§10-4 Collisions in 2D

Recall: momentum $\vec{p} = m\vec{v}$

Conservation of momentum $\vec{P}_{total} = \vec{P}'_{total}$ (before) (after)

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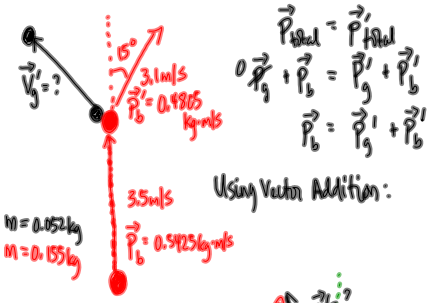
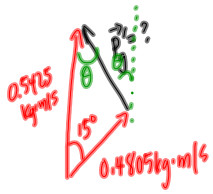


$\vec{P}_{total} = \vec{P}'_{total}$

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

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

Using Vector Addition:



Law of Cosines:

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

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

$c = 0.1470$ kg·m/s

$v = \dfrac{0.1470 \text{ kg·m/s}}{0.052 \text{ kg}}$

$\boxed{v = 2.8 \text{ m/s}}$

To find the direction: use Law of Sines:

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

$\dfrac{0.4805 \text{ kg·m/s}}{\sin\theta} = \dfrac{0.147 \text{ kg·m/s}}{\sin 15°}$

$\boxed{\theta = 58°}$

The velocity of the golf ball after the collision is 2.8 m/s [58° CCW from the orig dir of the bill ball]

Alternative Solution (x-y chart before + After)

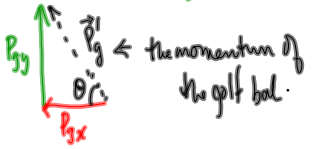
BEFORE:

	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	P_{gx}	P_{gy}
P_b	0.4805 sin 15	0.4805 cos 15°
P_{total}	0	0.5425 kg·m/s

same same



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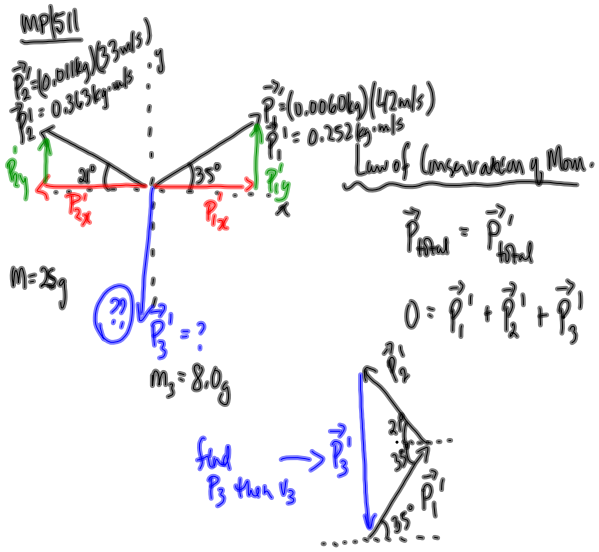


Law of Conservation of Mom.

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

$0 = \vec{p}_1' + \vec{p}_2' + \vec{p}_3'$

Using an x-y chart

BEFORE: $\vec{p}_{total} = 0$

$\therefore \vec{p}_{x\,total} = 0$

$\vec{p}_{y\,total} = 0$

	x	y
p_1'	$0.252\cos 35°$	$0.252\sin 35°$
p_2'	$-0.363\cos 21°$	$0.363\sin 21°$
p_3'	p_{3x}'	p_{3y}'
p'_{total}	0	0

Along x-axis:

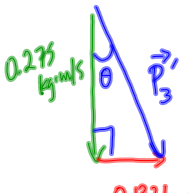
$0.252\cos 35° - 0.363\cos 21° + p_{3x}' = 0$

$p_{3x}' = 0.132 kg\cdot m/s$

Along y-axis:

$0.252\sin 35° + 0.363\sin 21° + p_{3y}' = 0$

$p_{3y}' = -0.275 kg\cdot m/s$



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

$c^2 = 0.132^2 + 0.275^2$

$c = 0.305 kg\cdot m/s$

$\tan\theta = \frac{0.132}{0.275}$

$\theta = 25.6°$

$\vec{p}_3' = 0.30 kg\cdot m/s$ [26° ccw from -y axis]

$\vec{v}_3' = \frac{0.30 kg\cdot m/s}{0.0080 kg}$ [26° ccw from neg y-axis]

FINALLY! → $\vec{v}_3' = 38 m/s$ [26° ccw from neg y-axis]

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