§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:

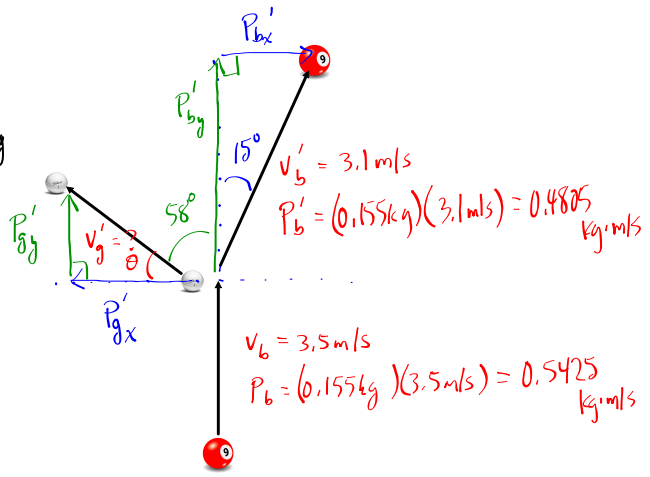
$$\Delta\vec{P}_A = -\Delta\vec{P}_B$$

(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 kg·m/s
P_{total}	0	0.5425 kg·m/s

AFTER

	x	y
P_g	x	y
P_b	$0.4805 \cdot \sin 15°$	$0.4805 \cos 15°$
P_{total}	0	0.5425 kg·m/s

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

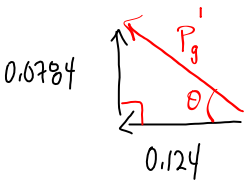
$x = -0.4805 \sin 15°$

$x = -0.1244$ kg·m/s

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

$y = 0.0784$ kg·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·m/s

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

$\theta = 32°$

$p = mv$

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

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

$v = 2.8$ m/s

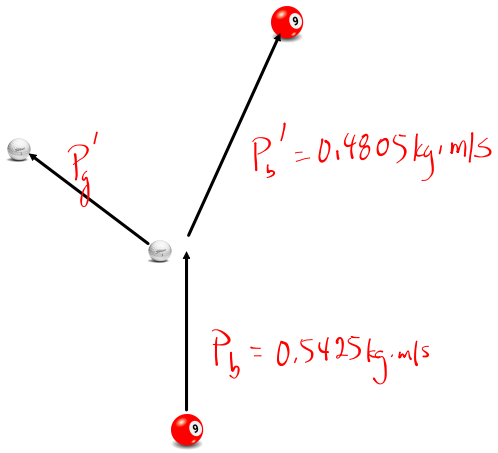
The velocity of the golf ball after the collision will be:

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

MP|505

$m_b = 0.155 kg$

$m_g = 0.052 kg$



Method 2

Momentum Vector Addition Diagram

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

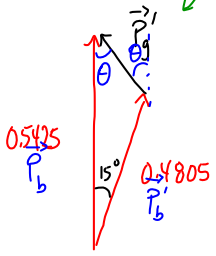
$$\vec{P}_{total} = \vec{P}'_{total}$$

$$\vec{P}_b + \vec{P}_g^{\,0} = \vec{P}_b' + \vec{P}_g'$$

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

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

Vector Addition Diagram



Using the law of Cosines:

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

$$c^2 = (0.5425)^2 + (0.4805)^2 - 2(0.5425)(0.4805)\cos 15^\circ$$

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

Using the Law of Sines:

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

$$\frac{0.147}{\sin 15^\circ} = \frac{0.4805}{\sin \theta}$$

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

$\theta = 58^\circ$

$$p = mv$$

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

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

$v = 2.8 \ m/s$

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

TO DO: PP|509