# §10-4 Collisions and Explosions

Recall the Conservation of Momentum:

$$\vec{P}_{total} = \vec{P}'_{total}$$

(in an isolated system i.e. no friction)

What this really means in 2D:

$$\vec{P}_{x\,total} = \vec{P}'_{x\,total}$$

$$\vec{P}_{y\,total} = \vec{P}'_{y\,total}$$

Another way to express the Conservation of Momentum:

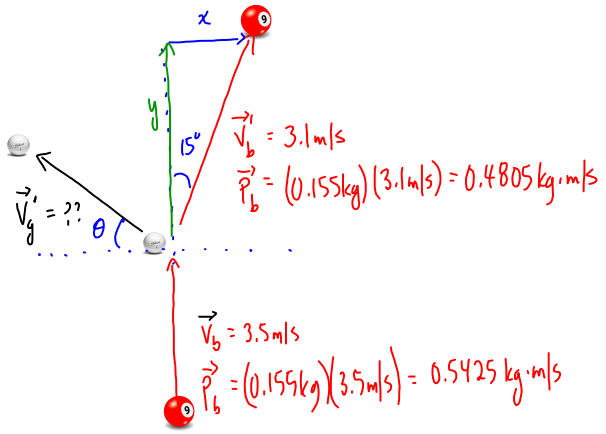
$$\Delta\vec{P}_A = -\Delta\vec{P}_B$$

(recall $\Delta\vec{p}$ = impulse)

MP/505

$m_b = 0.155kg$

$m_g = 0.052kg$




Method 1 - Using Components

BEFORE

| | x | y |
|---|---|---|
| $P_g$ | 0 | 0 |
| $P_b$ | 0 | 0.5425 |
| $P_{total}$ | 0 | 0.5425 |

AFTER

| | x | y |
|---|---|---|
| $P_g$ | x | y |
| $P_b$ | $0.4805\sin 15°$ | $0.4805\cos 15°$ |
| $P_{total}$ | 0 | 0.5425 |

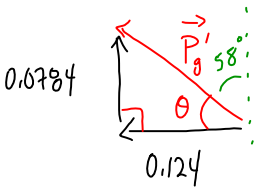
Along the x-axis: $x + 0.4805\sin 15° = 0$

$x = -0.124 kg \cdot m/s$

Along the y-axis: $y + 0.4805\cos 15° = 0.5425$

$y = 0.0784 kg \cdot m/s$

Now find the momentum of the golf ball




$c^2 = a^2 + b^2$

$c^2 = (0.0784)^2 + (0.124)^2$

$c = 0.147 kg \cdot m/s$

$\tan\theta = \frac{0.0784}{0.124}$

$\theta = 32°$

$p = mv$

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

$v = \frac{0.147 kg \cdot m/s}{0.052 kg}$

$v = 2.8 m/s$

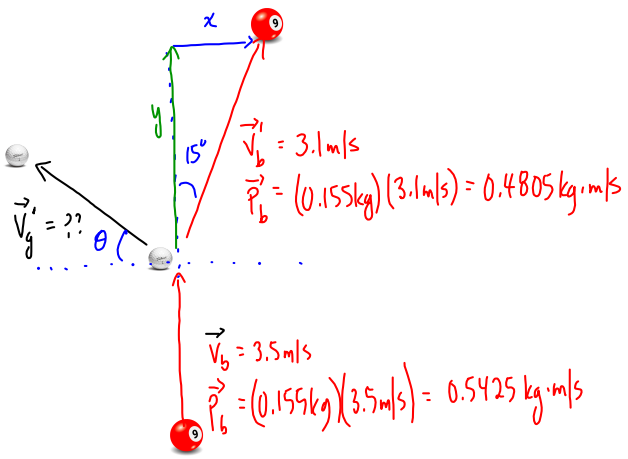
The velocity of the golf ball after the collision will be:

2.8 m/s [58° ccw from the original direction of the billiard ball]

MP|505

$m_b = 0.155kg$

$m_g = 0.052kg$




Method 2- Using a Momentum Vector Addition Diagram

* use only if working with 3 vectors (i.e. a triangle)

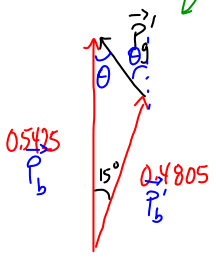
$$\vec{P}_{total} = \vec{P}'_{total}$$

$$\vec{P}_b + \vec{P}_g = \vec{P}'_b + \vec{P}'_g$$

$$\vec{P}_b = \vec{P}'_b + \vec{P}'_g$$

$\vec{P}_b$: know; $\vec{P}'_b$: know; $\vec{P}'_g$: want to find

Vector Addition Diagram




Using the law of Cosines:

$$c^2 = a^2 + b^2 - 2ab\cos C$$

$$C^2 = (0.5425)^2 + (0.4805)^2 - 2(0.5425)(0.4805)\cos 15°$$

$C = 0.147 \ kg \cdot m/s$

Using the Law of Sines:

$$\frac{a}{\sin A} = \frac{b}{\sin B}$$

$$\frac{0.147}{\sin 15°} = \frac{0.4805}{\sin \theta}$$

$$\sin\theta = \frac{(0.4805)(\sin 15°)}{0.147}$$

$\theta = 58°$

$p = mv$

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

$v = \frac{0.147 \ kg \cdot m/s}{0.052 \ kg}$

$v = 2.8 \ m/s$

$\vec{V} = 2.8 \ m/s$ [58° CCW from the original dir of billiard ball]

TO DO: PP|509