A 4.0 kg object is travelling south at a speed of 2.8 m/s when it collides with a 6.0 kg object travelling east at a velocity of 3.0 m/s. If these objects stick together upon collision, at what velocity do the combined masses move? 2.1 m/s [E 32° S]



Before

$m_A = 6$ kg

$v_A = 3.0$ m/s [E]

$m_B = 4$ kg

$v_B = 2.8$ m/s [S]

After

$v_A' = ?$

$v_B' = ?$

$\Big\}$ v' stick together

x - Dir

$$m_A v_{Ax} + m_B v_{Bx} = m_A v_{Ax}' + m_B v_{Bx}'$$

$$(6)(3) + (4)(0) = (6+4) v_x'$$

$$18 = 10 v_x'$$

$$1.8 = v_x'$$

y-dir

$$m_A v_{Ay} + m_B v_{By} = m_A v_{Ay}' + m_B v_{By}'$$

$$(6)(0) + 4(-2.8) = (6+4) v_y'$$

$$-11.2 = 10 v_y'$$

$$-1.12 = v_y'$$

Solve for v'

$$v' = \sqrt{(v_x')^2 + (v_y')^2}$$

$$= \sqrt{(1.8)^2 + (-1.12)^2}$$

$$= 2.1 \text{ m/s}$$

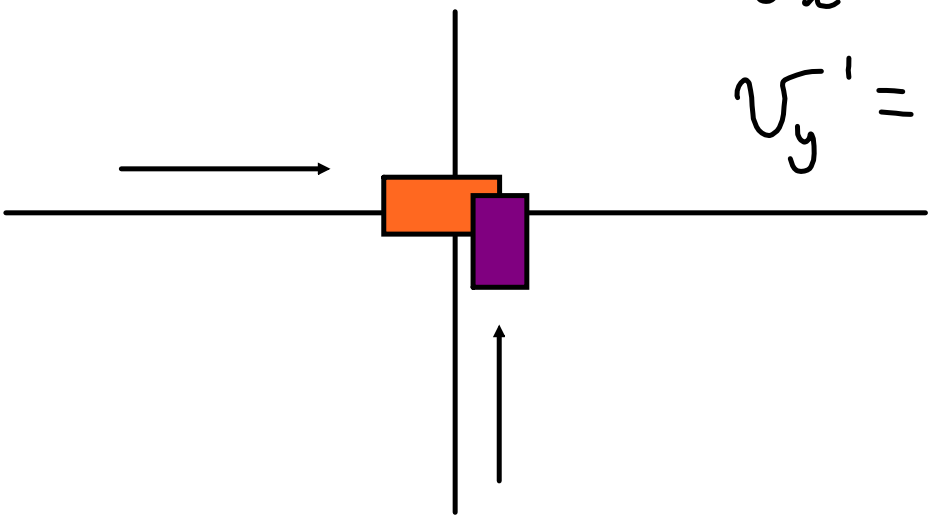
$$\theta = \tan^{-1}\left|\frac{v_y'}{v_x'}\right|$$

$$\theta = \tan^{-1}\left(\frac{1.12}{1.8}\right)$$

$$\theta = 32°$$

$$v' = 2.1 \text{ m/s } [E\ 32° S]$$

Example: A 1325 kg car moving north at 27.0 m/s collides with a 2165 kg car moving east at 17.0 m/s. They stick together. In what direction and with what speed do they move after the collision? (14.7 m/s, E44° N)



$v_x' = 10.5\ m/s$

$v_y' = 10.3\ m/s$