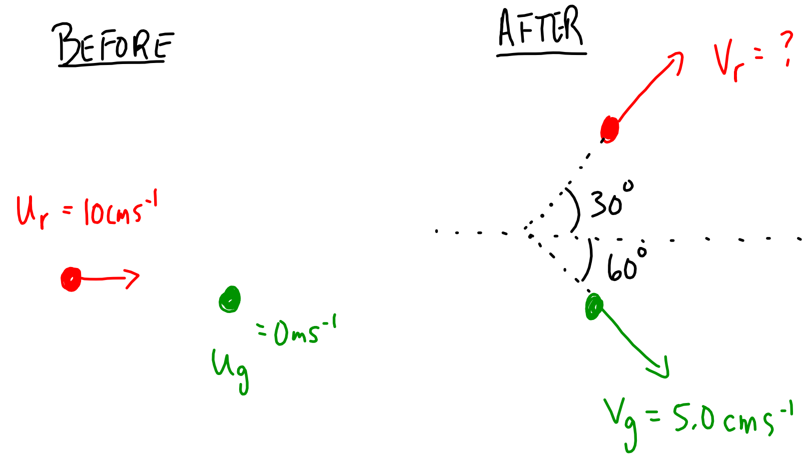
Example

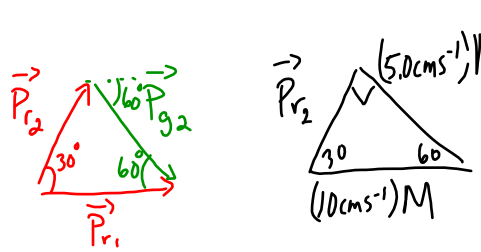
Consider the collision with two identical billiard balls given below



$$\vec{P}_{total(before)} = \vec{P}_{total(after)}$$

$$\vec{P}_{r_1} + \underset{0}{\cancel{\vec{P}_{g_1}}} = \vec{P}_{r_2} + \vec{P}_{g_2}$$

$$\vec{P}_{r_1} = \vec{P}_{r_2} + \vec{P}_{g_2}$$



Let M be the mass

$\sin\theta = \frac{opp}{hyp}$

$\sin 60° = \frac{P_{r_2}}{(10 cm s^{-1})M}$

$P_{r_2} = \left(\frac{10\sqrt{3}}{2} cm s^{-1}\right)M$

So the momentum of the red ball after the collision is $\left(\frac{10\sqrt{3}}{2} cm s^{-1}\right)M$

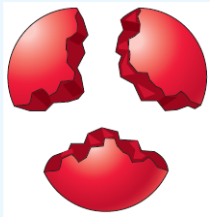
so the velocity is $\left((5\sqrt{3}) cm s^{-1}\right)$

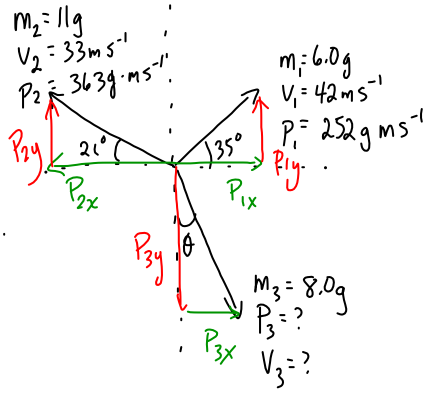
$v = \frac{P}{m}$

Example

A 25 g spherical fire cracker explodes into three parts. You were able to get a photograph taken under a strobe light of two dimensions of the explosion. However, one of the fragments was out of the range of the photograph. After the explosion, you measured the mass of the two fragments and calculated the velocity of the fragments from the photograph. By superimposing a coordinate system on the photograph, you measured the angles at which the fragments moved. A 6.0 g fragment moved off at an angle of 35° with the positive x axis at a velocity of 42 m/s. An 11 g fragment moved off at an angle of 21° cw with the negative x axis. What was the velocity of the third fragment? @33m/s

8g

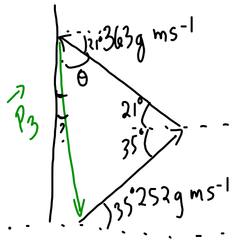




According to the Law of Conservation of Linear Momentum

$$\vec{P}_{total(before)} = \vec{P}_{total(after)}$$

$$0 = \vec{P}_1 + \vec{P}_2 + \vec{P}_3$$



(vector addition diagram)

- use Law of Cosines $c^2 = a^2 + b^2 - 2ab\cos C$
- use Law of Sines $\frac{a}{\sin A} = \frac{b}{\sin B}$

OR using components:

$$P_{1x} + P_{2x} + P_{3x} = 0$$

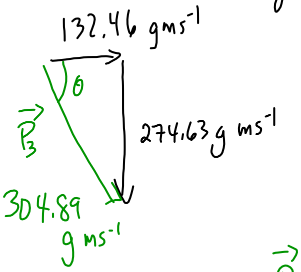
$$(252 g ms^{-1})(\cos 35°) - (363 g ms^{-1})\cos 21° + P_{3x} = 0$$

$$P_{3x} = 132.46 g ms^{-1}$$

$$P_{1y} + P_{2y} + P_{3y} = 0$$

$$(252 g \cdot ms^{-1})(\sin 35°) + (363 g ms^{-1})\sin 21° + P_{3y} = 0$$

$$P_{3y} = -274.63 g ms^{-1}$$



$$\tan\theta = \frac{274.63}{132.46}$$

$$\theta = 64°$$

$$\vec{P}_3 = 304.89 g ms^{-1} \text{ [64° CW from + x-axis]}$$

$$\vec{V}_3 = \frac{304.89 g ms^{-1}}{8.0 g} \text{ [64° CW from + x-axis]}$$

$$\vec{V}_3 = 38 ms^{-1} \text{ [64° CW from + x-axis]}$$